Springer Proceedings in Business and Economics

Nicholas Tsounis
Aspasia Vlachvei *Editors*

Advances in Time Series Data Methods in Applied Economic Research

International Conference on Applied Economics (ICOAE) 2018

Springer

Springer Proceedings in Business and Economics

More information about this series at http://www.springer.com/series/11960

Nicholas Tsounis · Aspasia Vlachvei
Editors

Advances in Time Series Data Methods in Applied Economic Research

International Conference on Applied Economics (ICOAE) 2018

Springer

Editors
Nicholas Tsounis
Department of International Trade
Western Macedonia University
of Applied Sciences
Kastoria, Greece

Aspasia Vlachvei
Department of International Trade
Western Macedonia University
of Applied Sciences
Kastoria, Greece

ISSN 2198-7246 ISSN 2198-7254 (electronic)
Springer Proceedings in Business and Economics
ISBN 978-3-030-02193-1 ISBN 978-3-030-02194-8 (eBook)
https://doi.org/10.1007/978-3-030-02194-8

Library of Congress Control Number: 2018957635

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This year conference is co-organised by the Department of Business Economics of the SGH Warsaw School of Economics and the Department of International Trade at Kastoria of the Western Macedonia University of Applied Sciences, Greece, after the kind invitation by Prof. Prokop, Vice Rector for International Relations, Head of Department of Business Economics who is also a co-chair of the conference.

The aim of the conference is to bring together economists from different fields of Applied Economic Research in order to share methods and ideas.

The topics covered include:

- Applied Macroeconomics
- Applied International Economics
- Applied Microeconomics Including Industrial Organisations
- Applied Work on International Trade Theory Including European Integration
- Applied Financial Economics
- Applied Agricultural Economics
- Applied Labour and Demographic Economics
- Applied Health Economics
- Applied Education Economic

All papers presented in ICOAE 2018 and published in the conference proceedings were peer reviewed by anonymous referees. In total, 71 works were submitted from 25 countries, while 58 papers were accepted for presentation and publication in the conference proceedings. **The acceptance rate for ICOAE 2018 was 78%**.

The organisers of ICOAE 2018 would like to thank:

- The Scientific Committee of the conference for their help and their important support for carrying out the tremendous work load organising and synchronising the peer-reviewing process of the submitted papers in a very specific short period of time.

- The anonymous reviewers for accepting to referee submitted to the conference papers and submit their reviews on time for the finalisation of the conference programme.
- Prof. Jacek Prokop, for accepting to host the conference at **SGH Warsaw School of Economics** and provide the required resources.
- Special thanks are due to Dr. Łukasz Skrok for taking care every little detail for the successful organisation of the conference.
- The local organising committee and the volunteering students of the **SGH Warsaw School of Economics** for their help for the success of the conference.
- Mr. Gerassimos Bertsatos for running the reception desk of the conference.

Kastoria, Greece

Nicholas Tsounis
Aspasia Vlachvei

Contents

Contributors

Spyridon Adam Department of Electrical and Electronics Engineering Educators, School of Pedagogical and Technological Education (ASPETE), Neo Heraklion, Greece

I. Antoniadis Department of Business Administration, Western Macedonia University of Applied Sciences, Kozani, Greece

Mikko Apiola University of Turku, Turku, Finland

Yakup Arı Alanya Alaaddin Keykubat University, Alanya, Turkey

Ewa Baranowska-Prokop SGH Warsaw School of Economics, Institute of International Management and Marketing, Warsaw, Poland

Doha Belimam Laboratory of Industrial and Computer Engineering, National School of Applied Sciences, Ibn Zohr University, Agadir, Morocco

Angela Besana IULM University, Milan, Italy

I. Botha Department of Accountancy, University of Johannesburg, Johannesburg, South Africa

Heloisa Lee Burnquist ESALQ/USP, Piracicaba, Brazil

Lenka Chorvatovičová Bratislava, Slovakia

Cinthia Cabral da Costa Embrapa Instrumentation, São Carlos, Brazil

Moammar Dayoub University of Turku, Turku, Finland

Mafalda Venâncio de Vasconcelos University of Turin, Turin, Italy

M. C. de Wet Department of Accountancy, University of Johannesburg, Johannesburg, South Africa

Sophia Dimelis Department of Informatics, Athens University of Economics and Business, Athens, Greece

Gabriela Dováľová Institute of Economic Research SAS, Bratislava, Slovakia

Chaido Dritsaki Department of Accounting and Finance, Western Macedonia University of Applied Sciences, Koila, Kozani, Greece

Nikolaos Dritsakis University of Macedonia, Thessaloniki, Greece

Annamaria Esposito IULM University, Milan, Italy

Ioannis Giotopoulos Department of Economics, University of Peloponnese, Peloponnese, Greece

Evita Grigoriou West Macedonia University of Applied Sciences, Kozani, Greece

Joaquim J. M. Guilhoto Organisation for Economic Co-operation and Development (OECD), Paris, France

Supandi Halim Faculty of Defense Management, Indonesia Defense University, Bogor, Indonesia

Jaakko Helminen University of Turku, Turku, Finland

Boris Hošoff Institute of Economic Research SAS, Bratislava, Slovakia

Pawel Jamroz University of Bialystok, Bialystok, Poland

Adam Karbowski Department of Business Economics, Warsaw School of Economics, Warsaw, Poland

Dimitrios Kartsonakis Mademlis University of Macedonia, Thessaloniki, Greece

Smita Kashiramka Department of Management Studies, Indian Institute of Technology Delhi, Delhi, India

S. Kontsas Department of Business Administration, Western Macedonia University of Applied Sciences, Grevena, Greece

Stephanie Krezel Centre of Supply Chain and Logistics, Deakin University, Melbourne, Australia

Ghizlane Lakhnati Laboratory of Industrial and Computer Engineering, National School of Applied Sciences, Ibn Zohr University, Agadir, Morocco

Corlise L. Le Roux University of Johannesburg, Johannesburg, South Africa

Helen Louri Department of Economics, Athens University of Economics and Business, Athens, Greece; London School of Economics, EI/HO, London, UK

Muhammad Kashif Majeed Liaoning Technical University, Fuxin, People's Republic of China

Elzbieta Majewska University of Bialystok, Bialystok, Poland

Katarina Frajtova Michalikova Faculty of Operation and Economics of Transport and Communication, Department of Economics, University of Zilina, Zilina, Slovakia

Loukas Pol. Michalis Department of Electrical and Electronics Engineering Educators, School of Pedagogical and Technological Education (ASPETE), Neo Heraklion, Greece

Muhammad Mohsin College of Business Administration, Liaoning Technical University, Xingcheng, China

Homa Monfared Research Assistant of Monetary and Banking Research Institute, Central Bank of Iran, Tehran, Iran

Marcos V. N. Montes Federal University of Espírito Santo, Vitória, Brazil

Ricardo Ramalhete Moreira Federal University of Espírito Santo, Vitória, Brazil

Argiro Moudatsou TEI of Crete, University of Applied Sciences, Heraklion, Greece

Michal Mursztyn Bialystok University of Technology, Bialystok, Poland

Ville Myllynpää University of Turku, Turku, Finland

Li Naiwen College of Business Administration, Liaoning Technical University, Xingcheng, China

Sobia Naseem Liaoning Technical University, Fuxin, People's Republic of China

Fatemeh Noorbakhsh Research Assistant of Monetary and Banking Research Institute, Central Bank of Iran, Tehran, Iran

Ourania Notta Department of Agricultural Technology (Agricultural Economics Program), Alexander Technological Institute of Thessaloniki, Thessaloniki, Greece

Niël Oberholzer Department of Finance and Investment Management, University of Johannesburg, Johannesburg, South Africa

Amarulla Octavian Faculty of Defense Management, Indonesia Defense University, Bogor, Indonesia

Joanna Olbrys Bialystok University of Technology, Bialystok, Poland

Martina Paliderova Faculty of Operation and Economics of Transport and Communication, Department of Economics, University of Zilina, Zilina, Slovakia

Spiros Panetsos Department of Electrical and Electronics Engineering Educators, School of Pedagogical and Technological Education (ASPETE), Neo Heraklion, Greece

Mário Papík Bratislava, Slovakia

Nicolas Pope University of Turku, Turku, Finland

Tomáš Pražák School of Business Administration in Karvina, Silesian University in Opava, Karvina, Czech Republic

Jacek Prokop Department of Business Economics, Warsaw School of Economics, Warsaw, Poland

Muhammad Fikruzzaman Rahawarin Faculty of Defense Management, Indonesia Defense University, Bogor, Indonesia

Nino Rukhaia-Mosemgvdlishvili David Agmashenebeli National Defence Academy of Georgia, Gori, Georgia

Bruno G. Rüttimann Inspire AG/ETH, Zürich, Switzerland

N. Sariannidis Department of Accounting and Finance, Western Macedonia University of Applied Sciences, Kozani, Greece

Markéta Šeligová Department of Finance and Accounting, School of Business Administration, Silesian University, Karviná, Czech Republic

Mahshid Shahchera Assistance of Monetary and Banking Research Institute, Central Bank of Iran, Tehran, Iran

Imlak Shaikh Management Development Institute, Gurgaon, Haryana, India

Tomasz Sikora SGH Warsaw School of Economics, Institute of International Management and Marketing, Warsaw, Poland

Pavlos Stamatiou Department of Accounting and Finance, Western Macedonia University of Applied Sciences, Koila, Kozani, Greece

Erika Stracová University of Economics in Bratislava, Bratislava, Slovakia

Erkki Sutinen University of Turku, Turku, Finland

Nisha Mary Thomas Department of Management Studies, Indian Institute of Technology Delhi, Delhi, India

Martina Treu IULM University, Milan, Italy

Aspasia Vlachvei Department of International Trade, Western Macedonia University of Applied Sciences, Kastoria, Greece

Elrida Vos Department of Finance and Investment Management, University of Johannesburg, Johannesburg, South Africa

Tomi Westerlund University of Turku, Turku, Finland

Georgios Xanthos TEI of Crete, University of Applied Sciences, Heraklion, Greece

Surendra Singh Yadav Department of Management Studies, Indian Institute of Technology Delhi, Delhi, India

Chapter 1
An Analysis of the Status of CSR Practice in the South African Business Context: A Framework for Analysis

Elrida Vos and Niël Oberholzer

Abstract South African organisations often focus on financial targets instead of building relationships with stakeholders in their operating environments (Verwey and Muir in Communication and media ethics in South Africa. JUTA & Company, Cape Town, pp. 210–229, 2011: 212). The political, economic and socio-economic circumstances within the country and increased demands from different stakeholders with their own specific interests, have created an unpredictable and volatile environment in which organisations have to function (Nasrullah and Rahim in CSR, sustainability, ethics & governance. Springer, Cham, 2014: 41). This volatility, along with mounting social pressure, means that no organisation can function in isolation. Implementing Corporate Social Responsibility (CSR) activities only for reputational benefit results in a "check-the-box" approach to CSR which is unsustainable over time. In order to address the unsustainable nature of CSR practices in South Africa, this paper proposes an adaptation of the DNA of CSR 2.0 model previously developed by Visser (CSR 2.0 transforming corporate sustainability and responsibility. Springer, London, 2014: 1). Limitations are addressed with regard to the South African business context, and recommendations are made to address the remaining limitations of this model.

Keywords Corporate social responsibility (CSR) · Sustainability Stakeholders · Socio economic conditions

E. Vos (✉) · N. Oberholzer
Department of Finance and Investment Management, University of Johannesburg, Johannesburg, South Africa
e-mail: elrida.vos@gmail.com

N. Oberholzer
e-mail: nielo@uj.ac.za

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_1

1.1 Defining the Problem

Corporate Social Responsibility (CSR) is often seen as a duty by South African based organisations and not necessarily a responsibility. This compliance approach has its origins in the Companies Act No. 71 of 2008, which references Corporate Social Responsibility, and which provides guidelines for conducting CSR activities in organisations. CSR principles are summarised in the King Reports. Although the principles set out in the King Reports are not legally binding, South African organisations do try and align their CSR initiatives according to the principles outlined because of the moral obligations and reputational benefits, and in this respect these principles guide CSR practice in South African organisations.

The application of CSR initiatives based on a legal obligation results in a "check-the-box" approach to implementing CSR activities. Consequently, CSR activities in the long run become unsustainable, short term and ineffective.

In addition, CSR activities suppose a moral obligation on South African organisations. According to Hurn (2008: 348) business ethics can be defined as a process where moral and ethical considerations are applied within a business setting. Verwey and Muir (2011: 212) argue that organisations often only focus on financial targets, instead of also focusing on building and maintaining relationships with those with whom the business interacts on a frequent basis. Verwey and Muir (2011: 215) argue that businesses should undertake a strategy that pursues sustainable development in addition to a profit or financial motive since it will benefit all organisational stakeholders over the long term. Bosman and Buys (2010: 10) describe the foundation of sustainability as ethical decision making. They also argue that without sustainable development, organisations will not have a long term future (Bosman and Buys 2010: 10).

The political, economic and socio-economic circumstances within the country, as well as increased demands of different stakeholders' and their interests, have created an unpredictable and volatile environment in which organisations must function (Nasrullah and Rahim 2014: 41). Organisations can no longer operate in isolation. From a public perspective their actions are visible and continuously critiqued by the stakeholders, especially since these actions, values, and events are highly publicised on social media platforms and other media channels.

The necessity of protecting brand image and reputation has also driven a need to integrate CSR activities for businesses (Nasrullah and Rahim 2014: 41). However, initiating and implementing CSR activities only for brand and reputational benefit worsens the effects of the "check-the-box" approach. Ethical corporate branding is further emphasized by the consumer (Verwey and Muir 2011: 217). Consumers are very aware of the moral behaviour of the brands they buy which in turn affects their buying decisions. Stakeholders now choose the organisation and not the other way around. Consumers, now more than ever react to brands based on their feelings toward the organisation (Verwey and Muir 2011: 217).

Social fragmentation is observed in economies, politics, organisations and the world at large (Holman 2010: 1158). Change means systems need to adapt, however, dealing with these breakdowns is difficult and time consuming (Holman 2010: 1159). As soon as disruption occurs, systems fail and complexities arise. Renewal is therefore, crucial to any organisation or society.

Technological advancement manifests in society and it creates complexity that forces society to adapt (Verwey 2001: 82). Fukuyuma in Verwey (2001: 82) emphasises that human nature becomes disconnected and declines as social disorder increases and trust becomes an issue. These changes further result in job displacement, changes in values, and disintermediation. Furthermore, changes in world views, as organisations become increasingly decentralised and information becomes readily available to large audiences, becomes apparent (Verwey 2001: 84).

In a country where social pressures erupt in the form of student uprisings, anti-rape protests, corruption and socio-economic inequalities, there is a genuine societal thirst for legitimate and trustworthy actions from both State and private enterprises. Social legitimacy is a formative process, where socially and culturally driven pressures in environments are addressed which is then perpetuated as a belief or behaviour referred to as a norm or standard (Dowling and Pfeffer 1975: 112). Social legitimacy therefore greatly depends on context for its conception and its ascribed meaning (Dowling and Pfeffer 1975: 112). A disconnect between the intentions of organisations' CSR initiatives and the impact of these initiatives exist as organisations' initiatives are often unsustainable and short term oriented. A great need for legitimacy in a South African context is found with business interactions especially when it comes to CSR.

Dash (2005) clearly delineates the merit postmodernism embodied in understanding complex contexts shifts from a modernist and post-modernist approaches in science, is evident in the corporate reality (Overton-de Klerk and Verwey 2013: 370). Collaboration between different fields of research should, therefore, be used to develop and ensure the effectiveness of the development of paradigms and social sciences in the broader scheme.

1.2 CSR Defined

According to Visser (2014: 1) CSR can be defined as the way in which an organisation can create shared value within a society on a continuous basis by using different types of methods that includes economic development and good governance. Abdulai (2015: 432) defines CSR as "the case where companies regard as their home, the countries in which they operate". Acting responsibly which involves addressing social, environmental and economic impacts of operations is important, as is how well internal stakeholders are dealt with (Abdulai 2015: 431).

According to Munro (2013: 60) there is a lack in consensus with regards to the definition of CSR. This is partly because of the broad nature of CSR, as well as its intangibility (Munro 2013: 60). CSR is difficult to define because of its contextual nature since an organisation is influenced by the external environment within which the organisation operates as well as its internal environment.

According to Fasset (2012: 3) CSR is interpreted differently by different organisations. Organisations will often base their CSR activities on their own business requirements and based on the size of the organisation, they will often measure or evaluate these initiatives through the allocation of the company budget. When this occurs, organisations will refer to their CSR initiatives as Corporate Social Investment (CSI). Simply put CSR can be defined as the responsibility of Business towards the society (Fasset 2012: 4).

Based on the above mentioned definitions one can conclude the following:

- Stakeholders expect organisations to conduct their business ethically on a continuous basis;
- An organisation should contribute to economic development;
- Organisations should focus on the improvement of the quality of life of society at large, employees, shareholders, and the environment.

This emphasises the notion that organisations cannot exist in isolation and CSR is part of all organisational activities.

1.2.1 The International View of CSR

In Nasrullah and Rahim (2014: 41) CSR activities are driven internationally by the need to protect brand image and reputation. NGOs and intergovernmental initiatives also adopt to international voluntary codes to conduct business. Locally, organisations are forced to take into account CSR initiatives because of increased stakeholder needs and demands. Relationships consist of antecedents that are change drivers that include many stakeholders and publics (Ströh 2007: 125). These relationships have different outcomes and different strategies to manage them.

Technological advancement has heightened competition in a global sense (Zerfass and Huck 2007: 107). The need for a global economy has increased globalisation, with new markets being created across the world, forcing organisations and societies to become more innovative in order to keep up with the fast paced changes in society (Zerfass and Huck 2007: 108).

Technological connectivity has increased the speed of communication and it has reduced the costs of communication and bandwidth (Verwey 2001: 76). As connectivity increases organisations are forced to adapt and grow at a faster pace (Verwey 2001: 80).

Freedom of choice within individuals and organisations increases, but so does responsibility (Verwey 2001: 83). Although technological advancement spurs an individualistic culture, people want a sense of community (Verwey 2001: 83). It will thus require collaboration between communities and organisations to ensure sustainability. The information age creates fewer hierarchies as direct communication channels become easily accessible (Verwey 2001: 83). Technological advancement has a significant effect on organisations and society since it blurs boundaries, and connects people. This does, however, make it difficult for an organisation to maintain social order (Verwey 2001: 85).

Globally these trends drive CSR initiatives to become part of the organisations' daily practices and business models.

1.2.1.1 The King IV Report

The King IV Report (2016: 1) was drafted based on the knowledge that organisations are faced with a dynamic and volatile business environment. Therefore, leadership and corporate governance have become crucial. The objectives of King IV include promoting good governance in order to run a business that will deliver benefits such as (i) an ethical organisational culture; (ii) enhance performance and value creation of the organisation; (iii) enable the governing body to exercise adequate control and (iv) build and protect trust in the organisation as well as its reputation and legitimacy. South African organisations often align their CSR needs with the King Reports as a guideline to abide by.

1.2.2 CSR in South Africa

The African continent is faced with various challenges ranging from poverty, inequality and inadequate health care as well as poor education, HIV/AIDS and poor governance standards (Nasrullah and Rahim 2014: 41). Within Africa and South Africa CSR practices seem to be modelled for local issues such as poverty alleviation, the fight against HIV/AIDS and health and safety of mine workers in particular. According to Mersham and Skinner (2008: 240) a new partnership between government and businesses has come into play that works towards the socio-economic reconstruction and development of communities.

Abdulai (2015: 431) notes that the African continent has tended to regard CSR initiatives as charity or philanthrophy. Abdulai (2015: 431) suggests that CSR initiatives require more than funding to a build a school or supply water to communities, and that operational costs should be considered. Abdulai (2015: 431) suggests that CSR in Africa should operate in win-win environments that bring about change in communities.

Fighting poverty and improving sustainable development has become a global initiative as many countries have adopted Millennium Development Goals, and have developed frameworks to fight poverty and improve sustainability (Mersham and Skinner 2008: 239). In an African context, the new Partnership for African Development and the African Peer Review Mechanism provide African countries with forums and frameworks to implement CSR initiatives (Mersham and Skinner 2008: 239).

In 1977, the Sullivan Principles were drafted by Reverend Sullivan in order to let US organisations treat their African employees the same as their own employees in the Apartheid era in South Africa. These principles laid out labour rights that included the development of training programmes and promotion of African people to managerial positions (Nasrullah and Rahim 2014: 41). This created a set of CSR practices by African companies. However, since the adoption of the Sullivan Principles, the context in which organisations operate in South Africa, has changed dramatically. With the end of the Apartheid regime, specific attention has been cast toward addressing all socio-economic issues such as unemployment, community upliftment and poverty alleviation through the contribution and involvement of organisations (Overton-de Klerk and Oelofse 2010: 388). The practice of *Ubuntu* can be seen to be reflected in these activities (West 2014: 8).

The Broad Based Black Economic Empowerment Act (BBBEE) has ensured that BBBEE is part of organisations' daily agendas. The inclusion of CSI initiatives in codes stemming from the act, has led to a set of new priorities for organisations to follow within their CSI programmes (Mersham and Skinner 2008: 245). Broad Based Black Economic Empowerment is thus part of the South African context of CSI (Mersham and Skinner 2008: 245). In South Africa, CSR initiatives are not specifically legislated but many frameworks exist that govern CSR related issues. Some of these include the Broad Based Black Economic Empowerment Act, the Mine Health and Safety Act, the National Water Act, and the Skills Development Act.

HIV/AIDS has proven to be a great challenge in African life (Overton-de Klerk and Verwey 2013: 401). In South Africa, organisations like Eskom and Anglo Coal have initiated HIV prevention measures in the work place and broader community. Through the promotion of HIV/AIDS education and policies organisations have tried to protect their workers and families.

In 2002, the Johannesburg Stock Exchange required all listed organisations to abide by a code of conduct that specified that organisations had to disclose integrated sustainability reports. Since 1992, South Africa has formed more than 20 Social Responsible Investment funds (SRI) that regard organisations' social, environmental, and ethical performances.

As Mersham and Skinner (2008: 246) note, CSR initiatives within a South African context are often seen as CSI initiatives in which two example indicators have been identified—charity and corporate philanthropy. Charity refers to the short term and immediate effects or relief organisations can give to communities or stakeholders in need. These include donations and short term solutions to problems. The short term nature of these donations are however, often not sufficient and longer term solutions are required. Corporate philanthropy is a long term form of social investment which focuses on the bigger picture. It is also more strategic in nature. Both these forms of CSI should be considered by organisation.

Unemployment, poverty, and environmental sustainability have become important considerations for the manner in which businesses operate. Doing business in a democratic society has shed light on the need for dialogue within society at large (Spicer 2000: 127). Spicer (2000: 129) suggests that the organisation is assisted by strategic communication practitioners to ensure equal access to processes and equal participation to set ground rules as this will show goodwill

(*Ubuntu*) to communities if they feel that they are fairly treated. In order for a democratic country to grow, strategic approaches through communication should be adopted to facilitate problem-solving conversations.

For a South African context the practice and embracement of *Ubuntu* should be practiced in CSR initiatives. The Nguni word *Ubuntu* means "I am what I am because of who we are". According to Abdulai (2015: 433) *Ubuntu* refers to African humanism that states that no one and nothing lives in isolation. In essence, it is being a human being. Organisations should also realise that they cannot exist in isolation. South African businesses thrive when they focus on the well-being of communities and the people in which they operate. For a South African context, *Ubuntu* should be at the core of the DNA of CSR.

From an ethical perspective, many issues in South Africa seem to start with uncomfortable conversations. Spicer (2000: 129) insists that these uncomfortable conversations should be encouraged by organisations in order to establish trust within organisational and societal contexts. Ethical guidelines such as building trust, listening and acting according to corporate social responsiveness have become increasingly important since socio-economic factors rule both business and society (Overton-de Klerk and Oelofse 2010: 388).

In a study conducted by Overton-de Klerk and Oelofse (2010: 405) the role of communication in stakeholder activities have become crucial since involvement of communities in the development of initiatives and outreach projects is important in order to build trust. Involvement of employees, listening and having all stakeholders participate in the development of communication programmes is important for the overall sustainability of the organisation.

In order for the organisation to act responsibly within society, the organisation should become "one" with society by opening up its communication channels to its stakeholders, involving stakeholders in organisational processes. Reciprocal relationships are a necessary goal for operating ethically within a South African context. Being transparent is not enough as shown in research. Organisations are forced to become responsive and move away from a profit and maximised productivity mind set.

1.3 Finding a Framework

Reports and legislative regulations like the Companies Act No. 71 of 2008 and the King Reports, together with some indices in South Africa to a certain extent, governs South African CSR principles and initiatives as already mentioned. CSR in South Africa can be attributed to the establishment of the South African Social Investment Exchange (SASIX) (Mersham and Skinner 2008: 246). The goal of SASIX is to match organisations who want to donate funding with high-performance development projects. The JSE launched the Social Responsible Index (SRI) in 2004 to provide a measurement of triple bottom line reporting and performance by organisations (Mersham and Skinner 2008: 246). Although these indices, Acts and reports offer organisations guidelines from which to abide by, these models do not always seem integrated and sustainable. A need for a hybrid model or framework from which to measure and analyse CSR initiatives in South Africa is required.

1.3.1 The DNA of CSR 2.0

The failure and shortcomings of the implementation of most CSR initiatives by organisations, both nationally and internationally, led to the development of a new approach by Visser (2014: 1) labelled "Transformative CSR" or CSR 2.0. Based on Visser's (2014: 1) definition of CSR, CSR 2.0 is built on the premise of what is known as the DNA of CSR. The concept of the DNA of CSR 2.0 is the same as the four biological basis of DNA, however, in the case of the DNA of CSR 2.0, the strands of DNA (or responsibility bases) are Value Creation, Good Governance, Societal Contribution and Environmental Integrity (Visser 2014: 3). The major drawback of this model is the lack of recognising unique South African factors and occurrences within the South African economic, socio-economic- and political environment because CSR 2.0 is based on global best practice. Particular pressures are aimed at achieving partnerships between government and organisations that strive towards the socio-economic reconstruction and development of communities. Given this limitation, the researcher has expanded Visser's (2014: 1) model to include DNA strands that are unique to the South African context of CSR practice.

1.3.1.1 Application of Visser's (2014: 1) Model to the South African Context

In this section Visser's (2014: 1) model is applied to the South African CSR context:

- Value Creation

Value creation refers to CSR initiatives within an organisation that generates financial or intrinsic value to the organisation. Its strategic goal is economic development (Visser 2014: 3). This DNA base is expanded with an additional example indicator—Triple Bottom Line measurement (refer to Table 1.1). This will evaluate whether an organisation's financial reports include reporting on people, profit and planet. If the organisation aligns itself with the King report or similar social responsibility reporting standards, it will have complied with the fourth example indicator, environmental integrity. Sustainability reporting and development of the organisation business model to one where strategic goals emphasises people, planet, and profit is key as the organisation would be acting responsively and recognising that the organisation cannot operate in isolation.

Table 1.1 The DNA of CSR 2.0 a framework for a South African context

DNA Base	Strategic Goals	Example Indicators	Description
Value Creation	Economic Development	Capital Investment	Economic, social, human, natural capital
		Beneficial Products	Sustainable and responsible G & S
		Inclusive Business	Wealth distribution, bottom of pyramid markets
		Triple bottom line measurement	Alignment to reporting to people, planet and profit
Governance	Institutional Effectiveness	Leadership	Strategic commitment to sustainability and responsibility
		Transparency	Sustainable and Responsible Reporting, Government payments
		Ethical Practices	Bribery & Corruption prevention, business values
		BBBEE	Broad Based Black Economic Empowerment
		Good corporate citizenship	Compliance with legislation, regulation and ethical conduct
		Government Partnerships	Government and Private sector partnerships
		Anti-Corruption	Code of conduct, awareness campaigns
Societal Contribution	Stakeholder Orientation	Social Investment	Charitable donations, philanthropy, provision of public G&S
		Fair Labour Practices	Working conditions, rights, health & safety
		Supply Chain Integrity	SME Empowerment, labour & environmental Standards
		Community Upliftment	Communication with and from communities, involvement and projects
		HIV/AIDS	Awareness and combatting
		Skills development and training	Training, education and skills development of stakeholders
Environmental Integrity	Sustainable Ecosystems	Ecosystem Protection	Biodiversity conservation & Ecosystem restoration
		Renewable Resources	Renewable Energy Materials
		Zero Waste Production	Cradle-to-cradle processes, waste elimination
		Climate Change	Reduction in carbon footprint
UBUNTU	Responsiveness	Involvement	Organisation acts with stakeholders with stakeholder in mind not in isolation
		Leadership	Bottom up communication, CEO influence, inclusion of stakeholders in decisions, open communication, otherness, listening

Expanded DNA strands are indicated in grey

- Good Governance

According to Visser (2014: 3) good governance's goal is to achieve institutional effectiveness. This DNA strand shows that companies that adopt the CSR 2.0 initiative will have to ensure their businesses are aimed at achieving sustainability and responsibility (refer to Table 1.1). For the DNA base governance to reach its strategic goal of institutional effectiveness, four extra example indicators will be added. These include Broad Based Black Economic Empowerment through black ownership and development of black employees (BBBEE), good corporate citizenship, government partnerships and anti-corruption initiatives. Good corporate citizenship includes compliance with socio-economic, constitutional legislation and regulation as well as compliance with an ethics code. Government partnerships will evaluate whether the government and private sector work together to relieve social pressures. Finally, anti-corruption will evaluate whether organisations were effectively fighting corruption through initiatives, planning, awareness creation and leadership.

- Societal Contribution

The main strategic goal of societal contribution is to ensure a stakeholder orientation. In order to achieve a stakeholder oriented strategic goal, the DNA base will be expanded with three example indicators and the philanthropy example indicator is adapted to one of Social Investment which includes charitable donations and philanthropy (refer to Table 1.1). Community upliftment projects include involvement in schooling projects, housing initiatives, feeding schemes and similar outreaches by organisations in order to assist the socio economic conditions in the communities. HIV/Aids awareness campaigns include educating communities, employees and children about HIV/Aids. It also includes projects to fight against HIV/Aids that encompass treatment related campaigns.

Skills Development and Training are extremely important for a South African context, this example indicator will include training initiatives of employees (refer to Table 1.1). Creating projects that offer communities the chance to receive training and education will indicate a narrowing in the gap between the organisation and the community. It will also assist with the development of better socio-economic circumstances that offers organisations the chance to build trustworthy relationships with the community. This is important for self-value, unemployment and productivity.

- Environmental Integrity

The last of the four DNA strands considers the achievement of sustainable ecosystems (Visser 2014: 3). A fourth example indicator required for effective achievement of sustainable ecosystems. Although South African practices at this stage do not offer much to combat climate change, reducing carbon footprint is a reality for most organisations and a goal these organisations work towards. Refer to Table 1.1.

- ***Ubuntu***

A fifth DNA base for the South African context is added, *Ubuntu* (refer to Table 1.1). *Ubuntu* can be practised in all CSR and normal business activities and is a crucial South African value. The practice of *Ubuntu* emphasises that an organisation cannot operate in isolation. Working towards the greater good and focusing on the people (all of the organisation's stakeholders) is more important than focusing on the profit. *Ubuntu* is a core DNA base of CSR in South Africa and can be measured through the involvement of the organisation in its communities, and the leadership roles it fulfils, its transparency and use of bottom-up communication channels to listen to its stakeholders. *Ubuntu* enables organisations to respond with empathy to the situations' of others and to consider others in its decision making.

1.4 Limitations

This model offers a hybrid perspective of the aspects and activities that should be in place in order for an organisation to act responsively and to manage CSR sustainably. There are however, still limitations as regards to the usefulness of the framework. Although it will assist an organisation to define the gaps in their CSR initiatives there are still no measures of CSR identified. As such it remains a normative type of framework which does not necessarily inspire organisations to implement CSR initiatives from a strategic perspective, such as their purpose for being.

It is important to recognise that the framework is also not industry specific. Different industries in South Africa have different organisational values, size, objectives, legal requirements and goals. Therefore, this framework, although it is a hybrid framework will not necessarily provide industry specific guidance. The approach to measuring CSR initiatives is also not defined. A top-down analysis is an approach that is preferred in the financial sector where one investigates the "big picture" (Baker and Wurgler 2007: 130). The analysis is then narrowed down to smaller components or companies that operate within the greater environment to determine the effect the greater environment has on the organisation In bottom-up analysis the focus is company specific and disregards the industry or larger economic environment. This analysis assumes that despite the overall context, it is possible for companies to perform well (Baker and Wurgler 2007: 130).

Further investigation into the level of measurement should be directed at determining how to measure the efficiency of these DNA indicators, and to determine the extent to which they contribute to organisational purpose. Measures could be compared to industry levels to provide indicators of CSR performance. Measurement could also consist of either a qualitative value that is coded to become a quantitative measurement, or could consist of only quantitative indicators, or a combination of both. The proposed measures could be used to develop a rating system in the CSR context that is similar to credit agency ratings or scores such as, AAA-status to Junk status.

The DNA indicators identified for a South African context constitute a framework of what ought to be included for successful CSR practices. However, this approach will not be effective if organisations only follow a "check-the-box" approach which lists activities against each DNA base.

1.5 Conclusion

With the end of the Apartheid regime, specific emphasis has been placed on socially responsive behaviour of organisations in the South African business context. However, many South African organisations follow a "check-the-box" approach towards CSR initiatives. Within the South African context, there is mounting pressure to build reciprocal two-way relationships and sustainable partnerships with all stakeholders. Unique South African pressures also include government partnerships and transformation in which Black Economic Empowerment has had a game changing influence.

The impact of these global and local changes, and drivers have necessitated the South African business environment to adopt a strategic intent and purposefulness when it comes to CSR activities. The purpose of this paper was to develop a theoretical framework of DNA strands which need to be considered for effective and sustainable CSR practices in South African context. The framework was adapted from Visser's (2014: 1) original model of the DNA of CSR 2.0 to fit a South African business context. Although the framework does provide an inclusive framework for CSR practices in South Africa, it does not as yet address the issue of CSR measurement.

References

Abdulai, D. (2015). From charity to mutual benefit: A new and sustainable look at CSR in Africa. In *New perspectives on corporate social responsibility* (pp. 427–442).

Baker, M., & Wurgler, J. (2007). Investor sentiment in the stock market. *Journal of Economic Perspectives, 21*(2), 129–151.

Bosman, P., & Buys, P. (2010). *The ethics of corporate sustainability* (pp. 9–12). Autumn: Word and Action.

Dash, N. K. (2005). *Selection of the research paradigm and research methodology* [Online]. Available from: http://www.celt.mmu.ac.uk/researchmethods/Modules/Selection_of_methodology/. Accessed August 22, 2016.

Dowling, J., & Pfeffer, J. (1975). Organizational legitimacy: Social values and organizational behavior. *The Pacific Sociological Review, 18*(1), 122–136.

Fasset (Finance and Accounting Services Sector Education and Training Authority). (2012). *Corporate social responsibility course handbook*. Johannesburg: Fasset.

Holman, P. (2010). *Engaging emergence. Turning upheaval into opportunity*. San Francisco: Berrett-Koehler Publishers.

Hurn, B. J. (2008). Ethics in international business. *Industrial and Commercial Training, 40*(7), 347–355.

King, M. E. (2016). *Draft King IV Report on corporate governance for South Africa 2016*. Institute of Directors South Africa (unpublished).

Mersham, G., & Skinner, C. (2008). Corporate social responsibility in South Africa: Emerging trends. *Society and Business Review, 3*(3), 239–255.

Munro, V. (2013). Stakeholder understanding of Corporate Social Responsibility (CSR) in emerging markets with a focus on Middle East, Africa (MEA) and Asia. *Journal of Global Policy and Governance, 2,* 59–77. https://doi.org/10.1007/s40320-013-0026-3.

Nasrullah, N. M., & Rahim, M. M. (2014). Trends in CSR practices in developed and developing countries. In *CSR, sustainability, ethics & governance*. Cham: Springer. Available from: https://doi.org/10.1007/978-3-319-02350-2_3.

Overton-de Klerk, N., & Oelofse, E. (2010). Poor communities as corporate stakeholders: A bottom up research approach. *Communicatio, 36*(3), 388–408.

Overton-de Klerk, N., & Verwey, S. (2013). Towards an emerging paradigm of strategic communication: Core driving forces. *Communicatio, 39*(3), 362–382.

Spicer, C. H. (2000). Public relations in a democratic society: Value and values. *Journal of Public Relations Research, 12*(1), 115–130.

Ströh, U. (2007). Relationships and participation: A complexity science approach to change communication. *International Journal of Strategic Communication, 1*(2), 123–137.

Verwey, S. (2001). Into the age of communication. *Communicatio, 27*(1), 75–91.

Verwey, S., & Muir, C. (2011). Ethical corporate communication cultures within brand environments. In N. Hyde-Clarke (Ed.), *Communication and media ethics in South Africa* (pp. 210–229). Cape Town: JUTA & Company.

Visser, W. (2014). *CSR 2.0 transforming corporate sustainability and responsibility* (1st ed.). London: Springer.

West, A. (2014). Ubuntu and business ethics: Problems, perspectives and prospects. *Journal of Business Ethics, 121,* 47–61.

Zerfass, A., & Huck, S. (2007). Innovation, communication and leadership: New developments in strategic communication. *International Journal of Strategic Communication, 1*(2), 107–123.

Chapter 2
Asset Structure of Commercial Banks and Its Impact on Profit Levels

Mário Papík and Lenka Chorvatovičová

Abstract After the Great recession of years 2008 and 2009 the sector of commercial banks started its transformation. It had to adapt to new macroeconomic conditions such as low interest rates or higher level of regulation. Profits of these institutions being influenced by these conditions, the situation led to re-evaluation of accumulated financial assets allocation owned by these institutions during period. The aim of this article is to monitor financial assets owned by commercial banks and to identify the most important portfolio components which have impact on their profit. Linear regression models with mixed effects were created for this analysis. Data from financial statements were collected for period from year 2009 to 2014 for 19 commercial and saving banks for the purpose of this research. Results will contribute to better understanding of asset structure of commercial bank sector after the financial crisis. It will also identify and stress the importance of certain portfolio components. Therefore this paper will contribute to the improvement of legislative governance of financial institutions and avoidance of another financial crisis outbreak in this sector.

Keywords Asset structure · Commercial banks · Profit

2.1 Introduction

Under the circumstances of turbulent economic environment during years 2008 and 2009 financial institutions have begun to seek safer financial instruments or instruments that would better match conditions of financial markets in the world. These changes contributed to gradual alteration of portfolios of commercial banks, savings banks, pension and investment funds and insurance companies. Commercial banks in Slovakia were not an exception to this trend. They had to handle the arrival of new Euro currency and fall in interest rates along with reduction in household spending.

M. Papík (✉) · L. Chorvatovičová
Bratislava, Slovakia

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_2

Economic environment introduced by the Great Recession of years 2008 and 2009 not only uncovered weaknesses in financial system in Slovakia but also in the entire world (National Bank of Slovakia 2010) It also raised a question as to how properly regulate commercial banks, whose role in society is essential, in such a way that potential failure of one of these banks would not trigger another economic crisis (Brau et al. 2014). For this reason, before any major legislative changes are introduced, it is necessary to properly understand asset structure of these institutions, their risks and impact on generated revenues.

2.2 Literature Review

Topic of impact of asset structure and capital on company profits has been addressed and studied by several authors. Research focuses on finding an optimal capital structure and on looking for an appropriate company asset structure through various financial indicators. Individual research segment consists of studies focused on financial institutions environment with main focus on the impact of financial assets.

An analysis of investment assets structure of US insurance companies, which was held between years 1988 and 1995 in a form of linear regression model, has indicated that volume of bonds and real estate assets has statistically no significant change over time. On the other hand, with shares, mortgages and other assets such a change occurs. Despite these changes bonds have had a dominant position among assets of an insurance company. This research has highlighted the danger of rigorous regulation of company shares while regulators are not investigating gradual increase in the volume of non-specified other assets, such as various derivatives and short-term investments (Henebry and Diamond 1998).

In the case of pension funds research is even more widespread. Certain correlation between the percentage of equity securities and expected rate of return of pension funds has been discovered by Amir and Benatzi (1998). This research indicates that overall income of pension funds is better predicted based on percentage of equity securities rather than expected rate of return. Regression model of theirs has also shown that asset allocation is the only significant predictor and that returns of funds are not dependent on their size. These observations have been subsequently confirmed by other authors. Li and Klumpes (2013) similarly demonstrated that expected rate of return is not dependent on size of pension funds in the United Kingdom, but they have rejected the hypothesis of dependency on asset allocation.

Currently the topic of pension funds asset structure is subject of research by a group of researchers led by Louton et al. (2015) or Naczyk and Domonkos (2016). Part of Louton's research (2015) focuses on structure of US pension funds. This research has partly confirmed correlation between US equity securities and real estate ($p = 0.56$), US equity securities and other assets ($p = 0.77$), non-US equity securities and real estate ($p = 0.46$) and non-US equity securities and other assets

(p = 0.65). The correlation shows certain degree of interactivity between individual asset items that needs to be considered in the creation of mathematical models.

Unlike previous mathematical models, there are also studies focused on the impact of legislation on pension funds asset structure. Case studies based on datasets from Slovakia, Poland and Hungary have been done by Naczyk and Domonkos (2016).

All of the above mentioned studies divided financial instruments only into categories, such as bonds, shares, stocks, fixed term deposits, real estate and other assets. Such a classification of financial instruments provides only basic information about asset structure in individual financial institutions. Other parameters, such as issuance currency, debt instrument maturity or accounting categorization are all means as to how specify investment intention with which an asset was acquired by a particular company. Holding higher amounts of held-to-maturity instruments indicates that financial institution does not anticipate any early sale of this financial asset and uses it primarily to receive regular cash inflows in order to cover cash outflows. Papík (2017) considered this kind of financial instruments classification when analyzing stock pension funds. His research has indicated that certain kinds of assets have higher impact on profits of these institutions than other kinds of assets.

Ownership of higher volume of financial assets held for sale or trading assets indicates more active way how to manage company asset portfolio, whilst companies also try to profit from price differences in secondary market. Such portfolios are more likely to be adaptable to unfavorable market situation because these institutions are not obliged to hold inappropriate financial instruments until maturity and can sell them freely if necessary.

Financial instruments categorization under international accounting standards is also of great importance when comparing parts of financial sector. Same share of financial instruments in companies from various sectors does not necessarily mean the same investment intention of these individual sectors which might be discovered by the accounting categorization.

2.3 The Aim of the Article

The aim of this article is to monitor financial assets owned by commercial banks and to identify the most important portfolio components which have impact on profit of these institutions. This relationship will be described by linear regression model with mixed effects which will determine significant variables affecting profit. This information would help to monitor trends in each company's preferred financial assets of their portfolios easier. For this purpose data have been collected from financial statements of 19 Slovak commercial banks for the period from 2009 to 2014.

2.4 Research Methodology

The data have become input values of linear mixed-effects models which monitor relationship between the amount of various assets and commercial banks' profits. Model contains random slopes which represent specific years and company ID along with fixed scopes representing each asset component.

Tested model (2.1) has following form

$$Y_{it} = \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \delta_t T_t + \gamma_1 E_1 + \cdots + \gamma_n E_n + \varepsilon_{it} \tag{2.1}$$

where Y_{it} is a dependent variable representing income from financial investments i.e. sum of interest income, interest expense, net profit or loss from financial operations, exchange rate differences on financial asset. Index i denotes specific financial institution and index t denotes time in the period from 2009 to 2014. Variable $X_{k,it}$ is an independent variable which presents volume of financial assets to total assets. Variable β_k represents coefficients of the regression line for respective independent variable, and k denotes the number of independent variables tested. For commercial banks k was equal to 12 variables. Variable T_t is an auxiliary variable of binary character expressing individual years during the period from 2009 to 2014. δ_t is a random effect factor for the binary auxiliary time variable. Variable E_n is an auxiliary binary independent variable specific to each financial institution. γ_n represents random effect factor for the financial binary auxiliary variable. Variable n then represents total number of institutions considered in each of financial sectors. For banking sector it is 19 commercial banks. The last variable ε_{it} reflects value of corresponding residual component of linear regression model with mixed effects for particular financial institution i in time t.

Profit level depends on the financial market situation in the model (2.1), but in addition also on the ability of financial institutions to influence structure of individual financial assets as well as their quality.

Coefficients of the model (2.1) were estimated by using statistical software R and programmed functions from the package of linear regression model with mixed effects "lme4". Final model was tested for the absence of multi-collinearity with the "vif" package, and the accuracy of model was verified by the chi-square of goodness of fit test, the log-likelihood ratio function, the Akaike Information Criteria and the Bayesian Information Criteria. Values estimated by the model were tested by the Shapiro test of normal data distribution, and estimated values of final model were described in the Residuals versus Fitted plot and Normal Q-Q plot (Field et al. 2012).

2.5 Results of Analysis

As of January 1, 2018, 28 banks and branches of foreign banks are registered in Slovakia. In addition to standard banking services, 13 banks have the right to provide investment services, 8 banks have the right to provide mortgage services and 3 banks have the right to provide building savings. 6 Slovak commercial banks operate under the direct supervision of the European Central Bank. Out of total number of 28 banks and foreign bank branches, 9 banks are excluded from this research sample due to impossibility to obtain complete accounting records for the selected period from 2009 to 2014.

Report of The National Bank of Slovakia concludes that commercial banks experienced slight increase in financial assets between years 2009 and 2014 in their proportion to total assets. Bank assets, as per Table 2.1, consist of more than 65% of loans to other banks and non-financial institutions. During reviewed period credit volume, which is extended to other banks, fell by almost a half. Volume of loans held by the non-financial sector, however, grew by about the same percentage. This demand was driven mainly by an increase in household demand and subsequent higher interest in mortgage loans as well as an increase in retail lending.

The duration of entire portfolio slightly increased to 1.2. This increase is mainly caused by an increase in the duration of debt securities to nearly 4 years and an increase in duration of retail loans to 1.4 years. Combined with declining duration of fixed term deposits to 0.45 years which is the result of low interest rates, time resolution between incoming interest payments and outgoing interest payments results in more complex and demanding liquidity management requirements.

Most securities owned by commercial banks are evaluated at their fair value. The most significant portion of these financial instruments are debt securities,

Table 2.1 Commercial banks' financial assets

	2009	2010	2011	2012	2013	2014
Financial assets (%)	92.35	92.63	96.18	96.51	95.87	96.46
Cash and cash equivalents (%)	3.82	3.89	3.47	3.15	3.81	5.45
FVTPL securities (%)	4.14	3.70	4.51	4.31	3.95	3.84
Bonds (%)	2.37	2.45	2.83	2.72	2.54	2.39
Stocks (%)	0.56	0.33	0.12	0.12	0.14	0.13
Derivatives (%)	1.05	0.85	1.30	1.18	0.97	1.01
Loans (%)	0.17	0.07	0.25	0.29	0.30	0.31
Available for sale securities (%)	10.02	10.38	9.93	9.84	10.22	10.46
Bonds (%)	9.82	10.13	9.45	9.35	9.01	9.26
Shares (%)	0.07	0.03	0.02	0.02	0.19	0.24
Stocks (%)	0.13	0.22	0.46	0.46	1.02	0.96
Held to maturity securities (%)	6.96	7.17	10.45	11.67	10.84	9.35
Bonds (%)	6.96	7.17	10.45	11.67	10.84	9.35
Loans and receivables (%)	67.10	67.17	67.40	67.01	66.32	66.62
To banks (%)	16.12	12.78	10.19	9.47	8.52	8.84
To customers (%)	50.98	54.39	57.20	57.53	57.81	57.78
Investments in subsidiaries (%)	0.27	0.29	0.38	0.49	0.64	0.64
Real estate (%)	0.04	0.04	0.04	0.03	0.09	0.10

Source Own calculation based on annual financial statements government bonds and treasury bills in particular. In addition to Slovak debt securities, papers issued by Czech, Cypriot, Polish and Italian issuers account for no more than 3% of portfolios (National Bank of Slovakia 2011, 2013, 2014)

Banks, as the only examined financial institutions in Slovakia deposit, part of their surplus funds into real estate. (Papík 2016a, b). Ownership of these properties arises when borrowers do not repay back their mortgages. This lack of mortgage repayments almost doubled during the examined period. This is caused by an increase in customer insolvency during this period, as well as by an increase in real estate price levels—especially in the region of West Slovakia, which is an excellent investment opportunity in real estate.

The sub-sector of commercial banks has been well established in Slovak financial market over the long term. This is the main reason why it does not experience year-over-year fluctuations in individual balance sheet accounts nor the profit and loss account items. Income from financial investments account regularly for approx. 5% of total assets value. Total pre-tax profits in recent years have risen by more than 1% of total assets and profit after also experienced growing trend ranging from 0.5 to 0.85%. This fact is in contradiction with opinions claiming that falling profits are caused by cuts in interest rates. This increase in pre-tax profits was mainly caused by an increase in net interest revenues and fee revenues. Certain growth portion can be contributed to reduction of losses arising from securities revaluation after year 2012. Overall comprehensive gains and losses did not significantly differ from profit after tax and they followed trends in particular years, as shown in Table 2.2.

None of the commercial banks has reported negative income from financial investments during reviewed period. Trend across these institutions differs and only a few of these institutions have reported steady level of financial investments income such as Privatbanka, Tatra banka, Sberbank Slovensko or Slovenská sporiteľňa have reported. Stability of this income would be ensured by an exceptional legislative change made for this financial sector in particular.

Linear regression model with mixed effects (1) for commercial banks has identified statistically significant variables affecting financial investment income as bonds in fair value through profit and loss ($t\ (112.50) = 2.427$, $p < 0.05$), bonds ($t\ (60.20) = 1.888$; $p < 0.001$) and stocks ($t\ (112.82) = 2.769$; $p < 0.01$) available for sale, bonds held to maturity ($t\ (77.48) = 4.763$; $p < 0.001$) and loans to customers ($t\ (45.03) = 11.697$; $p < 0.001$). Coefficients for all statistically significant

Table 2.2 Commercial banks' incomes

	2009	2010	2011	2012	2013	2014
Financial investment income (%)	5.63	4.81	4.88	5.73	4.63	4.64
Profit before income taxes (%)	0.81	0.75	0.62	0.82	1.11	1.08
Profit after income taxes (%)	0.57	0.56	0.49	0.72	0.85	0.83
Comprehensive income (%)	0.67	0.44	0.37	1.29	0.71	0.92

Source Own calculation based on annual financial statements

Table 2.3 Results of linear mixed-effects model

Fixed effects	Coefficient	Standard error	Degr. of freedom	t value	Pr(>|t|)	Sign.
Bonds in FVTPL	0.0494230	0.0203660	112.50	2.427	0.01682	*
Loans in FVTPL	0.1473830	0.1291900	65.39	1.141	0.25811	
Stocks in FVTPL	0.2718940	0.1462760	109.10	1.859	0.06576	.
Derivatives in FVTPL	0.1293600	0.0685090	69.29	1.888	0.06319	.
Bonds AFS	0.0350670	0.0097650	60.20	3.591	0.00066	***
Stocks AFS	0.0899440	0.0324860	112.82	2.769	0.00658	**
Bonds HTM	0.0471490	0.0099000	77.48	4.763	0.00001	***
Investments in subsidiaries	−0.0096950	0.0913540	63.25	−0.106	0.91582	
Loans to banks	0.0068120	0.0120930	123.52	0.563	0.57425	
Loans to customers	0.0498640	0.0042630	45.03	11.697	0.00000	***
Investments in subsidiaries	−0.1289960	0.7044290	120.38	−0.183	0.85501	
Cash and Cash Equivalents	0.0157580	0.0198340	115.36	0.794	0.42855	
R-squared	0.787530					
Residual deviance	−848.5					
Degrees of freedom residuals	109					
Akaike Inf. Criterion	−818.4588					
Bayesian Inf. Criterion	−776.1546					
Log-likelihood ratio test	424.2					
Shapiro-Wilk norm. test (*p*-value)	0.00207					

Significance codes 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Source Own calculation in R studio based on annual financial statements

variables are positive which is also confirmed by confidence interval with 95% probability. This confirms positive influence of these independent variables on studied variable. Coefficients of all tested variables and other parameters related to designed model are listed in Table 2.3.

Analysis of estimated parameters shows, as per Fig. 2.1 and its part Fitted versus Residuals plot, that this model is homoscedastic because residual values are evenly spaced. Normal Q-Q plot suggests that residual components of the model do not originate from normal distribution. This statement is also confirmed by the Shapiro-Wilk normality test with its zero hypothesis (W = 0.96372; $p < 0.001$) being rejected. This characteristic of residues is graphically expressed by the fact that the tail values within Normal Q-Q plot are both significantly below and above theoretical quantile.

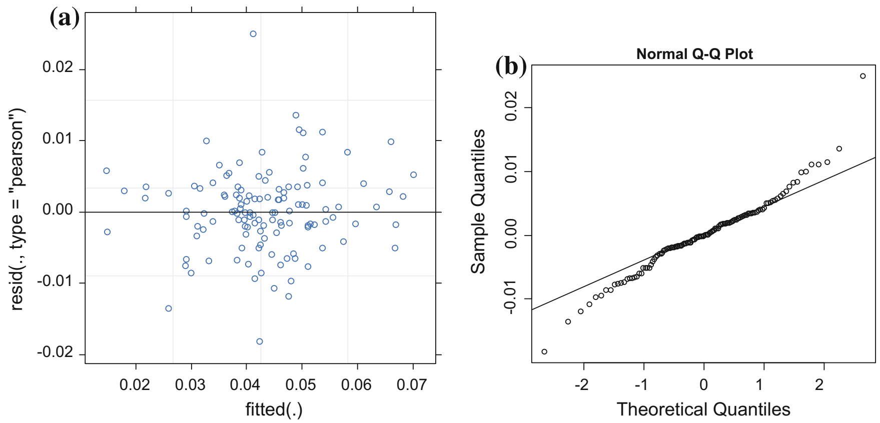


Fig. 2.1 **a** Fits versus residuals plot and **b** normal Q-Q plot for commercial banks' model

Coefficient of determination of the entire model equals 0.788. This value represents very favourable estimation of dependent variable (financial investments income) by independent variables for commercial banks.

Final model for commercial banks is tested by scattering analysis. Results of this testing have indicated that there is a difference (SD = −848.46; $\chi 2$ (1) = 29.103; $p < 0.001$) between linear model with mixed effects, which does not contain any random effects, and between model which considers not only time frame as a random effect, but it also considers particular commercial bank (1). This information proves that there is a difference in income arising from holding of same of a kind financial assets among commercial banks. Asset management can therefore influence return on portfolio by correct asset allocation and this income also depends on different macroeconomic trends.

2.6 Conclusions

Tested model has confirmed that there is a relationship between some of the financial instruments and income originating from investment assets. Model has also identified bonds in fair value through profit and loss, bonds and stocks available for sale, bonds held to maturity and loans to customers as statistically significant variables. Previous studies identified only bonds in fair value through profit and loss as statistically significant on a sample of equity and mixed pension funds. (Papík 2017)

This paper also proves that income from investment activities depends on the development of financial markets and macroeconomic trends. This indicates that assets of these financial institutions depend on both interest rates and volatility of financial markets, which directly affects value of bank assets.

Slovak commercial banks are not considered to be huge investment institutions, but the value of their assets is much more considerably influenced by fluctuation of financial markets, especially when they evaluate their assets based on fair value principle. Not even strict legislative framework in this area in Slovakia does not guarantee immunity of these banks against market shocks.

Hypothesis for commercial banks is accepted in a form that profits made by these institutions depend on their asset management. This hypothesis confirms that there are differences in capabilities of portfolio managers between each of individual commercial banks. In the case of commercial banks the difference between these institutions is more significant than for pension funds where such a dependence does not occur (Papík 2017). Such differences are also present among commercial banks and these differences strongly correlate with interest income each of the individual companies report.

Net income of banks is under highest risk during a period of low interest rates, and many times even product portfolio of a bank providing high interest rates faces the expense of margin of this particular bank.

It will be also interesting to apply same methodology on research sample of European commercial banks after the date of January 1, 2018 when new IFRS 9 standard became effective. This standard changes the categorization of financial assets and liabilities, rules regarding hedge management and also impairment of financial assets. This methodology might considerably influence the results of our research since the research was conducted under the IAS 39 accounting standard.

Results of this research outline possibilities of further research in this field. Banking sector in European banking sector is not the only sector in Europe which has to face challenges related to macroeconomic changes and trends. During the time of gradual rise in interest rates in the United States it will be interesting to monitor and predict a trend of bank asset structure for Slovak and European banks.

References

Amir, E., & Benatzi, S. (1998). The expected rate of return on pension funds and asset allocation as predictors of portfolio performance. *The Accounting Review, 73*(3), 335–352.

Brau, J., Dahl, D., Zhang, H., & Zhou, M. (2014). Regulatory reforms and convergence of the banking sector: Evidence from China. *Managerial Finance, 40*(10), 956–968.

Field, A., Miles, J., & Field, Z. (2012). *Discovering Statistics Using R*. London: SAGE Publications Ltd.

Henebry, K. L., & Diamond, J. M. (1998). Life insurance company investment portfolio composition and investment regulation. *Journal of Insurance Issues, 21*(2), 183–203.

Li, Y., & Klumpes, P. J. (2013). Determinants of expected rate of return on pension assets: Evidence from the UK. *Accounting and Business Research, 43*(1), 3–30. https://doi.org/10.1080/00014788.2012.685286.

Louton, D., McCarthy, J., Rush, S., Saraouglu, H., & Sosa, O. (2015). Tactical asset allocation for US pension investors: How tactical should the plan be? *Journal of Asset Management, 16*(7), 427–436.

Naczyk, M., & Domonkos, S. (2016). The financial crisis and varieties of pension privatization reversals in eastern Europe. *Governance, 29*(2), 167–184. https://doi.org/10.1111/gove.12159.

National Bank of Slovakia. (2010). *Analýza slovenského finančného sektora za rok 2009*. Bratislava: Národná banka Slovenska.

National Bank of Slovakia. (2011). *Analýza slovenského finančného sektora za rok 2010*. Bratislava: Národná banka Slovenska.

National Bank of Slovakia. (2013). *Analýza slovenského finančného sektora za rok 2012*. Bratislava: Národná banka Slovenska.

National Bank of Slovakia. (2014). *Analýza slovenského finančného sektora za rok 2013*. Bratislava: Národná banka Slovenska.

Papík, M. (2016a). Composition of pension funds' investment portfolio and its impact on profit. In *European Financial System. Proceedings of the 13th International Scientific Conference*. Brno, Czech Republic: Masarykova univerzita.

Papík, M. (2016b). The impact of investment portfolio of insurance companies on their profit. In *Management in theory and practice*. Prague, Czech Republic: Comenius University.

Papík, M. (2017) Composition of equity and mixed pension funds in Slovakia. In *Oeconomia Copernicana*. Faculty of Economic Sciences and Management. Toruń, Poland: University in Toruń.

Chapter 3
Does Credibility Matter for Interest Rate Changes and Output Gaps? Econometric Experiment for an Emerging Economy

Marcos V. N. Montes and Ricardo Ramalhete Moreira

Abstract According to the credibility hypothesis, the higher the monetary policy credibility the lower the social costs underlying the efforts to sustain price stability, that is, the disinflation cost from adjusting the basic interest rate is decreasing in monetary policy credibility (Blinder in American Economic Review 90(5):1421–1431, 2000; Bomfim and Rudebusch in Journal of Money, Credit, and Banking 32:707–721, 2000; Walsh in Monetary theory and policy. MIT Press, 2010). We aimed at testing such a hypothesis for Brazil, from January 2003 to May 2015. By using five indicators for monetary policy credibility and performing VAR and Markov-Switching (MS) models, we found robust results suggesting a negative effect of credibility gains on interest rate changes and output gaps, thereby confirming the hypothesis for the Brazilian economy.

Keywords Monetary policy credibility · Output gaps · VAR · Markov-switching Brazil

JEL Classification 310 · E37 · E58

3.1 Introduction

Several studies have recommended the inflation targeting regime as an efficient nominal anchor for monetary policy, based on the idea of credible rules that effectively contribute to price stability in long-run (Svensson 1997; Ball 1999; Mishkin 1999). The inflation targeting regime is commonly associated with a gradual gain of reputation for Central Banks and monetary policy credibility over time. In turn, such reputation and credibility allow inflationary expectations to be

M. V. N. Montes · R. R. Moreira (✉)
Federal University of Espírito Santo, Vitória, Brazil
e-mail: ricardo.moreira@ufes.br

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_3

anchored on the announced inflation target (Kydland and Prescott 1977; Barro and Gordon 1983; Clarida et al. 1999).

In this perspective, monetary policy credibility can be understood as the probability level which the public associates with the convergence of the expected future inflation to the announced inflation target (Drazen 2000; Moreira 2013a; Cukierman 2015). Higher credibility levels enhance the ability of the monetary authority in reacting to shocks and business cycle with more efficacy and so flexibility, thereby avoiding excessive interest rates volatility and output losses as a sacrifice in order to maintain price stability.

As a corollary, the higher the monetary policy credibility, the lower the social costs underlying the efforts to sustain price stability. It means that the disinflation cost from adjusting the basic interest rate is decreasing in monetary policy credibility. Such an idea corresponds to the "credibility hypothesis" (Blinder 2000; Bomfim and Rudebusch 2000; Walsh 2010; Cukierman 2015). However, given that monetary policy credibility is an unobservable variable, the analysis of its relations with other macroeconomic variables requires specific methodologies and available indicators or proxies to perform economic experiments.

In the empirical literature regarding monetary policy credibility we find some indicators such as in Cecchetti and Krause (2002), de Mendonça (2007), de Mendonça and de Guimarães e Souza (2009) and Tejada et al. (2013), which measure credibility directly by generally comparing expect inflation values to inflation targets, as well as applying some ad hoc bounds to the measurement process for normalizing the indicator between 0 and 1. On the other hand, there are also indicators that calculate credibility by an indirect process, that is, by extracting unobservable variables or time-varying coefficients of estimated regressions (Moreira 2013a, b). In general, the latter use some type of statistical filter, such as the Kalman filter.

It is important to stress that this article did not intend to compare those different indicators with respect to their relative efficacy as monetary policy credibility proxies. In contrast, we aimed mainly at testing the credibility hypothesis for Brazil, thereby performing econometric experiments by jointly using five credibility indicators as a robustness strategy. Therefore, we gave special attention to responses of output gaps to monetary policy credibility shocks in Brazil over recent years.

The remainder of this work is structured as follows: Sect. 3.2 presents the definition of the credibility hypothesis, the benchmark theoretical model and a brief revision of the indicators selected for the empirical experiment; in Sect. 3.3 we presented the economic data, the methodological strategy and the analysis of the empirical results. At last, we showed results from a robustness checking test and their comparison to benchmark findings.

3.2 Related Theoretical Aspects

3.2.1 The "Credibility Hypothesis"

The literature on reputation and credibility regarding monetary policy has developed expressively over the last decades, especially since the seminal works of Kydland and Prescott (1977) and Barro and Gordon (1983). The dynamics of the public's expectations became a core issue to evaluate the monetary policy efficacy under regimes with rules or discretion. In inflation targeting and optimal monetary policy models (Svensson 1997; Ball 1999; Galí and Gertler 2007), the goal of controlling the public's expectations has been regarded as a central aspect of the Central Bank's strategy in order to accomplish inflation targets without implying significant social costs in terms of higher output gaps (Woodford 2003).

The main principle is that the building of higher credibility levels is accompanied by inflationary expectations in which the announced inflation target has an expressive influence, so that wages and prices are formed based on such a target and not on the lagged or observed inflation rate (Moreira 2013a). Therefore, the current inflation rate converges more rapidly to inflation target as a response to shocks. On the other hand, it is important that the Central Bank performs systematically well over time so as to make the announced targets credible in the public's evaluation (de Mendonça and de Guimarães e Souza 2009).

In this case, the formation of monetary policy credibility is associated with an anchoring process for expectations and smoothing for the basic interest rate, which in turn can be adjusted less frequently and at lower magnitude as a response to shocks. Such a smoothing of the basic interest rate is thus the result of improved efficacy of the monetary policy and besides results in better outcomes for output in relation to potential output, especially under supply shocks due to the related trade-off between both the output and inflation variability (Taylor 1994). Hence, the credibility hypothesis predicts an improvement of the monetary policy gradualism (da Natividade Silva et al. 2016) and thus a decrease in sacrifice ratios as an effect of enhancing monetary policy credibility over time (Blinder 2000; Bomfim and Rudebusch 2000; Walsh 2010). The Scheme 3.1 demonstrates the intuition of the credibility hypothesis.

3.2.2 A Benchmark Model

We present a small-scale model that resembles the main principles of new-keynesian models commonly used for monetary policy evaluation (see Svensson 1997; Clarida et al. 1999; Woodford 2003; Walsh 2010; Romer 2011). However, we introduced in such a benchmark model an endogenous monetary policy credibility component, following Moreira (2013a). The goal is to formally expose the inverse relation between monetary policy credibility and output gaps, Improving credibility → Anchoring of expectations → Smoothing for interest rates → Lower sacrifice ratios

Scheme 3.1 The credibility hypothesis. *Source* Own elaboration

thereby demonstrating the credibility hypothesis. We start from conventional dynamic IS (3.1) and forward-looking Phillips (3.2) curves that have microfoundation into the economic agents' optimizing behavior:

$$y_t = my_{t-1} - nr_{t-1} + \eta_t \tag{3.1}$$

In the dynamic IS curve (3.1), y_t stands for the output gap, r_{t-1} for the real interest rate deviation (in relation to the long-run real interest rate) in $t - 1$ period and η_t for a demand shock with zero mean and constant variance overt time. The parameters m and n are positive. So, an increase in real interest rate in $t - 1$ is followed by a decrease in output gap in t. In turn, the supply side of the economy is described by a Phillips curve (3.2):

$$\pi_t = E_t[\pi_{t+1}] + \varpi y_{t-1} + g_t \tag{3.2}$$

The inflation deviation π_t (in relation to the inflation target) is dependent on the expected inflation deviation for $t + 1$ period ($E_t[\pi_{t+1}]$), on the output gap in $t - 1$ and on a cost shock g_t with zero mean and constant variance over time. The parameter ϖ is positive and measures the sensitivity of inflation deviation to output gaps. The Central Bank is assigned to an inflation target, thereby adjusting counter-cyclically real interest rate deviation according to a Taylor Rule, such that:

$$r_t = (1 - \rho)(z_1\pi_t + z_2 y_t) + \rho r_{t-1} + \psi_t \tag{3.3}$$

In (3.3) the higher the inflation deviation and/or the output gap the higher the real interest rate deviation. The parameter ρ represents the inertial or smoothing behavior of interest rate (Clarida et al. 1999), z_1 and z_2 are positive parameters and ψ_t stands for a monetary policy innovation with zero mean and constant variance over time. Now, let us define the way expected inflation deviation is determined:

$$E_t[\pi_{t+1}] = (1 - C_{t-1})\pi_{t-1} \tag{3.4}$$

By (3.4), expected inflation deviation for $t + 1$ depends on the inflation deviation in $t - 1$. Such a dependence increases when credibility C_{t-1} decreases. If C_{t-1} assumes 1.0 (the case for full credibility), then expected inflation deviation is zero regardless the inflation deviation in $t – 1$. If C_{t-1} assumes 0.0 (the case for zero credibility), then we have the strict adaptive expectations case, so that expected inflation deviation for $t + 1$ is equal to inflation deviation in $t - 1$. Otherwise, we have the general case with $0 < C_{t-1} < 1$ and only a part of lagged inflation deviation is translated into expected inflation deviation for t + 1. In turn, the next equation expresses the time behavior of credibility:

$$C_t = \delta C_{t-1} + (1-\delta)\left[\frac{|\alpha|\pi_{t-1}| - 1|}{\alpha|\pi_{t-1}| + 1}\right] \tag{3.5}$$

Monetary policy credibility is thus regarded as an endogenous and non-linear variable (Moreira 2013a). The endogenous nature is due to the role of the past values of C and the inflation deviation observed in t − 1 period. The parameter δ measures the credibility inertia. On the other hand, the non-linear nature is due to the fact that the parameter α, which measures the sensitivity of C_t to inflation deviation in t − 1, varies over time. In particular, Moreira (2013a) proposes that the higher the credibility the lower the α, and vice versa. It means that with higher levels of credibility, it becomes less sensitive to economic fluctuations, thereby allowing for its lower variability over time.

Now, considering absence of shocks, i.e. $\eta_t = g_t = \psi_t = 0$, we can define the inflation deviation by substituting (3.4) and (3.5) in (3.2):

$$\pi_t = \left\{\left(1 - \left[\delta C_{t-2} + (1-\delta)\left[\frac{|\alpha|\pi_{t-2}| - 1|}{\alpha|\pi_{t-2}| + 1}\right]\right]\right)\pi_{t-1}\right\}\varpi y_{t-1} \tag{3.6}$$

If we now substitute (3.6) in (3.3) we find the resulting real interest rate deviation as:

$$r_t = (1-\rho)\left\{z_1\left\{\left\{\left(1 - \left[\delta C_{t-2} + (1-\delta)\left[\frac{|\alpha|\pi_{t-2}| - 1|}{\alpha|\pi_{t-2}| + 1}\right]\right]\right)\pi_{t-1}\right\} + \varpi y_{t-1}\right\} + z_2 y_t\right\} + \rho r_{t-1} \tag{3.7}$$

And rearranging,

$$r_t - \rho r_{t-1} = (1-\rho)\left\{z_1\left\{\left\{\left(1 - \left[\delta C_{t-2} + (1-\delta)\left[\frac{|\alpha|\pi_{t-2}| - 1|}{\alpha|\pi_{t-2}| + 1}\right]\right]\right)\pi_{t-1}\right\} + \varpi y_{t-1}\right\} + z_2 y_t\right\} \tag{3.8}$$

Equation (3.8) is important because it expresses the real interest rate deviation *change* over time. Indeed, there is a negative relation between credibility levels and such a change. At last, we can define the output gap from substituting (3.7) in (3.1), so that:

$$\begin{aligned} y_t = \; & m y_{t-1} - n\left\{(1-\rho)\left[z_1\left\{\left\{\left(1 - \left[\delta C_{t-3} + (1-\delta)\left[\frac{|\alpha|\pi_{t-3}| - 1|}{\alpha|\pi_{t-3}| + 1}\right]\right]\right)\pi_{t-2}\right\} + \varpi y_{t-2}\right\}\right.\right. \\ & \left.\left. + z_2 y_{t-1}\right] + \rho r_{t-2}\right\} \end{aligned} \tag{3.9}$$

Equation (3.9) establishes a clear negative relation between monetary policy credibility and output gap. It means that by increasing credibility Central Banks can reduce real interest rate variability (3.8) as a response to inflation deviation, thereby allowing for lower output gaps. Therefore, such an analysis stresses the role of the credibility in achieving more stability for the real economy in the short-run.

3.2.3 Indicators for Monetary Policy Credibility

As we do not directly observe monetary policy credibility, several studies have proposed specific indicators to measure it by using values concerning inflation targets and inflationary expectations. A first proposal is found in Cecchetti and Krause (2002):

$$\mathrm{IC_{CK}} = \begin{cases} 1 & \text{if} \quad \mathrm{E}(\pi) \leq \pi^* \\ 1 - \frac{1}{0{,}2-\pi^*}[\mathrm{E}(\pi) - \pi^*] & \text{if} \quad \pi^* < \mathrm{E}(\pi) < 20\% \\ 0 & \text{if} \quad \mathrm{E}(\pi) \geq 20\% \end{cases} \tag{3.10}$$

Given $\pi^* =$ inflation target; $\mathrm{E}(\pi) =$ expected inflation. Thus such an indicator can assume values between 1 (full credibility) and 0 (zero credibility). In this index the credibility level is equal to 1 when expected inflation is equal or below the inflation target; the credibility level is equal to 0 if the expected inflation is equal or above 20% per year; and the credibility level fluctuates between 0 and 1 when expected inflation is higher than the inflation target and lower than 20% per year. According to Cecchetti and Krause (2002) this expected inflation level would be a critical one thereby implying an absence of the monetary policy's efficacy in shaping inflation dynamics.

In turn, de Mendonça (2007) pointed out that the indicator developed by Cecchetti and Krause (2002) was created for analyzing advanced economies in which inflation rates are generally low and stable over time. Therefore the index formed in de Mendonça (2007) makes and adaptation such that:

$$IC_M = \begin{cases} 1 & \textit{if} \quad E(\pi) = \pi^* \\ 1 - \frac{1}{\pi_M^* - \pi^*}[E(\pi) - \pi^*] & \textit{if} \quad \pi^*_{Min} < E(\pi) < \pi^*_{Max} \\ 0 & \textit{if} \quad E(\pi) \geq \pi^*_{Max} \ \textit{ou} \ E(\pi) \leq \pi^*_{Min} \end{cases} \tag{3.11}$$

Given $\pi^*_{\mathrm{Max}} =$ maximum bound for the inflation target; $\pi^*_{\mathrm{Min}} =$ minimum bound for the inflation target; and $\pi^*_{\mathrm{M}} =$ value obtained when the expected inflation stays between the maximum and the minimum bounds for inflation target. Similar to the first indicator, this second one implies a full credibility when expected inflation is equal to inflation target. However, the zero credibility condition arises when expected inflation extrapolates the bounds for the interval target. Otherwise, if expected inflation fluctuates between such bounds the credibility level fluctuates between 0 and 1.

As a third proposal we have de Mendonça e de Guimarães e Souza (2009), which made another modification of the seminal indicator in Cecchetti and Krause (IC_{CK}), so that:

$$IC_{SM} = \begin{cases} 1 & if \quad \pi^*_{Min} \leq E(\pi) \leq \pi^*_{Max} \\ 1 - \frac{1}{0.2 \; -\pi^*_{Max}} \left[E(\pi) - \pi^*_{Max}\right] & if \quad \pi^*_{Max} < E(\pi) < 20\% \\ 1 - \frac{1}{-\pi^*_{Min}} \left[E(\pi) - \pi^*_{Min}\right] & if \quad 0\% < E(\pi) < \pi^*_{Min} \\ 0 & if \quad E(\pi) \geq 20\% \; ou \; E(\pi) \leq 0\% \end{cases} \tag{3.12}$$

The variables in this index have the same meaning as in the former two indicators. The key difference of this third proposal is that it gives more weight to expected inflation levels that stay between the bounds for the inflation target. Thus if the inflation rate is different from the inflation target, but it is not higher than the maximum bound nor lower than the minimum one so the credibility is equal to 1. On the other hand, credibility decreases linearly as expected inflation converges to 20% per year or to 0% per year. Otherwise, if expected inflation becomes higher than 20% or lower than 0% thus credibility is equal to 0.

IC_K, IC_M and IC_{SM} can be regarded as measuring credibility by a direct process because they calculate the index by using and comparing values regarding expected inflation and inflation targets, as well as imposing some ad hoc limits on the measurement procedure. Furthermore, these three indicators are linear as the impact on credibility is the same regardless the magnitude of the inflation deviation. However, there exist some indicators that impose a non-linear procedure, so that the credibility sensitivity changes in response to the magnitude of inflation deviations. Two examples of these non-linear indicators are Tejada et al. (2013) and Moreira (2013a, b)[1]. The former defines:

$$IC_{SM} = \begin{cases} 1 & if \quad \pi^*_{Min} \leq E(\pi) \leq \pi^*_{Max} \\ 1 - \frac{1}{0.2-\pi^*_{Max}} \left[E(\pi) - \pi^*_{Max}\right] & if \quad \pi^*_{Max} < E(\pi) < 20\% \\ 1 - \frac{1}{-\pi^*_{Min}} \left[E(\pi) - \pi^*_{Min}\right] & if \quad 0\% < E(\pi) < \pi^*_{Min} \\ 0 & if \quad E(\pi) \geq 20\% \; ou \; E(\pi) \leq 0\% \end{cases} \tag{3.13}$$

The basic idea in IC_{TRL} is that when expected inflation diverges from inflation target but in small magnitude then the credibility loss is also small. However, if the divergence of expected inflation from inflation target is expressive thus monetary

[1]In addition, Moreira (2013a, b) can be classified as an indirect indicator because it does not measure credibility by comparing directly expected inflation levels and inflation target, but rather by estimating a time-varying coefficient related to the expected inflation sensitivity to observed inflation rate. Such an extraction method is possible with the application of the Kalman filter.

policy credibility decreases rapidly. In turn, Moreira (2013a, b) specify an expected inflation equation such that:

$$E_t[\pi_{t+1}] = \alpha_{1t}E_{t-1}[\pi_t] + \alpha_{2t}(\pi_{t-1}) + \sum_{j=1}^{T} \alpha_{j+2}x_{jt-1} + V_t \tag{3.14}$$

Given $\alpha_{2t} = 1 - C_{t-1}$ and C_{t-1} is the credibility level in t − 1. Thus if $\alpha_{2t} = 0$, then we have full credibility in t − 1, while if $\alpha_{2t} = 1$ we have zero credibility in t − 1. In general $0 < \alpha_{2t} < 1$, so that the credibility level stays between 1 and 0. Moreover, $\sum_{j=1}^{T} \alpha_{j+2}x_{jt-1}$ represents a group of control variables that are statistically significant in driving expected inflation. Therefore, IC_{MR} measures credibility indirectly by the time-varying behavior of α_{2t}, which in turn can be extracted through the application of the Kalman filter to a specific estimated regression for (3.14).

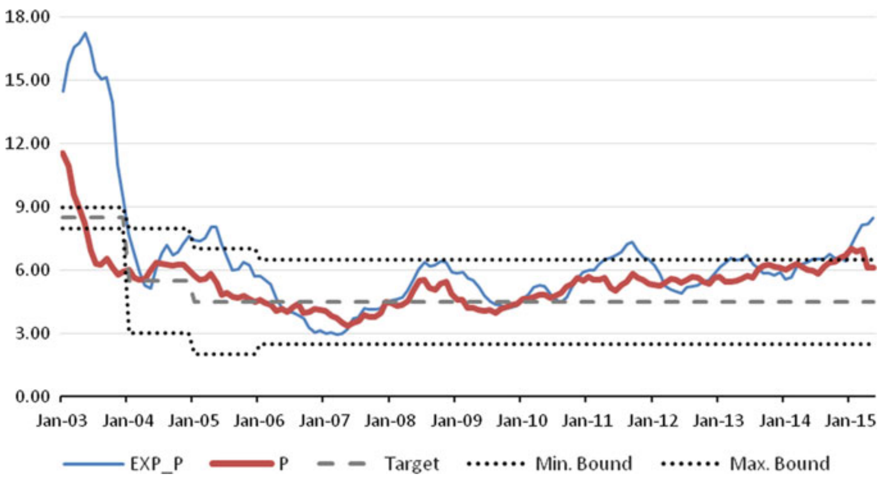
3.3 Empirical Application to Brazil

3.3.1 Data

The time series adopted in this work have monthly basis e cover the period from January 2003 to May 2015. The beginning of the sample was due to availability of the *Economic Activity Indicator* of the Brazilian Central Bank (BCB), used commonly as a proxy for Brazil's GDP in monthly basis. The variables can be described as follows:

EXP_P: expected annual inflation for 12 months forward, based on information published by the BCB; *DESV_EXP_P*: expected annual inflation (EXP_P) deviation in relation to inflation target in each period; *P*: annual inflation rate based on the *Broad Consumer Prices Index; DESV_P*: annual inflation deviation in relation to inflation targets; *E*: Nominal Exchange rate (Real/US dollar); *Y*: *Economic Activity Indicator* of the Brazilian Central Bank (BCB); *GAP_Y*: output gap measured with the application of the Hodrick-Prescott filter to Y; *I*: Effective basic interest rate (Selic rate); *DIV*: Net domestic public debt as a ratio to Brazil's GDP; *ICBR*: Commodities prices indicator calculated by the Brazilian Central Bank; *U*: Unemployment rate measured by the *Brazilian Institute of Geography and Statistics; GAP_U*: Unemployment rate gap calculated with the application of the Hodrick-Prescott filter to U.

Finally, we used the five indicators for monetary policy credibility mentioned previously, that is, IC_CK (Cecchetti and Krause 2002), IC_M (de Mendonça 2007), IC_SM (de Mendonça and de Guimarães e Souza 2009), IC_TRL (Tejada



Graph 3.1 EXP_P, P and inflation targets (Jan/2003–May/2015). *Source* Own elaboration

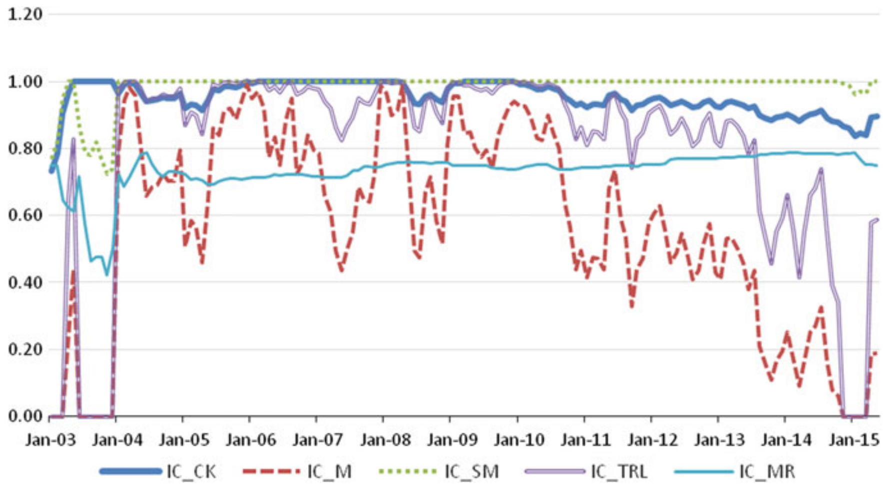
et al. 2013) and IC_MR (Moreira 2013a)[2]. Regarding the behavior of expected inflation and observed inflation in relation to inflation target it is possible to identify that in most part of the sample the maximum and minimum bounds were achieved in Brazil. Such a context is showed in Graph 3.1.

Another important aspect is the joint behavior of the indicators used to reflect monetary policy credibility in our work (Graph 3.2). Two stylized facts are corroborated by all the indicators: first, during 2003 there was low credibility levels presumably due to confidence problems in turn related to the election of Luiz Inácio Lula da Silva as the Brazilian president. Second, since the beginning of 2014 there was a new episode of credibility disruption associated with fiscal and political concerns under the presidency of Dilma Rousseff. All the indicators fit relatively well to these two key moments of Brazil, although each of them presents its specific dynamics.

3.3.2 *Methodological Strategy*

To test the credibility hypothesis in a robust way we performed a *Vector Autoregressive model* (VAR) for each credibility indicator jointly with selected macroeconomic variables for Brazil, so that we initially estimated 05 VAR models. In turn, in order to identify the optimal lag of each VAR model we verified the statistics regarding some information criteria, such as *Akaike (AIC), Schwarz (SC)* and *Hannan-Quinn (HQ)*, besides adjusting such a lag set according to results in

[2]As this last one is measured with an indirect process we presented its estimates in the Appendix.



Graph 3.2 IC_CK, IC_M, IC_SM, IC_TRL and IC_MR (Jan/2003–May/2015). *Source* Own elaboration

auto-correlation tests (*LM test*) and stability tests (*inverse roots of AR characteristic polynomial*).

However, as a previous step we tested for the integration order of the time series, based on the *Augmented Dikey-Fuller (ADF), Phillips-Perron (PP)* and *Dikey-Fuller GLS (DF/GLS)* unit root tests. Thus, after identifying the integration order of the time series and the lag set for each VAR model, we extracted its *generalized impulse-response functions* such that we could highlight the statistically significant responses of the macroeconomic variables to credibility shocks.

As pointed out in Lutkenpohl (1991), Koop et al. (1996) and Pesaran and Shin (1998), *generalized impulse-response functions* eliminate the problem related to ordering the variables into the VAR estimation, so that tests for exogeneity/endogeneity among the series can be disregarded. Furthermore, after analyzing the impulse-response relations for each credibility indicator individually (or each VAR model), we stressed those relations that presented statistical significance for at least 03 indicators (or at least 03 VAR models), thereby focusing specific impulse-response relations regarded as robust or common ones among all indicators and estimated VAR models in this work.

Finally, we applied some robustness tests to the benchmark experiment. First, we replaced the output gap by the unemployment gap in order to observe if the credibility hypothesis could be still identified. Second and more important, we aimed at testing for possible different regimes on the subjacent correlation of the credibility hypothesis. Such a test was performed by estimating a *basic two-regimes markov-switching (MS) regression* for each of the credibility indicator used in this work. This method is the so-called markov-switching model of Hamilton (1989), in which the estimates vary according to different regimes or structures that are regarded as random states of the economy over time. Thus, a state can be replaced by others by a stochastic process that is ruled by a Markov chain. Recently, the Hamilton's framework has been applied to several economic subjects, especially related to finance series (Giesecke et al. 2011; Switzer and Picard 2016).

3.3.3 Results

Table 3.1 presents the results regarding the unit root tests carried out so as to identify the integration order of the time series. Based on these statistics, we performed the following Vector Autoregressive models with the I(1) series in their first differences, while the I(0) series in level values. Thus, we estimated five initial VAR models, each of them with one specific indicator for monetary policy credibility along with DESV_EXP_P, D(DESV_P), D(DIV), D(E), D(I) and GAP_Y, thereby taking into account the appropriate transformation of the I(1) series.

First, with respect to the VAR model with the indicator proposed in Cecchetti and Krause (2002), i.e. IC_CK, the optimal lag was verified by the Akaike (AIC), Schwarz (SC) e Hannan-Quinn (HQ) information criteria (Table 3.2—Appendix). The results suggested the VAR model with only 01 lag. However, when we applied the LM autocorrelation test to it, we could observe it suffers from the residual autocorrelation problem. On the other hand, by increasing the lag order of the VAR we normally mitigate problems of autocorrelation. Indeed, we found that only with a VAR(9), i.e. a VAR with 09 lags, the residual autocorrelation was rejected at 10% (Table 3.3—Appendix). Besides, the VAR(9) also presents parameter stability (Graph 3.3—Appendix). Thus, we chose this VAR set to make the following predictions.

From the generalized impulse-response functions we note that a credibility positive shock is accompanied over time by a decrease of the expected inflation deviation, output gap and inflation deviation change, as well as a decrease of exchange rate and basic interest rate change (Graph 3.4). These results corroborate the hypothesis that an increase of credibility causes an anchoring expectation process and allows a more flexible and smoother monetary policy facing economic disturbances. Specifically, the reduction in the output gap occurs over two months immediately after the shock, while the negative effect on the Selic interest rate change prevails from the 2nd to the 7th month after the shock. Therefore, these findings are consistent with the credibility hypothesis when we apply the Cecchetti and Krause (2002)'s indicator.

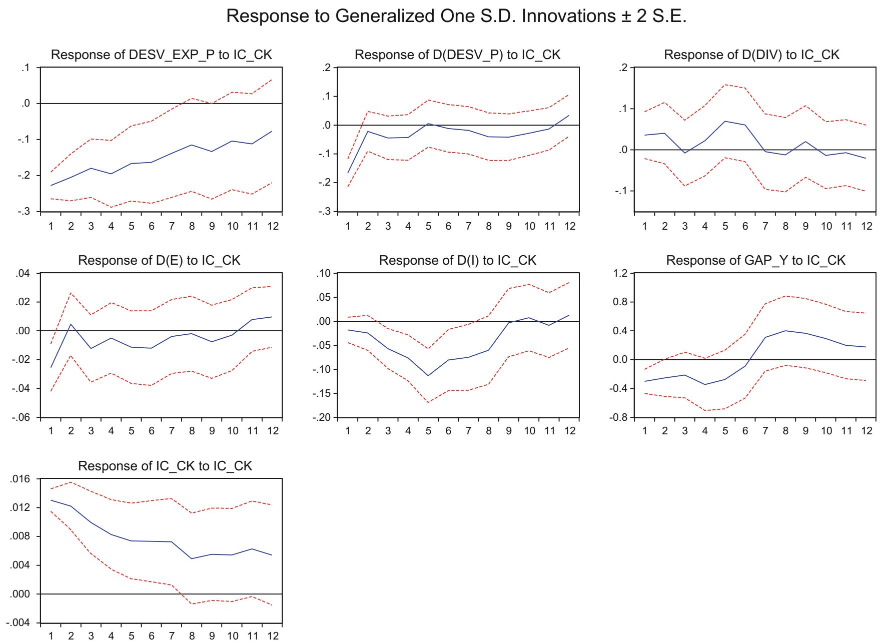
In turn, in the case of de Mendonça (2007)'s indicator, the information criteria by Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) (Table 3.4—Appendix), along with the LM test (Table 3.5—Appendix) and the stability test (Graph 3.5—Appendix), also suggested a VAR(9) for estimating the generalized impulse-response relations. Such relations showed that a positive shock to IC_M is followed months forward by statistically significant and negative responses of expected inflation deviation, output gap and the Selic interest rate change

Table 3.1 Unit root tests: Level and first differences tests

	ADF		PP		DF/GLS		
Variables	Level	First dif.	Level	First dif.	Level	First dif.	I(n)
E	−0.7467	−12.2431***	−0.7292	−12.2429***	0.1123	−6.8439***	I(1)
EXP_P	−7.0441***	–	−6.2499***	–	−0.4796	–	I(0)
DESV_EXP_P	−4.9551***	–	−5.2832***	–	−1.4761	–	I(0)
I	−4.0047**	−3.8852**	−1.9743	−4.3369***	−2.4136	−2.6839	I(1)
P	−1.9750	−7.6622***	−2.3130	−6.2966***	−0.5802	−3.3282**	I(1)
DESV_P	−3.1504***	−8.2700***	−2.3198	−8.1314***	−1.8029	−4.3971***	I(1)
Y	2.7264	−12.3692***	2.7573	−12.3689***	1.2309	−12.4118***	I(1)
GAP_Y	−3.3684***	–	−3.5351***	–	−3.0731***	–	I(0)
DIV	−2.1834	−4.9071***	0.4955	−9.4449***	−2.0701	−4.7171***	I(1)
ICBR	−3.1871*	−9.6657***	−2.4903	−9.5838***	−2.4120	−6.9682***	I(1)
U	−2.3535	–	−3.2364*	–	−3.0171***	–	I(0)
GAP_U	−5.5516***	–	−4.9697***	–	−3.1000**	–	I(0)
IC_CK	−7.6587***	–	−6.9627***	–	−0.9361	–	I(0)
IC_M	−3.3101*	–	−3.2712*	–	−1.8364	–	I(0)
IC_SM	−4.9961***	–	−5.1703***	–	−0.8400	–	I(0)
IC_TRL	−3.5555***	–	−3.6150***	–	−1.2771	–	I(0)
IC_MR	−2.5421	−7.0451***	−4.4540***	−11.1800***	−2.3624	−7.0264***	I(1)

Notes (*), (**) and (***) represents respectively statistical significance at 10, 5 and 1%. The DF/GLS tests were performed with trend and intercept in data. Regarding ADF and PP tests, we adopted trend and intercept in data, except for DIV, ICBR, GAP_U e IC_MR, which were tested without trend and intercept based on the statistical significance criterion. In turn, Y, IC_SM e IC_TRL were tested only with intercept

Source Own elaboration

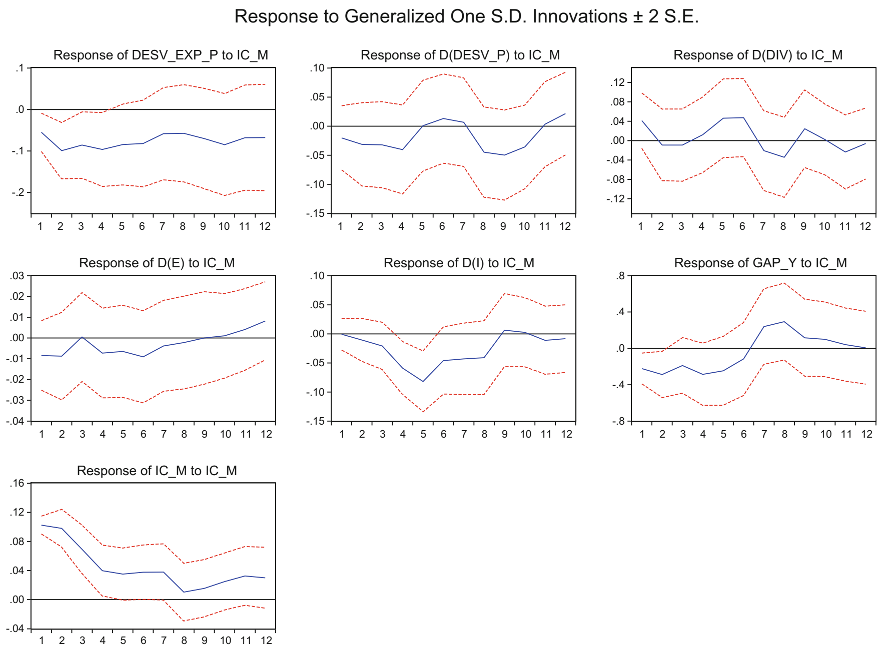


Graph 3.4 Generalized macroeconomic response to an impulse to IC_CK. *Source* Own elaboration

(Graph 3.6). In other words, credibility gains are associated with a convergence of inflationary expectations to the inflation target, which in turn permits a smoother monetary policy and more output stability. The results from the VAR model with IC_M then were similar to those generated with the Cecchetti and Krause (2002)'s indicator, thereby confirming again the credibility hypothesis (Blinder 2000; Bomfim and Rudebusch 2000; Walsh 2010; Cukierman 2015).

When we performed the VAR with the de Mendonça and de Guimarães e Souza (2009)'s indicator (IC_SM) the lag set process indicated a VAR (11) as the appropriate specification (Tables 3.6 and 3.7 and Graph 3.7—Appendix). On the one hand, this VAR (11), although confirming the hypothesis of residual non-autocorrelation at 10%, did not confirm simultaneously the hypothesis of parameter stability. On the other hand, this VAR set generated statistically significant impulse-response relations that have converged to those observed for the other indicators. Therefore, we chose to maintain the VAR(11) for the de Mendonça and de Guimarães e Souza (2009)'s indicator.

Regarding the macroeconomic responses to shocks to IC_SM, except for the responses associated with public debt change and output gap, all the other responses presented statistical significance and negative sign (Graph 3.8). That is, where there exists an increase in monetary policy credibility measured by IC_SM we can expect



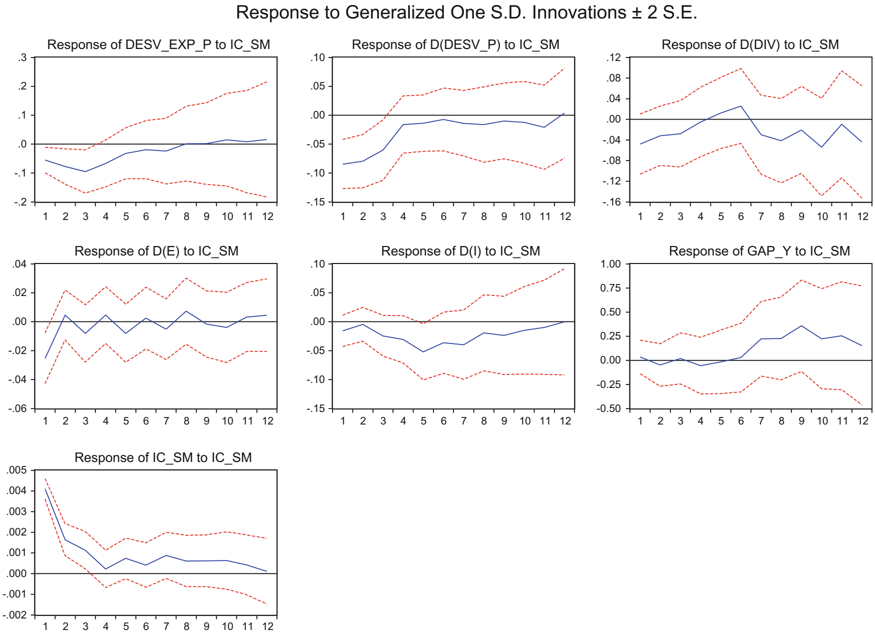
Graph 3.6 Generalized macroeconomic response to an impulse to IC_M. *Source* Own elaboration

a gain of flexibility of the monetary policy facing economic disturbances, thereby supporting the previous results obtained with IC_CK and IC_M.[3]

Furthermore, Tables 3.8 and 3.9, besides the Graph 3.9 in Appendix, show the appropriate lag specification for the VAR model with the indicator proposed in Tejada et al. (2013), that is, a VAR(9). The macroeconomic responses to positive shocks to IC_TRL indicate that, except for responses of public debt changes, an increase in monetary policy credibility is followed by the same general effects obtained with the previous model specifications. In other words, a gain of credibility is translated into convergence of inflationary expectations to the inflation target and higher levels of monetary policy efficacy over time (Graph 3.10).

At last, we performed the VAR specification incorporating the Moreira (2013a)'s indicator proposal. Based on the same criteria, we found that the VAR(9) was an adequate lag set (Tables 3.10 and 3.11, and Graph 3.11—Appendix). Specifically for IC_MR, it is important to make a preliminary explanation. Such an indicator is the only one that presents unit root among the indicators adopted in this work,

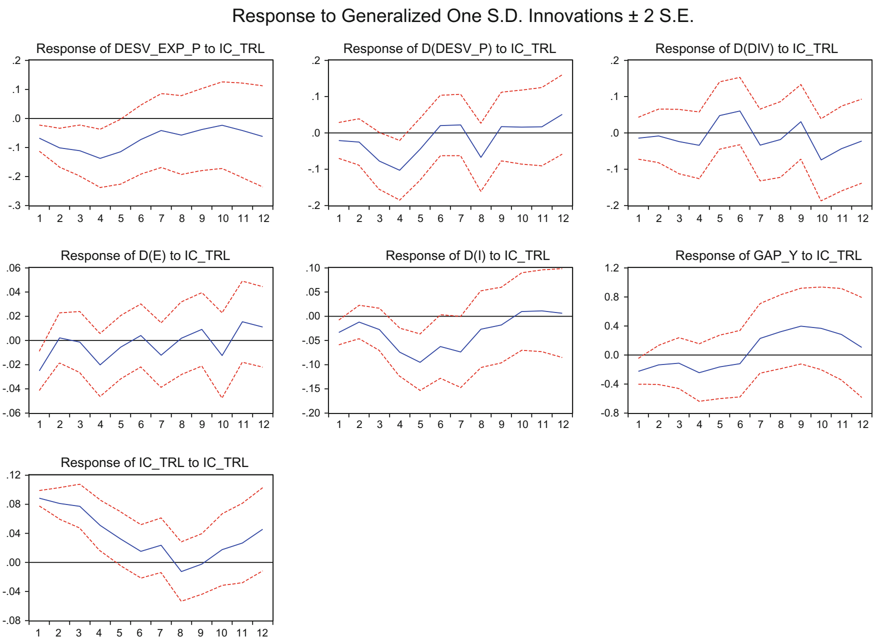
[3]However, the response of the Selic interest rate change to credibility in the case of IC_SM occurs only discretely in the 5th month after the shock if we account for the statistical significance criterion, although the D(I) central response is below its normal value over 12 months after the credibility shock.



Graph 3.8 Generalized macroeconomic response to an impulse to IC_SM. *Source* Own elaboration

according to the unit root tests previously applied. It means that, in line with the theoretical model in Moreira (2013a), a positive shock to the IC_MR *change*—D (IC_MR)—should be regarded as a decrease in monetary policy credibility. It occurs because an increase in D(IC_MR) reflects an increase in IC_MR sensitivity to macroeconomic fluctuations. According to Moreira (2013a), the lower the credibility level the higher the credibility sensitivity to macroeconomic fluctuations. Such a relation is associated with the non-linear nature of the credibility concept of this indicator. Thus, in interpreting the following impulse-response functions one should regard an increase in D(IC_MR) as a decrease in monetary policy credibility.

We can observe the macroeconomic responses to positive shocks to D(IC_MR) in Graph 3.12. In particular, an increase in D(IC_MR) is accompanied by a statistically significant increase in expected inflation deviations, inflation deviation changes and Selic rate changes, suggesting that a loss of credibility leads to a rise in those variables. Therefore, taking into account the inverse meaning with regard to the Moreira (2013a)'s indicator, such impulse-response functions support the general evidence obtained with IC_CK, IC_M, IC_SM and IC_TRL.

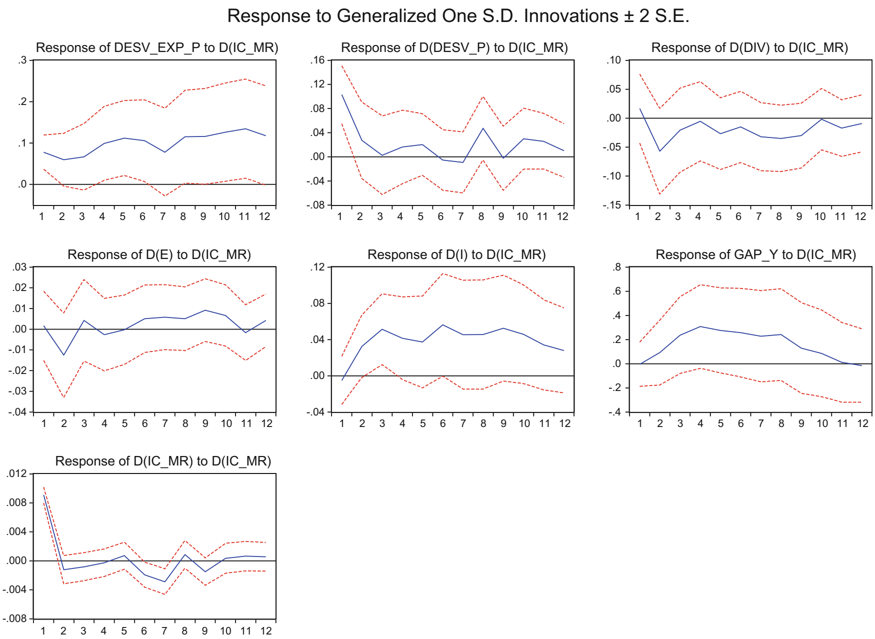


Graph 3.10 Generalized macroeconomic response to an impulse to IC_TRL. *Source* Own elaboration

3.3.4 Identifying Common Responses Among the Credibility Indicators

For identifying the impulse-response relations that showed convergent behavior among the estimated models and their respective credibility indicator, we adopted the criterion of selecting those relations with statistical significance and the same sign in at least 03 VAR models. Such convergent responses were regarded as common or robust responses.

Table 3.12 presents the set of responses considered as common or robust among all estimated models. We verified 05 common macroeconomic responses to credibility shocks. Except for the public debt change response, all the other macroeconomic responses obtained common behavior, statistically significant and with negative sign following a credibility shock. It means that, in a robust way, an increase of monetary policy credibility enhances the expected and effective inflation stabilization and gives higher flexibility to the Central Bank to accommodate shocks in the short-run, thus avoiding expressive movements of the basic interest rate.



Graph 3.12 Generalized macroeconomic response to an impulse to D(IC_MR). *Source* Own elaboration

Table 3.12 Common macroeconomic responses found based on the VAR models with all the credibility indicators

		IMPULSE					
		IC_CK VAR(9)	IC_M AR(9)	IC_SM VAR (11)	IC_TRL VAR(9)	D (IC_MR) VAR(9)	Common response
RESPONSE	DESV_EXP_P	(−)	(−)	(−)	(−)	(+)	(−)
	D(DESV_P)	(−)		(−)	(−)	(+)	(−)
	D(DIV)						
	D(E)	(−)		(−)	(−)		(−)
	D(I)	(−)	(−)	(−)	(−)	(+)	(−)
	GAP_Y	(−)	(−)		(−)		(−)

Note "(−)" represents a statistically significant response with negative sign. "(+)" represents a statistically significant response with positive sign. As mentioned, a positive shock to D(IC_MR) should be interpreted as a decrease in credibility

Source Own elaboration

3.3.5 Robustness Checking

3.3.5.1 Unemployment Gap and the Credibility Hypothesis

As a first step, we performed a change on the benchmark estimation so as to test for robustness. We replaced GAP_Y by GAP_U, that is, the unemployment rate gap, into the 05 previous VAR models. Table 3.13 presents the resulting estimates. As in the benchmark model, there are five common macroeconomic responses to credibility shocks. In other words, a positive credibility shock is accompanied by a decrease in expected inflation deviation, inflation deviation change, exchange rate change, Selic rate change and unemployment gap, thus implying a context of lower social costs. Furthermore, it is important to stress that such results are obtained with the use of five credibility indicators available in the literature.

3.3.5.2 Testing for Asymmetries and Different Regimes

We estimated a basic two-regimes markov-switching regression for each of the credibility indicator used in this work. We allowed for switching-coefficients in GAP_Y_{t-1} and j_{t-1}, given j = indicator for credibility. On the other hand, we applied D_I and D_E as control variables, without switching-coefficients, that is, as common factors in both regimes. After estimating for several lags of such control variables, we identified D_I_{t-7} and D_E_{t-11} as appropriate options based on statistical significance. Table 3.14 shows the estimates.

We can verify that the expected result of a negative relation between monetary policy credibility and output gap occurs in Regime 2, rather than in Regime 1. The key difference between both regimes is the inertial component of the output

Table 3.13 Common macroeconomic responses found based on the VAR models with all the credibility indicators (with GAP_U instead of GAP_Y)

		Impulse					
		IC_CK VAR(8)	IC_M VAR (5)	IC_SM VAR(13)	IC_TRL VAR(9)	D (IC_MR) VAR(8)	Common response
Response	DESV_EXP_P	(−)	(−)	(−)	(−)	(+)	(−)
	D(DESV_P)	(−)		(−)	(−)	(+)	(−)
	D(DIV)			(−)			
	D(E)	(−)	(−)	(−)	(−)		(−)
	D(I)	(−)	(−)		(−)		(−)
	GAP_U	(−)		(−)	(−)	(−)	(−)

Note "(−)" represents a statistically significant response with negative sign. "(+)" represents a statistically significant response with positive sign. As mentioned, a positive shock to D(IC_MR) should be interpreted as a decrease in credibility
Source Own elaboration

Table 3.14 Markov-switching regression (BFGS/Marquardt steps optimization method)

	j = IC_CK	j = IC_M	j = IC_SM	j = IC_TRL	j = d (IC_MR)
Regime 1					
GAP_Y(−1)	0.980249***	4.43329***	0.977759***	0.988647***	3.910789***
	(0.083686)	(0.214298)	(0.083221)	(0.087825)	(0.678015)
	[11.71348]	[20.68753]	[11.74889]	[11.25707]	[5.767999]
j(−1)	0.401199*	−3.015022***	0.384066*	0.445116	87.66325***
	(0.238564)	(0.429228)	(0.227749)	(0.280824)	(9.474079)
	[1.68173]	[−7.024294]	[1.686357]	[1.585033]	[9.252957]
Regime 2					
GAP_Y(−1)	0.825036***	0.842326***	0.826875***	0.823345***	0.843242***
	(0.045863)	(0.034808)	(0.046009)	(0.047812)	(0.03392)
	[17.98925]	[24.19906]	[17.97186]	[17.22042]	[24.85957]
j(−1)	−0.254075**	−0.011757	−0.250285**	−0.235989*	1.226991
	(0.123762)	(0.122856)	(0.123049)	(0.136757)	(1.923442)
	[−2.052925]	[−0.095696]	[−2.034023]	[−1.725611]	[0.637914]
Common					
D_I(−7)	−0.45318***	−0.38716***	−0.45534***	−0.44645***	−0.39519***
	(0.142285)	(0.12842)	(0.140977)	(0.148304)	(0.120917)
	[−3.18508]	[−3.014852]	[−3.229891]	[−3.010412]	[−3.26827]
D_E(−11)	1.220178*	1.085371	1.219783*	1.242054*	1.37133*
	(0.688947)	(0.685431)	(0.690554)	(0.687593)	(0.733983)
	[1.771076]	[1.583487]	[1.766383]	[1.80638]	[1.868341]
Durbin–Watson stat	1.965962	2.063958	1.96664	1.973834	2.064557
Akaike criterion	3.034706	2.828468	3.034369	3.035311	2.875119

Notes We used Huber-White robust standard errors and covariance method; (***) for statistical significance at 1%; (**) at 5% and (*) at 10%. () for standard error and [ ] for the z-statistic
Source Own elaboration

gap. The coefficient associated with the lagged GAP_Y is higher in Regime 1 for all credibility indicators. It means that the credibility hypothesis is mainly supported for periods of lower inertia degree in GAP_Y. In turn, all the MS-specifications confirmed the negative relation between Selic interest rate change and the output gap, while its positive relation with nominal exchange rate change was observed in most of cases. The estimated MS-model with the best Akaike criterion was the one with de Mendonça (2007)'s credibility indicator.

In turn, the *constant transition probabilities* associated with each estimated model are presented in Table 3.15. These results show that the Regime 2 is probabilistically more prevalent than Regime 1 for all credibility indicators, i.e. in all estimated MS-models. For instance, in the case of IC_M, when the economy is under Regime 1, the probability of continuity of such a Regime is $1.78e^{-09}$, while

Table 3.15 Constant transition probabilities: P(i, k) = P(s(t) = k| s(t − 1) = i)

	j = IC_CK		j = IC_M		j = IC_SM		j = IC_TRL		j = d(IC_MR)	
	1	2	1	2	1	2	1	2	1	2
1	$1.21e^{-08}$	1.0	$1.78e^{-09}$	1.0	$4.07e^{-09}$	1.0	$8.54e^{-09}$	1.0	$4.55e^{-09}$	1.0
2	0.502	0.498	0.027	0.973	0.498	0.502	0.463	0.537	0.021	0.979

Source Own elaboration

the probability of a transition to Regime 2 is 1.0. On the other hand, if the economy is under Regime 2 the probability of continuity is 0.973, while the probability of a transition to Regime 1 is 0.027. These probabilities, calculated by means of a Markov chain method, suggest that the general case for our time series is under the Regime 2—in which we identified the validation of the credibility hypothesis—, while the Regime 1 can be regarded as a special and uncommon domestic scenario.

3.4 Concluding Remarks

This paper tested for the credibility hypothesis in Brazil, during the period from January 2003 to May 2015. With the aim of achieving robust results we adopted 05 credibility indicators found in the related literature, i.e. Cecchetti and Krause (2002), de Mendonça (2007), de Mendonça and de Guimarães e Souza (2009), Tejada et al. (2013) and Moreira (2013a, b).

We then performed 05 estimated VAR models. Taking into account the macroeconomic impulse-responses with statistical significance and the expected short-run sign, we thus found those responses that could be regarded as common or robust among the credibility indicators. The most important common response was the negative response of interest rate changes and output gaps to a positive shock to monetary policy credibility and it corroborated the expected relation of the credibility hypothesis. In turn, the robustness experiments also suggested important and common real responses from shocks to monetary policy credibility.

First, when we replaced the output gap by the unemployment gap in the estimated VAR models, we identified that in general an increase of credibility is accompanied by a decrease of the unemployment gap in Brazil. Second, we estimated MS-models in order to test for possible structural breaks or different regimes on the subjacent correlation of the credibility hypothesis. The MS-models estimates showed that in general the credibility hypothesis occurs when the output gap has lower inertia, or autoregressive behavior, over time. Furthermore, such a regime is more prevalent than the alternative one.

Finally, from a normative perspective, these findings suggest that the credibility hypothesis occurs in Brazil mainly when its output dynamics performs with more flexibility and stability (or less rigidity) over time. Thus, policies aiming at enhancing macroeconomic stability and such flexibility can also improve the monetary policy's efficacy by making easier the occurrence of the credibility hypothesis.

Appendix

See Tables 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11 and Graphs 3.3, 3.5, 3.7, 3.9, 3.11.

Table 3.2 Optimal lag for the VAR model with IC_CK

LAG	AIC	SC	HQ
0	1.8650	2.0107	1.9242
1	−4.1570	−2.9914*	−3.6834*
2	−4.3634*	−2.1778	−3.4753
3	−4.3064	−1.1008	−3.0037
4	−4.2415	−0.0159	−2.5244
5	−4.1988	1.0467	−2.0672
6	−3.9828	2.2826	−1.4367

Note (*) indicates the optimal lag order by the criterion
Source Own elaboration

Table 3.3 LM Autocorrelation test for the VAR model with IC_CK (prob)

LAGS	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)
1	0.0000	0.0078	0.0001	0.0124	0.3990	0.0447	0.0872	0.0060	0.8523
2	0.0000	0.0000	0.0006	0.0268	0.0318	0.0027	0.0242	0.6481	0.4879

Source Own elaboration

Graph 3.3 Parameter stability test for the VAR model with IC_CK. *Source* Own elaboration

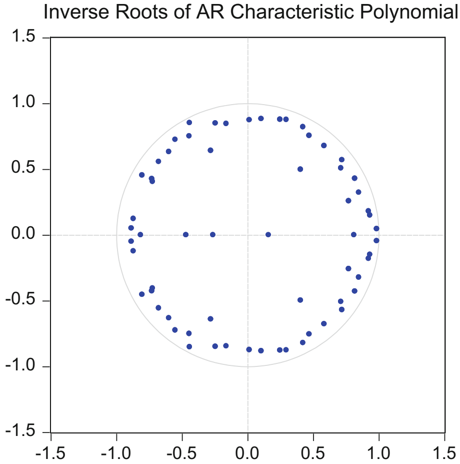


Table 3.4 Optimal lag for the VAR model with IC_M

LAG	AIC	SC	HQ
0	7.0969	7.2426	7.1561
1	0.9574	2.1231*	1.4311*
2	0.7648*	2.9504	1.6529
3	0.8829	4.0885	2.1856
4	0.9814	5.2070	2.6985
5	1.0417	6.2873	3.1733
6	1.2672	7.5327	3.8132

Note (*) indicates the optimal lag order by the criterion
Source Own elaboration

Table 3.5 LM autocorrelation test for the VAR model with IC_M (prob)

LAGS	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)
1	0.0000	0.0003	0.0105	0.0012	0.6530	0.0546	0.1270	0.0974	0.6263
2	0.0002	0.0003	0.0004	0.0003	0.0157	0.0089	0.0542	0.5999	0.8429

Source Own elaboration

Graph 3.5 Parameter stability test for the VAR model with IC_M. *Source* Own elaboration

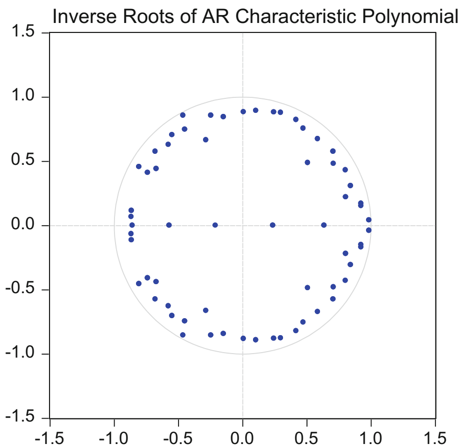


Table 3.6 Optimal lag for the VAR model with IC_SM

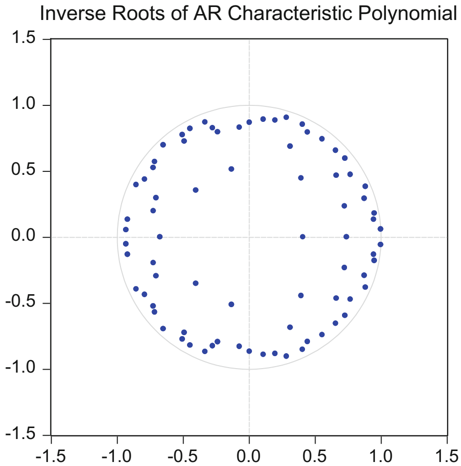
LAG	AIC	SC	HQ
0	3.0733	3.2190	3.1325
1	−3.0381	−1.8725*	−2.5644*
2	−3.3508	−1.1652	−2.4627
3	−3.3671	−0.1614	−2.0644
4	−3.3920*	0.8335	−1.6749
5	−3.3574	1.8880	−1.2259
6	−3.2722	2.9932	−0.7261

Note (*) indicates the optimal lag order by the criterion
Source Own elaboration

Table 3.7 LM autocorrelation test for the VAR model with IC_SM (prob)

LAGS	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)	VAR (10)	VAR (11)
1	0.0000	0.0004	0.0000	0.0167	0.0795	0.0117	0.0220	0.0045	0.5856	0.0000	0.1014
2	0.0000	0.0000	0.0005	0.4033	0.0331	0.0008	0.0835	0.6992	0.0723	0.0000	0.4589

Source Own elaboration



Graph 3.7 Parameter stability test for the VAR model with IC_SM. *Source* Own elaboration

Table 3.8 Optimal lag for the VAR model with IC_TRL

LAG	AIC	SC	HQ
0	7.0482	7.1939	7.1074
1	0.8004	1.9661*	1.2741*
2	0.6006*	2.7862	1.4887
3	0.7259	3.9315	2.0285
4	0.7970	5.0226	2.5141
5	0.7878	6.0334	2.9194
6	0.8783	7.1438	3.4244

Note (*) indicates the optimal lag order by the criterion
Source Own elaboration

Table 3.9 LM autocorrelation test for the VAR model with IC_TRL (prob)

LAGS	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)
1	0.0000	0.0000	0.0077	0.0000	0.1702	0.0739	0.0034	0.0194	0.7748
2	0.0000	0.0011	0.0002	0.0000	0.0293	0.0011	0.0188	0.2253	0.6203

Source Own elaboration

Graph 3.9 Parameter stability test for the VAR model with IC_TRL. *Source* Own elaboration

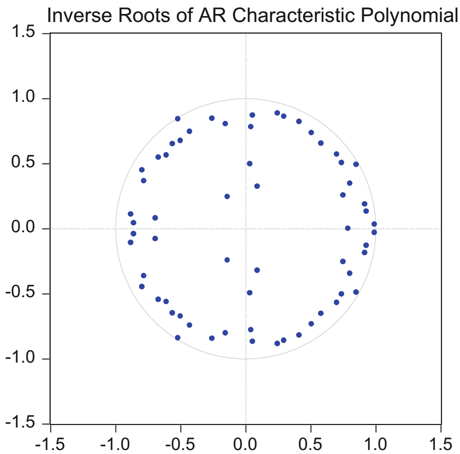


Table 3.10 Optimal lag for the VAR model with D(IC_MR)

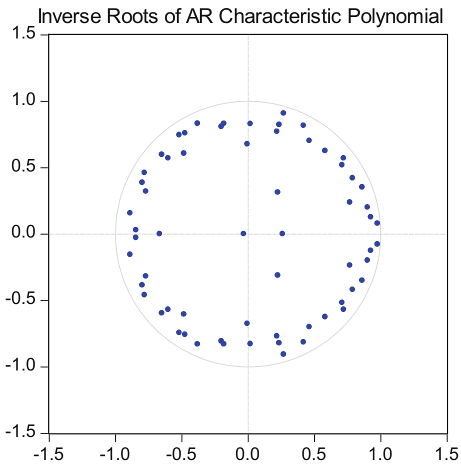
LAG	AIC	SC	HQ
0	2.5598	2.7055	2.6190
1	−3.3482	−2.1825*	−2.8745*
2	−3.4992	−1.3135	−2.6110
3	−3.7258*	−0.5201	−2.4231
4	−3.7005	0.5250	−1.9834
5	−3.6801	1.5654	−1.5485
6	−3.6682	2.5972	−1.1222

Note (*) indicates the optimal lag order by the criterion
Source Own elaboration

Table 3.11 LM autocorrelation test for the VAR model with D(IC_MR) (prob)

LAGS	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)
1	0.0000	0.0000	0.0007	0.0000	0.0000	0.0002	0.1775	0.1036	0.1646
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0209	0.0309	0.2288

Source Own elaboration



Graph 3.11 Parameter stability test for the VAR model with D(IC_MR). *Source* Own elaboration

References

Ball, L. (1999). Policy rules for open economies. In J. Taylor (Ed.), *Monetary policy rules* (pp. 127–144). Chicago: University of Chicago Press.

Barro, R. J., & Gordon, D. (1983). Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics, 12,* 101–121.

Blinder, A. (2000). Central-bank credibility: Why do we care? How do we build it? *American Economic Review, 90*(5), 1421–1431.

Bomfim, A., & Rudebusch, G. D. (2000). Opportunistic and deliberate disinflation under imperfect credibility. *Journal of Money, Credit, and Banking, 32,* 707–721.

Cecchetti, S. G., & Krause, S. (2002). *Central bank structure, policy efficiency and macroeconomic performance: Exploring empirical relationships*. Federal Reserve Bank of St. Louis, July–August, pp. 47–59.

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature, 37*(4), 1661–1717.

Cukierman, A. (2015). The choice of flexibility in targeting inflation during normal times and during disinflations. *Research in Economics, 69*(4), 494–502.

Da Natividade Silva, M. J., Brasil, G. H., Moreira, R. R. (2016). Dynamic relations of the inertia of monetary policy: Application to the Brazilian case by a Kalman approach. *International Journal of Monetary Economics and Finance*, *9*(1) 1–24.

de Mendonça, H. F. (2007). Towards credibility from inflation targeting: The Brazilian experience. *Applied Economics, 39*(20), 2599–2615.

de Mendonça, H. F., & De Guimarães e Souza. (2009). Inflation targeting credibility and reputation: The consequences for the interest rate. *Economic Modelling, 26*(6), 1228–1238.

Drazen, A. (2000). *Political economy in macroeconomics*. Princeton University Press.

Galí, J., & Gertler, M. (2007). Macroeconomic modeling for monetary policy evaluation. *Journal of Economic Perspectives, 21*(4), 25–46.

Giesecke, K., Longstaff, F., Schaefer, S., & Strebulaev, I. (2011). Corporate bond default risk: A 150-year perspective. *Journal of Finance Economics, 102,* 232–250.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica, 57,* 357–384.

Koop, G., Pesaran, M. H., & Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics, 74*(119), 147.

Kydland, F. E., & Prescott, E. C. (1977). Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economic, 85*(3), 473–492.

Lutkenpohl, H. (1991). *Introduction to multiple time series analysis*. Berlin: Springer.

Mishkin, F. (1999). International experiences with different monetary policy regimes. *Journal of Monetary Economics, 43*(3), 579–605.

Moreira, R. R. (2013a). The Central Bank's endogenous and non-linear credibility in a dynamic stochastic general equilibrium model: theory and a small computational simulation. *International Journal of Computational Economics and Econometrics, 3,* 2–10.

Moreira, R. R. (2013b). Expected inflation, lagged inflation and the Central Bank's credibility: Time-varying and VAR analysis for the recent Brazilian case. *The Empirical Economics Letters, 12,* 619–628.

Pesaran, M. H., & Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics Letters, 58,* 17–29.

Romer, D. (2011). *Advanced macroeconomics* (4th ed.). McGraw-Hill.

Svensson, L. E. O. (1997). Inflation forecast targeting: Implementing and monitoring inflation targets. *European Economic Review, 41*(6), 1111–1146.

Switzer, L. N., & Picard, A. (2016). Stock market liquidity and economic cycles: A non-linear approach. *Economic Modelling, 57,* 106–119.

Taylor, J. (1994). The inflation-output variability tradeoff revisited. In J. Fuhrer (Ed.), *Goals guidelines, and constraints facing monetary policymakers* (pp. 21–38). Federal Reserve Bank of Boston.

Tejada, C. A. O., Ranciaro Neto, A., Leal, R. A. (2013). Credibilidade não linear para as metas de inflação no Brasil. *Anais do 41º Encontro Nacional de Economia, ANPEC*, p. 1–17.

Walsh, C. (2010). *Monetary theory and policy* (3rd ed.). MIT Press.

Woodford, M. (2003). *Interest and prices: Foundations of a theory of monetary policy*. Princeton University Press.

Chapter 4
Patents and Enterprise Innovation in Network Industries

Adam Karbowski

Abstract We investigate factors that determine product innovation in network industries. We develop a demand-pull-technology-push model of enterprise innovation and find that enterprise innovation depends on firm's specific abilities to extend the network, consumer preferences over product price and network coverage, and the extent of knowledge spillovers in the network industry. Enterprise innovation increases when consumers value the network development more and when consumers are less sensitive to price increases. The enterprise innovation rises if effective R&D investments to a higher extent translate into network extending. The enterprise innovation is larger when the size of knowledge spillovers in the network industry is smaller. Enterprise innovation under no patent protection is higher or equal to the enterprise innovation under patent protection. Under patent protection, individual sunk costs of R&D increase and constitute a significant disincentive to invest in research and development.

4.1 Introduction

The ability of business firms to develop integrated technological networks has become an important source of competitive advantage in many industries (Dunning 1993; Howells and Wood 1993; Zander 1995; Dunning 1996; Cantwell and Janne 1999; Murray 2002; Corsaro et al. 2012), including telecommunications, banking, entertainment, media, and commerce. According to Newman (2010), basic and fundamentally important technological networks are the telephone network, the Internet, power grids, transportation networks, and delivery and distribution networks.

This paper was supported by funds from the National Science Centre (NCN), Poland, through grant No 2016/22/M/HS4/00361.

A. Karbowski (✉)
Department of Business Economics, Warsaw School of Economics,
Al. Niepodległości 162, 02-554 Warsaw, Poland
e-mail: adam.karbowski@sgh.waw.pl

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_4

In this paper, we set out to investigate factors that determine enterprise innovation in network industries. Special attention in our analysis is given to the role of patents in determining enterprise innovation in such industries.

Kleinknecht et al. (2002) distinguish the following measures of enterprise innovation: R&D efforts, patents and patent applications, total innovation expenditures, sales of imitative and innovative products, new product announcements, and significant (or basic) innovation. R&D efforts (as an input measure of enterprise innovation) can be understood as firm's spendings on R&D (either absolute or relative to the firm's total sales). Patents and patent applications are an intermediate output measure of enterprise innovation. However, we should bear in mind that high patent counts do not necessarily mean a high level of enterprise innovation (Morck and Yeung 2000; Karbowski and Prokop 2013), since not all patented inventions are turned into products or processes introduced into marketplace (consider, e.g., cases of patent shelving, see Shavell 2004). Moreover, firms may engage in patent thicketing (Morck and Yeung 2000), i.e., filing numerous patents on minor variants of the original patent, only to head off rivals' attempts to circumvent the original patent. Total innovation expenditures, in contrast to measures based on R&D efforts, take non-R&D innovation expenditures (cf., Kleinknecht et al. 2002) into account. Sales of imitative and innovative products are shares of those types of products in company's total sales. New product announcements in trade and technical journals is a fairly straightforward measure of enterprise innovation activity. Lastly, significant (or basic) innovation is a direct measure of the successful market introduction of significant (basic, earthshaking) innovations (Kleinknecht et al. 2002).

In this paper, we focus on two, the most frequently used measures of enterprise innovation in the industrial organization literature, i.e., R&D efforts (basic input indicator) and patents (basic output indicator). Interestingly, we show how company R&D efforts and patent protection are interrelated in the simple elasticity model of firm innovation.

The next section is devoted to the presentation of elasticity model of enterprise innovation in network industries. The model implications for industrial organization theory and innovation policy are discussed in the third section. The fourth section concludes the paper.

4.2 The Model

Let us consider a duopoly market for a network product. Let us further denote the set of companies operating in this market as $\Omega 0 = \{i, j\}$. For simplicity, assume that for both firms marginal costs of production (MC) are constant and equal to the average costs of production. Assume next that the consumers' utility from using a product offered by company i is characterized by the following utility function: $U_i = U(p_i, N_i)$, where p_i stands for a price of product offered by company i and N_i denotes the coverage of technological network that is utilized by the users of a given product. Consumers' utility decreases with respect to price and increases with respect to the coverage of technological network attached to the product. The coverage of technological network is a non-decreasing function of the maintenance expenditures (m_i) and effective R&D investments (X_i) of company i, i.e. $N_i = N(m_i, X_i)$. The effective R&D investments of a given company are defined here as in Kamien et al. (1992), i.e. $X_i = x_i + \beta x_j$, where x_i denotes firm's i own investments in research and development and parameter β determines the size of R&D externalities (so called "knowledge spillovers", see, e.g., Geroski 1995; Prokop and Karbowski 2013), which can be defined as the benefits for a given company obtained as a result of research undertaken by the rival. Higher value of β means that the R&D investments made by one company allow the rival to develop its network to a higher extent for free. The demand for a product offered by company i depends on the utility drawn by consumers from using firm's i product and the utility of consumers resulting from consumption of a product offered by company's rival (firm j). Let us express it in the form of following demand function (cf., Lee and Sung 2005): $q_i = q(U_i, U_j)$. Clearly, demand for a product offered by company i rises in U_i and falls in U_j. The size of company is measured in our model by the value of total sales $(S_i = p_i q_i)$. The measure of enterprise innovation is, in turn, the corporate R&D intensity (the ratio of company's own investment in R&D to the value of company's sales). Assume also that the entry of new firms to the industry is unprofitable.

The profit function for the company i can be expressed as follows:

$$\pi_i = p_i q_i - MC_i q_i - x_i - m_i \tag{4.1}$$

We set out to find the firm's R&D intensity. The firm plans its R&D investments and sets the product price to maximize profits (company's own R&D investments and product price constitute decision variables in our model). The maintenance expenditures are a stochastic variable and its value cannot be determined ex ante.

Starting with company's own investment in R&D, we obtain the following:

$$\frac{\partial \pi_i}{\partial x_i} = -1 + (p_i - MC_i)\frac{\partial q_i}{\partial x_i} = 0 \tag{4.2}$$

Next, let us define the elasticity of demand with respect to firm's own investments in research and development. We have: $\varepsilon^{qx} = \frac{x_i}{q_i}\frac{\partial q_i}{\partial x_i}$. Based on (4.2), we can now express the profit-maximizing R&D investments in the following way:

$$x_i = (p_i - MC_i)\varepsilon^{qx} q_i \tag{4.3}$$

From the first order condition for profit maximization with respect to product price, we obtain the following:

$$q_i + (p_i - MC_i)\frac{\partial q_i}{\partial p_i} = 0 \tag{4.4}$$

By defining the price elasticity of demand as $\varepsilon^{qp} = -\frac{p_i}{q_i}\frac{\partial q_i}{\partial p_i}$ and based on (4.4), we can write down that

$$S_i = (p_i - MC_i)\varepsilon^{qp} q_i \tag{4.5}$$

Based on (4.3) and (4.5), we have:

$$\alpha_i = \frac{x_i}{S_i} = \frac{\varepsilon^{qx}}{\varepsilon^{qp}} \tag{4.6}$$

where α_i denotes company's R&D intensity.

In our model, we are going to consider two cases, i.e., (a) no patent protection of inventions, and (b) patent protection of inventions. R&D investments of companies lead to creation of inventions that develop the technological network by extending its coverage. However, under patent protection, when firm j $(j \neq i)$ first obtains the patent for a given invention, firm i is not allowed to use it (we do not consider licensing possibilities here), and, as a result, firm's i R&D investments do not lead to network extending. For simplicity and without loss of generality, let us further assume that each of companies obtains the patent with probability half.

Observe next that $\varepsilon^{qx} = \frac{x_i}{q_i}\frac{\partial q_i}{\partial U_i}\frac{\partial U_i}{\partial N_i}\frac{\partial N_i}{\partial X_i}\frac{\partial X_i}{\partial x_i}$. Further, if $\varepsilon^{qp} = -\frac{p_i}{q_i}\frac{\partial q_i}{\partial p_i} = -\frac{p_i}{q_i}\frac{\partial q_i}{\partial U_i}\frac{\partial U_i}{\partial p_i}$, $n_i = \frac{N_i}{U_i}\frac{\partial U_i}{\partial N_i}$, $\eta_i = -\frac{p_i}{U_i}\frac{\partial U_i}{\partial p_i}$, $\psi_i = \frac{n_i}{\eta_i}$, $c_i = \frac{X_i}{N_i}\frac{\partial N_i}{\partial X_i}$ and $\delta_i = \frac{x_i}{X_i}\frac{\partial X_i}{\partial x_i}$, then

$$\alpha_i = c_i \psi_i \delta_i \tag{4.7}$$

From (4.7) we can draw some interesting inferences. First, note that, in our model, the enterprise innovation depends, in fact, on three factors, i.e., c_i that can be interpreted as firm's specific abilities to extend the network (firms in industry vary in terms of those abilities), ψ_i which describes the consumer preferences over product price and network coverage, and δ_i which indirectly shows the extent of knowledge spillovers in the industry. Certainly, it is worth observing that the first distinguished factor is a supply-side factor, the second factor is demand-side, and, finally, the third factor seizes the existence of knowledge externalities in the given market. It is also worth stressing the complementarity of factors in expression (4.7). As a result, a "deficiency" in one factor reduces a company's R&D intensity in a multiplicative manner, and consequently, negatively impacts on the enterprise innovation. On the other hand, an increase in one factor, enhances the corporate innovation also in a multiplicative way.

The importance of the complementarity of factors in modern microeconomic theory is accurately covered by Garbicz (2005) who states that standard economics assumes wide possibilities of substitution between factors, while economic realities make us think in terms of complementarity, as if the weakest link were decisive (see also Karbowski 2016).

From (4.7) we can derive that enterprise innovation increases when, first, consumers value the network development more, and, second, when consumers are less sensitive to price increases. Further, the enterprise innovation rises here if effective R&D investments to a higher extent translate into network extending. Lastly, the enterprise innovation is larger when parameter β is smaller, so the size of knowledge externalities in the industry is smaller.

Let us now briefly elaborate upon the last result concerning the knowledge spillovers. From a public point of view, knowledge spillovers in an industry are a desirable phenomenon as they contribute to the diffusion of knowledge in a society (Wölfl 1998; Arrow 1962; Romer 1986; Karbowski 2016). From the private standpoint, however, knowledge spillovers in an industry may be viewed negatively as unintentional transfers that benefit rivals of the company (Karbowski 2016). Therefore, the clear conflict between the public and the private interest may arise. As a result, also in our model, the growing size of knowledge spillovers in the industry acts as a disincentive for companies to invest in research and development. In presence of knowledge spillovers, the rival of a given company free-rides on research efforts undertaken by that company. Therefore, increasing knowledge spillovers lead here to reduction in firm's efforts to innovate.

Let us next consider the role of patents. Under patent protection, when firm j $(j \neq i)$ first obtains the patent for a given invention, firm i is not allowed to use it, and, as a result, firm's i R&D investments do not lead to network extending. We also assumed that each of companies obtains the patent with probability half. If company j first obtains the patent, $X_i = 0$. However, if company i first obtains the patent, firm i is allowed to use the invention and extends the network according to $X_i = x_i + \beta x_j$. Since the probability that company i obtains the patent is half, the expected R&D intensity of firm i under patent protection is:

$$\alpha_i^e = \frac{c_i \psi_i \delta_i}{2} \tag{4.8}$$

Under no patent protection, the company i is allowed to use the invention, regardless of actions taken by the rival. Then, the network can be extended according to $X_i = x_i + \beta x_j$, and R&D intensity of firm i under no patent protection is given by (4.7).

Comparing two cases, with and without patent protection, we may conclude that corporate R&D intensity under no patent protection is, in our model, higher or equal to the corporate R&D intensity under patent protection. Since R&D intensity is our measure of enterprise innovation, we may say that in our analysis patents do not necessarily bring more innovation.

The latter conclusion refers to product innovations, because, in fact, we consider product innovations in our model. As already mentioned, R&D investments of companies lead here to creation of inventions that develop the network attached to the product offered by a duopolist.

Another analysis should be run for process innovations, where our conclusion stating that patents do not bring more innovation may not hold.

4.3 Discussion

Our formal analysis reveals that enterprise innovation increases when consumers value the network development more and when consumers are less sensitive to price increases. The enterprise innovation also rises if effective R&D investments to a higher extent translate into network extending. Lastly, the enterprise innovation is larger when the size of knowledge externalities in the industry is smaller.

The last result is in line with the previous research on the topic. Nieto and Quevedo (2005) notice that the existence of knowledge spillovers in the industry is, in fact, a significant disincentive to private investment in research and development. The presence of knowledge spillovers reduces companies' efforts to innovate (Spence 1984; Bernstein and Nadiri 1989; Nieto and Quevedo 2005). Following Nieto and Quevedo (2005), this disincentive effect can be explained in two ways. First, innovative companies limit their investments in research and development if they perceive a smaller likelihood of being able to make exclusive use of the results of their R&D efforts. Such explanation is provided by Spence (1984). On the other hand, imitators, if they can use the stock of public technological knowledge, will do so to the detriment of their own research activities, as long as the knowledge generated by competitors can be seen as a substitute for the technological knowledge generated internally (Levin and Reiss 1988; Henderson and Cockburn 1996; Nieto and Quevedo 2005).

Our analysis generates conclusions consistent with the explanation provided by Spence (1984). Also in our model, the innovation effort of an innovative enterprise is smaller for larger values of parameter β, so for larger size of knowledge externalities in the industry. This result is in line with seminal papers by d'Aspremont and Jacquemin (1988), De Bondt et al. (1992), Kamien et al. (1992), Suzumura (1992), Leary and Neary (1997), where the knowledge appropriability problem leads to a reduction of companies' incentives to invest in research and development —for a more detailed review of this strand of industrial organization literature, see Kaiser (1999).

As Spence (1984) notes innovative companies limit their investments in research and development if they perceive a smaller likelihood of being able to make exclusive use of the results of their R&D efforts. Following this line of reasoning, one may expect that patent protection which guarantees an exclusive use of patented inventions would alleviate the above-mentioned disincentive effect. But, surprisingly, in our model the innovation efforts of companies decrease even further when the patent protection of inventions is introduced. This decrease in research efforts can be explained by the increase in sunk costs of R&D activity when the rival first obtains the patent.

The sunk cost effect has been widely discussed in the industrial organization literature devoted to patent races (for a review, see, e.g., Kaplan et al. 2003). Dasgupta (1986) considers a patent competition where all firms incur R&D costs. The sunk cost assumption plays an important role in Dasgupta's model, since the R&D spendings of the losing firms occur prior to the determination of the patent race winner (Kaplan et al. 2003). Scherer (1967) and Reinganum (1981) also employ sunk costs in their deterministic models of patent competition, however the environments that they study are not a winner-take-all ones (cf., Kaplan et al. 2003). According to Stiglitz (1987), most R&D expenditures are, by nature, sunk costs. Firms' R&D activities may involve creating an R&D department, purchasing specific physical assets or training specialized labor force, which all are costs that may be considered, at least partly, as sunk costs (Manez et al. 2009). Thus, resources spent on R&D cannot be fully recovered, especially when the given invention has been first patented by company's rival. Therefore, obtaining a patent for a given technology by company's rival increases company's sunk costs of research and development (given technology cannot be legally used by company or sold on a second hand market without prior settlement with the patent holder).

Finally, it is worth stressing that our model of enterprise innovation in network industries is both technology-push and demand-pull model. As regards demand side, observe that enterprise innovation depends here on consumer tastes. The consumers have to decide how much they value a larger network coverage (treated as a specific product feature), and how much they can pay for such network development. Consumers' decisions exert an immediate influence on company's innovation efforts. From the technology side, note that the more effective are company's investments in network extending, the higher is the firm's equilibrium R&D intensity.

4.4 Conclusions

In this paper, we investigate factors that determine enterprise innovation in network industries. We find that enterprise innovation depends on firm's specific abilities to extend the network, consumer preferences over product price and network coverage, and the extent of knowledge spillovers in the network industry. Enterprise innovation increases when consumers value the network development more and when consumers are less sensitive to price increases. The enterprise innovation rises if effective R&D investments to a higher extent translate into network extending. The enterprise innovation is larger when the size of knowledge externalities in the network industry is smaller. Enterprise innovation under no patent protection is higher or equal to the enterprise innovation under patent protection. Under patent protection, individual sunk costs of R&D increase and constitute a significant disincentive to invest in research and development. We may then conclude that in our analysis patents do not necessarily bring more innovation. The latter conclusion refers to product innovations. In future research, another analysis should be run for process innovations, where our conclusion stating that patents do not bring more innovation may not be valid. Also, it is worth comparing the impact of various R&D patterns (R&D competition, R&D cartelization, RJV competition, RJV cartelization, cf., Kamien et al. 1992) on enterprise innovation, both under and without patent protection of inventions.

References

Arrow, K. (1962). Economic welfare and the allocation of resources for inventions. In R. Nelson (Ed.), *The rate and direction of inventive activity: economic and social factors*. Princeton: Princeton University Press.

Bernstein, J., & Nadiri, M. (1989). Research and development and intra-industry spillovers: An empirical application of dynamic duality. *Review of Economic Studies, 56,* 249–269.

Cantwell, J., & Janne, O. (1999). Technological globalisation and innovative centres: The role of corporate technological leadership and locational hierarchy. *Research Policy, 28,* 119–144.

Corsaro, D., Cantu, C., & Tunisini, A. (2012). Actors' heterogeneity in innovation networks. *Industrial Marketing Management, 41,* 780–789.

d'Aspremont, C., & Jacquemin, A. (1988). Cooperative and noncooperative R&D in duopoly with spillovers. *American Economic Review, 78,* 1133–1137.

Dasgupta, P. (1986). The theory of technological competition. In J. Stiglitz & G. Mathewson (Eds.), *New developments in the analysis of market structure*. Cambridge: MIT Press.

De Bondt, R., Slaets, P., & Cassiman, B. (1992). The degree of spillovers and the number of rivals for maximum effective R&D. *International Journal of Industrial Organization, 10,* 297–313.

Dunning, J. (1993). *Multinational enterprises and the global economy*. Boston: Addison-Wesley.

Dunning, J. (1996). The geographical sources of competitiveness of firms. Some results of a new survey. *Transnational Corporations, 5,* 1–21.

Garbicz, M. (2005). Niedorozwój a korzyści skali. In W. Pacho (Ed.), *Szkice ze współczesnej teorii ekonomii*. Warszawa: SGH.

Geroski, P. (1995). Do spillovers undermine the incentive to innovate? In S. Dowrick (Ed.), *Economic approaches to innovation*. Aldershot: Edward Elgar.

Henderson, R., & Cockburn, I. (1996). Scale, scope and spillover: The determinants of research productivity in drug discovery. *RAND Journal of Economics, 27,* 32–59.

Howells, J., & Wood, M. (1993). *The globalisation of production and technology*. Belhaven Press.

Kaiser, U. (1999). *Measuring knowledge spillovers in manufacturing and services: An empirical assessment of alternative approaches*, ZEW Discussion Papers No. 99–62.

Kamien, M., Muller, E., & Zang, I. (1992). Research joint ventures and R&D cartels. *American Economic Review, 82,* 1293–1306.

Kaplan, T., Luski, I., & Wettstein, D. (2003). Innovative activity and sunk cost. *International Journal of Industrial Organization, 21,* 1111–1133.

Karbowski, A. (2016). The elasticity-based approach to enterprise innovation. *International Journal of Management and Economics, 49,* 58–78.

Karbowski, A., & Prokop, J. (2013). Controversy over the economic justifications for patent protection. *Procedia—Economics and Finance, 5*, 393–402.

Kleinknecht, A., Van Montfort, K., & Brouwer, E. (2002). The non-trivial choice between innovation indicators. *Economics of Innovation and New Technology, 11,* 109–121.

Leary, D., & Neary, J. (1997). Public policy towards R&D in oligopolistic industries. *American Economic Review, 87,* 641–662.

Lee, C., & Sung, T. (2005). Schumpeter's legacy: A new perspective on the relationship between firm size and R&D. *Research Policy, 34,* 914–931.

Levin, R., & Reiss, P. (1988). Cost-reducing and demand-creating R&D with spillovers. *RAND Journal of Economics, 19,* 538–556.

Manez, J., Rochina-Barrachina, M., Sanchis, A., & Sanchis, J. (2009). The role of sunk costs in the decision to invest in R&D. *The Journal of Industrial Economics, 57,* 712–735.

Morck, R., & Yeung, B. (2000). *The economic determinants of innovation* (Occasional Paper No. 25). Industry Canada Research Publications.

Murray, F. (2002). Innovation as co-evolution of scientific and technological networks: exploring tissue engineering. *Research Policy, 31,* 1389–1403.

Newman, M. (2010). *Networks. An introduction*. Oxford: Oxford University Press.

Nieto, M., & Quevedo, P. (2005). Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort. *Technovation, 25,* 1141–1157.

Prokop, J., & Karbowski, A. (2013). *R&D cooperation and industry cartelization*. Economics Discussion Paper Series, 2013-41, Kiel Institute for the World Economy.

Reinganum, J. (1981). On the diffusion of new technology: A game theoretic approach. *The Review of Economic Studies, 48,* 395–405.

Romer, P. (1986). Increasing returns and long-run growth. *Journal of Political Economy, 94,* 1002–1037.

Scherer, F. (1967). Research and development resource allocation under rivalry. *The Quarterly Journal of Economics, 81,* 359–394.

Shavell, S. (2004). *Foundations of economic analysis of law*. Cambridge: Harvard University Press.

Spence, M. (1984). Cost reduction, competition and industry performance. *Econometrica, 52,* 101–121.

Stiglitz, J. (1987). Technological change, sunk costs and competition. *Brookings papers on economic activity, 3,* 883–937.

Suzumura, K. (1992). Cooperative and noncooperative R&D in an oligopoly with spillovers. *American Economic Review, 82,* 1307–1320.

Wölfl, A. (1998). *Spillover effects—An incentive to cooperate in R&D?*. Halle Institute for Economic Research Discussion Paper.

Zander, I. (1995). Technological diversification in the multinational corporation—Historical evolution and future prospects. In R. Schiattarella (Ed.), *New challenges for Europe and international business*. Rome: Confindustria.

Chapter 5
Banking Concentration and Firm Growth: The Impact of Size, Location and Financial Crisis

Sophia Dimelis, Ioannis Giotopoulos and Helen Louri

Abstract Using conditional quantile regressions for a panel of listed firms from euro-area countries in the 2005–2011 period, we explore the role of banking concentration in firm growth between micro and larger firms; pre-crisis and post-crisis years; periphery and core countries. The results provide evidence on the differentiated role of banking concentration in firms exhibiting different growth rates, depending at the same time on firm size, firm location and the financial crisis.

Keywords Firm growth · Banking concentration · Crisis · Euro area periphery High-growth firms · Low-growth firms · Panel quantile regressions

JEL Classification L10 · L25 · E51

5.1 Introduction

Positive and fast growth rates of firms are often indispensable for their survival (e.g. Audretsch and Mahmood 1995; Fotopoulos and Louri 2000; Cefis and Marsili 2005). Furthermore, a number of high-growth firms are necessary for economic

S. Dimelis (✉)
Department of Informatics, Athens University of Economics and Business, Athens, Greece
e-mail: dimelis@aueb.gr

I. Giotopoulos
Department of Economics, University of Peloponnese, Peloponnese, Greece
e-mail: giotopoulos@uop.gr

H. Louri
Department of Economics, Athens University of Economics and Business, Athens, Greece
e-mail: elouri@aueb.gr

H. Louri
London School of Economics, EI/HO, London, UK

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_5

development and job creation (e.g. Shane 2009; Henrekson and Johansson 2010). Exploring the determinants of firm growth can thus be of extreme interest as it can provide guidance for policy interventions and opportunities for economic advancement.

Financing firm investment projects originates either from the market or from banks and is a major determinant of firm growth. In the euro area financing comes mainly in the form of bank lending, which raises the importance of the banking sector and its structure for growth (Beck and Demirguc-Kunt 2006; Laeven and Valencia 2013). A concentrated banking sector, i.e. a sector with few large players, is expected to exert market power (amid low competition) and, consequently, charge higher loan rates (Boyd and De Nicolo 2005) implying higher cost and risk for firms. This in turn can be harmful for their investment decisions and obstruct their growth patterns. However, some authors argue that a less concentrated banking sector with a large number of banks is more prone to financial crises (and financing constraints) than a concentrated banking sector (Allen and Gale 2004; Beck et al. 2006). In the light of the 2008–09 euro-area crisis, a better understanding of firm growth and its linkages with the degree of concentration in the banking sector may help policy makers working towards a dynamic economic recovery.

Significant contributions in the topic usually refer to the relationship between banking concentration or (lack of) banking competition and firms' financial constraints (e.g. Carbo-Valverde et al. 2009; Claessens and Laeven 2004; Petersen and Rajan 1995; Rice and Strahan 2010). In this context a number of studies provide evidence for the impact of banking concentration on various aspects of firm characteristics, mostly firm entry (e.g. Bonaccorsi di Patti and Dell'Ariccia 2004; Black and Strahan 2002), size distribution of new firms (e.g. Cetorelli and Strahan 2006) and firm investment (e.g. Ratti et al. 2008). Yet, the empirical research focusing on the role that banking market structure plays in shaping the growth patterns of firms is rather limited (Beck and Demirguc-Kunt 2006).

What is more, the relevant literature remains silent about the potentially differentiated effects of banking concentration across growth quantiles for differentsize groups, economic conditions, and location. By offering empirical evidence from a panel of 2075 listed firms in the euro area in 2005–2011, this paper aims at advancing our knowledge on the role of banking concentration in different firm growth quantiles by exploring whether this relationship changes between smaller and larger firms, post- and pre-crisis periods, periphery and core countries. To this end, we employ conditional quantile estimations which to our knowledge have not so far been used in exploring the linkages of banking structure and firm performance. In our context, this technique enables to investigate whether the growth rates differ for high-growth firms (low-growth firms) in a country where the banking sector is concentrated in comparison with high-growth firms (low-growth firms) in a country where the banking sector is not concentrated.

The paper proceeds as follows: Sect. 5.2 describes the data used; section presents the methodology; Sect. 5.4 discusses the empirical results; and Sect. 5.5 concludes.

5.2 Data

Our study is based on panel data of 17 euro-area countries including 2075 listed firms and covering three years before and three years after the crisis of 2008. Various international sources were used to collect the data. Firm related data were retrieved from annual balance-sheets of quoted firms reported by Datastream, in the WorldScope Database. Only firms fulfilling consistent selection criteria of time and information continuity were included.

The dependent variable in all our regressions is the growth rate of firm sales measured by the difference of the natural logarithm of sales in two subsequent years. The independent variables include three firm-specific variables from the same database: firm size, leverage and liquidity. Firm size is measured by sales (rather than assets as our sample includes both manufacturing and service firms) and leverage is proxied by the ratio of total debt to total assets. Finally, liquidity is the ratio of current assets to current liabilities.

The main independent variable of interest, banking concentration, is measured by the market share of the 5 largest banks in each country as published by the ECB and is expected to affect negatively firm performance (Ratti et al. 2008). A second variable, financial stability, characterizing the banking sector and obtained from the World Bank database is also employed. Financial stability is proxied by the z-score at country-level. The higher the z-score, the lower the probability of insolvency of financial institutions, and the greater the stability of each country's financial system (Fielding and Rewilak 2015). Greater financial stability is expected to enhance firm growth. Sovereign risk is captured by (the inverse of) a composite index of sovereign risk obtained from the International Country Risk Guide. It consists of political, economic and financial sub-indices. Thus, the greater the value of the edited composite index, the higher the sovereign risk of a country and the more expensive and difficult for firms to grow.

Also, a correlation matrix is provided in Table 5.1 indicating the absence of any high correlation among the independent variables, which it turn reduces the possibility of multicollinearity problems in the econometric estimation.[1]

5.3 Methodology

Our empirical model follows the growth model introduced by Rajan and Zingales (1998) as adjusted at the firm level by Laeven and Valencia (2013). It is differentiated though from existing models in that we estimate the firm growth impact of the variables of interest at various quantiles by employing a quantile panel methodology. The purpose of such an approach is to enable us to consider the

[1]Applying also VIF tests confirms the absence of any multicollinearity problems.

Table 5.1 Correlation matrix

	CR	Size	Liquidity	Leverage	Risk	Z-score
CR	1	–	–	–	–	–
Size	−0.0779	1	–	–	–	–
Liquidity	−0.0058	−0.1518	1	–	–	–
Leverage	0.0457	−0.0303	−0.0075	1	–	–
Risk	0.1758	−0.0801	−0.0179	0.0270	1	–
Z-score	−0.2605	0.2156	−0.0346	−0.0178	−0.2072	1

existence of heterogeneity and non-Gaussian distributions (Koenker 2004), which are common when dealing with firm growth data.

As our focus in this paper is whether the impact of banking concentration on various firm growth quantiles (high- medium- low-growth firms) differentiates between smaller and larger firms; post- and pre-crisis periods; periphery and core countries, we proceed empirically as follows. First, the differentiation of the impact among firms of varying degree of growth is captured by the use of conditional quantile regressions which enables us to obtain parameter estimates at various parts of the firm growth distribution (from slower to faster growth firms) conditional on banking concentration.[2] Second, to capture potential size, location and financial crisis effects exerted from the main variable of interest, bank concentration, on firm growth by conditional quantile, we estimate three versions of a quantile regression model as specified below.

A linear panel quantile regression model is formulated with dependent variable the firm growth and explanatory variables the banking concentration variable—the variable of primary interest in our analysis—and the firm-specific and financial country-specific variables already presented. Hence, the empirical model we estimate takes the general form:

$$\begin{aligned} g_{ij,t} = \delta + \lambda(q)_1 CR * Dummy + \lambda(q)_2 CR * (1 - Dummy) + \lambda(q)_3 Size_{i,j,t} \\ + \lambda(q)_4 Liq_{i,j,t} + \lambda(q)_5 Lev_{i,j,t} + \lambda(q)_6 Risk_{j,t} + \lambda(q)_7 Stab_{j,t} + a_{ij} + u_{ij,t} \end{aligned} \tag{5.1}$$

where $g_{ij,t}$ denotes the growth rate of firm i in country j at time t. CR denotes the banking concentration variable and $Dummy$ stands for a dummy variable that allows us to differentiate the impact of CR between the three cases mentioned earlier. The parameters $\lambda(q)$ capture slope coefficients at various quantiles q $(0 < q < 1)$ of the conditional distribution. The α_{ij} are the fixed effects, δ is the constant term and $u_{ij,t}$ is the disturbance term. Among the explanatory variables, initial firm size (*Size*), leverage (*Lev*) and liquidity (*Liq*) are lagged one year to take into account potential

[2]For a more detailed and intuitive explanation of conditional quantile regression models see Hao and Naiman (2007) and Capasso et al. (2013).

endogeneity issues. Finally, the two country specific variables included are financial stability (*Stab*) and sovereign risk (*Risk*).

In estimating (5.1), the variable *Dummy* takes three possible values: Micro, Crisis, and Periphery defined as follows:

Case 1: Dummy = Micro = 1 if firm sales are less than €2 million[3] and 0 otherwise.
Case 2: Dummy = Crisis = 1 if firm operates in the post-crisis years 2009–2011 and 0 if it operates in the pre-crisis period.
Case 3: Dummy = Periphery = 1 if firm is located in the European periphery (Greece, Spain, Portugal, Slovenia, Italy, Ireland, Cyprus) and 0 if located in the other countries of the euro area.

Hence, we estimate regression (5.1) separately for each of the above three cases which correspond to the main questions posed in this paper, namely whether the potential role of banking concentration in firm growth is differentiated between micro and larger firms; post-crisis and pre-crisis years; periphery and core countries. Regarding the quantiles considered we chose to report the following five levels q = 10, 25, 50, 75 and 90% as more representative to answer the above questions.

5.4 Results

The key empirical findings obtained from panel quantile regressions are presented in Tables 5.2, 5.3 and 5.4, where the estimated coefficients are provided along with the standard errors in order to report the significant (or not significant) role of the explanatory variables in firm growth. In particular, the three tables report the estimation results corresponding to the three versions of Eq. (5.1) described in the previous section.

Our findings in Table 5.2 show that banking concentration has a strong and negative effect for the growth of micro firms, apart from the high-growth micro firms in the 75 and 90% conditional quantiles in which the relevant impact appears insignificant. On the other hand for larger firms, this relationship is significant and turns to be positive for only superfast high-growth firms (90% quantile). These interesting results imply that after conditioning on the control variables large firms with a high-growth commitment exhibit higher growth rates in countries with a more concentrated banking sector compared to large high-growth firms operating in countries with a lower degree of banking concentration. On the contrary, micro low-growth firms experience a higher contraction in terms of growth rates in a country where the banking sector is more concentrated compared to micro low-growth firms operating in countries characterized by less concentrated banking

[3]Following the definition of firm size groups provided.

Table 5.2 Firm growth and the differentiated effect of banking concentration, micro versus larger firms

	Panel quantile regressions				
	10%	25%	50%	75%	90%
CR*(Micro)	−0.148*** (0.042)	−0.044*** (0.014)	−0.033*** (0.012)	−0.036 (0.019)	0.050 (0.050)
CR*(1-Micro)	−0.101 (0.054)	−0.027 (0.017)	−0.004 (0.014)	0.047 (0.026)	0.304*** (0.073)
Size	0.018*** (0.003)	0.004*** (0.001)	−0.002** (0.001)	−0.019*** (0.002)	−0.053*** (0.005)
Liquidity	−0.010 (0.007)	−0.003** (0.001)	−0.0003 (0.002)	0.002 (0.006)	0.012 (0.016)
Leverage	−0.016 (0.011)	−0.0002 (0.002)	−0.0002 (0.0001)	0.0001 (0.0002)	0.0001 (0.010)
Risk	−0.898*** (0.134)	−0.546*** (0.047)	−0.458*** (0.044)	−0.568*** (0.058)	−0.649*** (0.152)
Z-score	0.003*** (0.001)	0.002*** (0.0003)	0.001*** (0.0003)	0.001*** (0.0004)	0.002 (0.001)
Constant term	−0.225*** (0.061)	−0.023 (0.024)	0.142*** (0.021)	0.471*** (0.035)	1.005*** (0.103)

Notes **The null hypothesis that each coefficient is equal to zero is rejected at the 5% level of significance. *** The null hypothesis that each coefficient is equal to zero is rejected at the 1% level of significance. Standard errors are reported in parentheses

Table 5.3 Firm growth and the differentiated effect of banking concentration, post-crisis versus pre-crisis periods

	Panel quantile regressions				
	10%	25%	50%	75%	90%
CR*(Crisis)	−0.287*** (0.044)	−0.136*** (0.018)	−0.068*** (0.011)	−0.067*** (0.019)	−0.018 (0.051)
CR*(1-Crisis)	−0.038 (0.034)	0.007 (0.013)	0.010 (0.011)	0.016 (0.021)	0.140*** (0.052)
Size	0.020*** (0.002)	0.005*** (0.001)	−0.001 (0.001)	−0.013*** (0.001)	−0.034*** (0.003)
Liquidity	−0.009 (0.007)	−0.003*** (0.001)	−0.001 (0.002)	0.003 (0.006)	0.018 (0.017)
Leverage	−0.016* (0.010)	−0.0001 (0.003)	−0.0002 (0.0002)	−0.0001 (0.0002)	−0.0005 (0.011)
Risk	−0.385** (0.161)	−0.209*** (0.059)	−0.288*** (0.045)	−0.364*** (0.065)	−0.188 (0.159)
Z-score	0.003*** (0.0006)	0.002*** (0.0003)	0.001*** (0.0003)	0.002*** (0.0005)	0.001 (0.001)
Constant term	−0.342*** (0.053)	−0.081*** (0.020)	0.099*** (0.017)	0.356*** (0.035)	0.688*** (0.085)

Notes **The null hypothesis that each coefficient is equal to zero is rejected at the 5% level of significance. ***The null hypothesis that each coefficient is equal to zero is rejected at the 1% level of significance. Standard errors are reported in parentheses

Table 5.4 Firm growth and the differentiated effect of banking concentration, periphery versus core countries

	Panel quantile regressions				
	10%	25%	50%	75%	90%
CR*(Periphery)	−0.180*** (0.062)	−0.047** (0.019)	−0.027 (0.014)	−0.001 (0.023)	0.312*** (0.076)
CR*(1-Periphery)	−0.142*** (0.043)	−0.039*** (0.013)	−0.023** (0.012)	−0.024 (0.018)	0.091 (0.055)
Size	0.020*** (0.002)	0.006*** (0.001)	−0.001 (0.001)	−0.014*** (0.001)	−0.035*** (0.003)
Liquidity	−0.010 (0.007)	−0.003*** (0.001)	−0.0001 (0.002)	0.002 (0.006)	0.025 (0.017)
Leverage	−0.016 (0.011)	−0.0003 (0.003)	−0.0002 (0.0001)	−0.00002 (0.0002)	−0.0005 (0.008)
Risk	−0.774*** (0.174)	−0.524*** (0.067)	−0.443*** (0.060)	−0.627*** (0.067)	−1.066*** (0.196)
Z-score	0.003*** (0.001)	0.002*** (0.0003)	0.001*** (0.0003)	0.001*** (0.0005)	0.004*** (0.001)
Constant term	−0.279*** (0.052)	−0.041** (0.020)	0.116*** (0.019)	0.412*** (0.031)	0.786*** (0.076)

Notes **The null hypothesis that each coefficient is equal to zero is rejected at the 5% level of significance. *** The null hypothesis that each coefficient is equal to zero is rejected at the 1% level of significance. Standard errors are reported in parentheses

systems. A potential explanation may be that large high-growth firms rely less on banks for finance and have better access to financial markets to raise funds.

Furthermore, in Table 5.3 our results indicate that in the post-crisis period banking concentration appears to be significant for the growth of all firms apart from the superfast-growth firms in the 90% quantile in which this strong effect disappears. This implies that in the post-crisis period low-growth firms in countries with a less concentrated banking system contract to a greater extent than the respective low-growth firms in countries with a more concentrated banking sector.

On the contrary, in the pre-crisis period we provide evidence that banking concentration does not matter except for the superfast 90% quantile which it plays a significant role. The insignificant coefficient at medium and low quantiles and the positive significant coefficient at the highest quantile suggest that the right tail of the firm growth conditional distribution becomes longer as banking concentration increases. This finding indicates that under normal economic conditions, that is pre-crisis, the highest-growth firms in a country where the banking sector is concentrated grow faster than the highest-growth firms in a country where the banking sector is less concentrated.

Also, in Table 5.4 it has been found that banking concentration plays a negative and significant role in the growth of low-growth (10 and 25% quantiles) firms located in the euro-area periphery and core countries. But although our results provide evidence that location in the periphery versus core countries does not differentiate the negative impact of banking market power on the performance of low-growth firms, it should be noted that the coefficients are larger in the case of periphery countries hinting at a more intensive response there. Also the results for the 75% quantile do not show any significant relationship between banking concentration and firm growth in either location. However, in the case of superfast-growth firms (90% quantile) differentiation seems to be evident between those located in the periphery and those located in core countries. In particular, the banking concentration coefficient appears to be significant with a positive sign only for superfast-growth firms located in the periphery, while it is insignificant for the respective ones located in the core countries.[4]

Overall, these results suggest that within the European periphery, the superfast-growth firms succeed faster growth patterns in environments characterized by a higher degree of banking concentration compared to superfast-growth firms operating in countries with a low banking concentration ratio. On the other hand, regarding the case of low-growth firms, the results clearly show that in both the periphery and the core countries examined the contraction of growth rates is more harmful in more concentrated banking systems compared to the low-growth firms operating in less concentrated banking systems.

Finally, with respect to the other examined variables that may affect the growth of listed euro-area firms, we find that higher financial stability facilitates firm growth, while higher sovereign risk obstructs firm growth as expected. Moreover, firm size has a positive effect in the lower quantiles of 10 and 25% of the firm growth distribution, while this effect turns to be negative in the upper quantiles of 75 and 90%. Regarding firm liquidity and leverage, our results indicate in most cases an absence of any strong association with firm growth.

5.5 Conclusions

This research explores the role of banking concentration in firm growth distribution. Emphasis is given to potential differentiation of such an effect on high- and low-growth firms between pre- and post-crisis years; micro and larger firms; and periphery and core countries in the euro area. To examine these different aspects of the firm growth-banking concentration nexus, we use panel quantile regressions and interact the banking concentration variable with pre- and post-crisis periods, micro-and larger size groups and core-periphery locations.

For the empirical analysis a combination of firm-level and country-level datasets are utilized based on a sample of 2075 listed firms operating in the euro-area countries during a 7-year time frame (2005–2011). Estimation results highlight that high-growth firms of large size, in pre-crisis and located in the periphery countries

[4]It should be noted that a similarity hypothesis between the CR*Dummy and CR*(1-Dummy) coefficients was rejected in all cases by an F test at 0.05.

exhibit faster growth rates in more concentrated banking systems compared to the respective ones in less concentrated banking systems. On the contrary, low-growth firms of micro size, in post-crisis that are located in the periphery and core countries experience more pronounced contractions in their growth patterns in more concentrated banking systems compared to the respective ones in less concentrated banking systems.

The above results provide a better understanding of the association between firm growth and banking concentration which may be useful for shaping policy reforms to encourage firm growth and expedite economic recovery.

Acknowledgement We would like to thank the reviewers for insightful comments and suggestions.

References

Allen, F., & Gale, D. (2004). Competition and financial stability. *Journal of Money, Credit, and Banking, 36*(3), 453–480.

Audretsch, D. B., & Mahmood, T. (1995). New firm survival: New results using a hazard function. *The Review of Economics and Statistics, 77*(1), 97–103.

Beck, T., & Demirgüç-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance, 30*(11), 2931–2943.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance, 30*(5), 1581–1603.

Black, S. E., & Strahan, P. E. (2002). Entrepreneurship and bank credit availability. *The Journal of Finance, 57*(6), 2807–2833.

Bonaccorsi di Patti, E., & Dell'Ariccia, G. (2004). Bank competition and firm creation. *Journal of Money, Credit, and Banking, 36*(2), 225–251.

Boyd, J. H., & De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance, 60*(3), 1329–1343.

Capasso, M., Cefis, E., & Frenken, K. (2013). On the existence of persistently outperforming firms. *Industrial and Corporate Change, 23*(4), 997–1036.

Carbo-Valverde, S., Rodriguez-Fernandez, F., & Udell, G. F. (2009). Bank market power and SME financing constraints. *Review of Finance, 13*(2), 309–340.

Cefis, E., & Marsili, O. (2005). A matter of life and death: Innovation and firm survival. *Industrial and Corporate Change, 14*(6), 1167–1192.

Cetorelli, N., & Strahan, P. E. (2006). Finance as a barrier to entry: Bank competition and industry structure in local US markets. *The Journal of Finance, 61*(1), 437–461.

Claessens, S., & Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit, and Banking, 36*(3), 563–583.

Fielding, D., & Rewilak, J. (2015). Credit booms, financial fragility and banking crises. *Economics Letters, 136,* 233–236.

Fotopoulos, G., & Louri, H. (2000). Determinants of hazard confronting new entry: Does financial structure matter? *Review of Industrial Organization, 17*(3), 285–300.

Hao, L., & Naiman, D. Q. (2007). *Quantile regression*. (No. 149). Sage.

Henrekson, M., & Johansson, D. (2010). Gazelles as job creators: A survey and interpretation of the evidence. *Small Business Economics, 35*(2), 227–244.

Koenker, R. (2004). Quantile regression for longitudinal data. *Journal of Multivariate Analysis, 91*(1), 74–89.

Laeven, L., & Valencia, F. (2013). The real effects of financial sector interventions during crises. *Journal of Money, Credit and Banking, 45*(1), 147–177.

Petersen, M. A., & Rajan, R. G. (1995). The effect of credit market competition on lending relationships. *The Quarterly Journal of Economics, 110*(2), 407–443.

Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. *The American Economic Review, 88*(3), 559–586.

Ratti, R. A., Lee, S., & Seol, Y. (2008). Bank concentration and financial constraints on firm-level investment in Europe. *Journal of Banking & Finance, 32*(12), 2684–2694.

Rice, T., & Strahan, P. E. (2010). Does credit competition affect small-firm finance? *The Journal of Finance, 65*(3), 861–889.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics, 33*(2), 141–149.

Chapter 6
Brexit and Global Implied Volatility Indices

Imlak Shaikh

Abstract The study examines major implied volatility indices of Eurozone, Asia-Pacific, Africa, Canada and USA on the event of Brexit poll of UK. To investigate the fear and greed of investors' on this historical event, we consider the window of 11-days. The findings suggest that investors' degree of over-reaction on Brexit decision was very disappointing and fueled concerns on the future investment and portfolio choices. The key volatility indices were on the rise prior to the decision, while the market noticed astray and breached its normal range on the day of Brexit poll results. The results are consistent with the market efficiency, and options trading that contain enough information to explain future stock market volatility. Definitely, the work has practical implications to volatility traders and portfolio managers. This empirical attempt provides a good opportunity for researchers in financial economics to examine global linkages of financial markets, more specifically gives an insight how EU's financial system and equity markets will perform in future. The Brexit events will change the way of risk management and assets management in the Europe and neighbor countries.

Keywords Abnormal returns · Brexit · Cumulative abnormal returns
Implied volatility · Stock returns · Volatility index

JEL Classification G11 · G14 · G15

6.1 Introduction

In the financial studies, numerous attempts indicate that financial, economic, technological and political shocks: such as global financial crisis, commodity price shocks and information technology bubble have significant effects on regional and national capital markets. An adjacent look at the global financial markets

I. Shaikh (✉)
Management Development Institute, Gurgaon 122007, Haryana, India
e-mail: imlak.shaikh@mdi.ac.in

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_6

performance and a cautious attention to recent global security issues such as terrorist attacks wield several contradicting market behaviors. However, although some scholars analyze cross-border capital movements and stock markets indices around historical market information (e.g. Hamao et al. 1990; Äijö 2008; Wagner and Szimayer 2004), there is a lack of research on the new market information events such as terrorist attacks, political uncertainty and regional fragmentations. The article, therefore, fills this important knowledge gap and underwrites to economic events literature by analyzing the behavior of global equity market on the historical Brexit announcement.

On 23 June 2016, Britain chosen to leave the European Union (EU), and the Brexit dialogs between the UK and the EU are presently enduring. In the quest of examination of equity market, we consider 12 prominent implied volatility indices (i.e. VIX, the trademark of CBOE) across the world stock markets. While the Brexit negotiation started investors' excitement about the portfolio management has increased. The global equity market has lost approximately US $2–3 trillion stock value due to the Brexit decision of UK. The implied volatility is the investors' fear and excitement index and stock markets' volatility expectation for the next 30-calendar days. Due to Brexit pronouncement on the Friday 24, 2016, the expected stock market volatility closed worldwide between 20 and 36%. The FTSE market reported VFTSE about 26% and Eurozone STOXX volatility VSTOXX reached at 36%. The high level of VIX as reported on Brexit day indicates the high degrees of market turmoil, and greater fear among the market players. The market players have started to reorganize their stock portfolio and buying safer and volatility products to hedge market position. Indeed, a great amount of distress is more likely to happen between UK and EU on this Brexit decision. The contagion effects can be observed for the next few years in terms of trading, investment, national income, economic development and politics.

Äijö (2008) examines the stock market integration in terms of implied volatility index (VDAX, VSMI & VSTOXX). The study concluded that the terms structure of implied volatility of these markets is highly correlated. On the information content of implied volatility as the forecast of future stock market volatility, it is confirmed that implied volatility outperforms the historical return volatility (e.g. Christensen and Prabhala 1998; Fleming et al. 1995; Blair et al. 2001; Hansen 2001; Giot 2005). The informational efficiency of implied volatility as a forecast of future volatility also tested in the emerging markets (e.g. Padhi and Shaikh 2014; Shaikh and Padhi 2014, 2016; Shaikh 2018).

Shaikh (2017) recently studies the impact of U.S. presidential election 2016 on global financial markets. The empirical outcome signifies that markets are inefficient in the short-run (i.e., election-year) and allows the opportunity to make abnormal gains from such market anomalies. The 'Republican president elect' has shown negative effects on the Nifty50, S&PASX200, and IPC equity markets while FTSE100, DJIA, Top40, EuroStoxx50 and Nikkei225 have reported positive returns. Whaley (2000, 2008) calculated the implied volatility for the OEX option market and first time reported the VIX as the volatility index and named investors' fear gauge index because investors are risk averse. The information contained in the important announcement and its impact on the investors' fear well documented in the studies of Nikkinen and Sahlström (2001, 2004), Kearney and Lombra (2004), Chen and Clements (2007) and Antonakakis et al. (2013) and also report that decline in the stock returns triggers the high level of implied volatility. Following the above-mentioned literature one can say that implied volatility is the measure of investors' market concern and remain on the higher side under political and economic uncertainties. Hence, the present work uncovers the effects of Brexit referendum on global financial markets gauged in the implied volatility index.

The empirical work has been prepared as Sect. 6.2 offers the data and empirical model, Sect. 6.3 reports the summary statistics and important results on Brexit and Sect. 6.4 concludes the paper.

6.2 Data Description and Econometric Model

6.2.1 Data Sources and Description

In order to analyze the impact of Brexit we collected the data on volatility indices across the global equity markets for 12 prominent stock markets viz. USA, UK, Switzerland, Germany, Eurozone, China, India, Japan, Korea, Australia, Canada and South Africa. The occurrence of the dataset sampled daily for the period January, 2015 to July, 2016. By convention most of the samples reported 240–260 trading days in the estimation window. There is a strong negative correlation between volatility and stock returns hence we consider the respective stock indices for all volatility indices. The volatility indices of the respective countries are comprising of observed options prices written on the underlying stock index.

The Brexit event 'UK exit of EU' announced on 24th June 2016. The global stock market response to the Brexit depicted graphically (see, Fig. 6.1). Figure 6.1 is the time series plot of AR and CAR for the event window; it is clearly observable that AR and CAR appears on the positive panel of the graph. This indicates that Brexit formed an ambiguity among the market participant throughout the Brexit negotiations and final outcome.

The first panel of Fig. 6.1 exhibits the abnormal returns on volatility index, it is seen clearly that AR to be more volatile on the pre-Brexit announcement and reaches at its extreme on the Brexit poll day. The AR deeps from 20 to −18% and near zero in the post announcement of Brexit. The second panel of Fig. 6.2 shows the plot of cumulative abnormal returns and one can see that more than 90% observations fall on the positive panel. The values of CAR remain more variable in the pre-Brexit period reaches up to 58% then falls exponentially in the post-Brexit period.

Table 6.1 describes the summary statistics for 12 prominent financial market around Brexit referendum. The rational of presenting descriptive measures is to show how equity market behaved following Brexit uncertainty. Panel A of Table 6.1 report the level equity indices and returns. It is seen clearly that majority

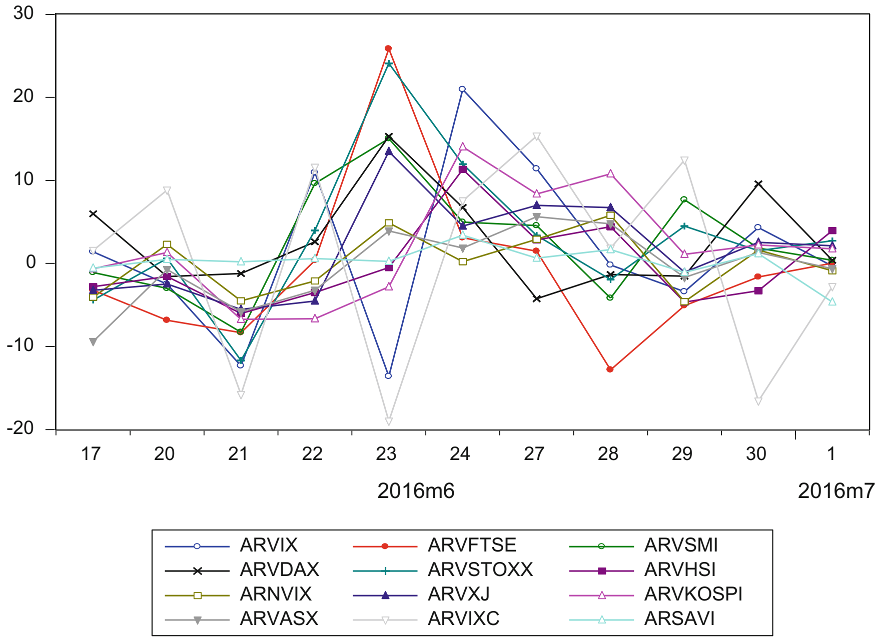


Fig. 6.1 Time series plot of abnormal returns (AR) for event window

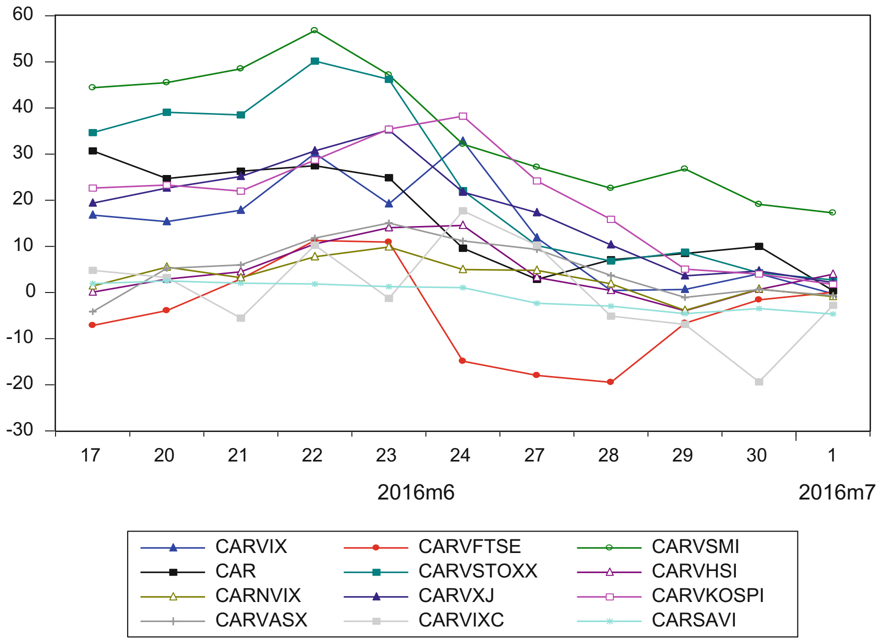


Fig. 6.2 Time series plot of cumulative abnormal returns (CAR) for event window

of the markets has experienced negative returns in Brexit event window. The annualized average returns of FTSE appear to be −11.59%, and the second highest loss occurred to Switzerland (SMI) −6.35% and Eurozone lost about −1.59%. In the Asia pacific counterpart Hon Kong, India, Japan and Korea were the main loser on Brexit concern. The other measures of central tenday, maximum and minimum statistics well explains that Brexit does contain important market related information and influenced the market participants. By looking at the volatility of the equity returns Eurozone (3.58) has shown greater amount of returns variability followed the Brexit negotiations with UK. Panel B shows the descriptive measures on VIX of 12 equity markets. One of the important findings reported in this table is that the average returns on the volatility index appears to be positive and it was highest for the Switzerland (4.42%) and Eurozone (3.74%). The maximum level implied volatility was stood for Japan (VXJ) 41.31%, second highest Eurozone (VSTOXX) 39.90%, then Germany (VDAX) 30.90% and UK (VFTSE) 31.27%. If we look at the volatility of volatility (i.e. standard deviation) the USA (VIX) has shown highest level of concern 17.55, then Canada (VIXC) 14.94, Korea (VKOSPI) 11.07 and Japan (VXJ) 8.68%. At this point one can say that summary statistics does provides adequate evidences that Brexit hold important concern for the financial market not only EU but also other continent of the globe.

Table 6.2 reports the correlation matrix of equity index and underlying volatility index. It is known that due to leverage and volatility feedback effects both indices are negatively associated. The degree of association also found to be statistically significant. It is clearly visible from the correlation coefficients that all markets do have asymmetric relation between stock and volatility index. There are four equity markets (i.e. UK −0.79, USA −0.74, Canada −0.74 and India −0.72) those have shown significant high degree of negative correlation followed by Brexit referendum.

6.2.2 *Econometric Model*

The event study methodology has been employed to study the impact of Brexit across the global equity markets. The event study requires event window and estimation window. To account for the investors' behavior on the Brexit we took the event window for 11-day, that is 5-day prior the event and 5-day post event. The estimation window ranges from 240 to 260 trading days for the sample period. The log-transformed percentage returns have been calculated as,

Stock index returns

$$R_{t_m} = ln\left(\frac{P_t}{P_{t-1}}\right) * 100 \tag{6.1}$$

and, returns on volatility index

Table 6.1 Summary statistics

Panel A	Underlying index and returns [11-days window]											
	USA		UK		Swiss		Germany		Europe		Hon Kong	
	SPX	RSPX	FTSE	RFTSE	SMI	RSMI	DAX	RDAX	STOXX	RSTOXX	HSI	RHSI
Mean	2071.71	−0.08	6250.40	−0.73	7885.87	−0.40	9752.60	−0.07	2847.92	−0.10	20,541.88	−0.26
Median	2083.25	−0.27	6226.55	−1.12	7935.75	−0.51	9680.09	−0.70	2832.18	−1.05	20510.20	−0.61
Maximum	2113.32	3.66	6577.83	3.20	8085.21	3.50	10,257.03	7.07	3037.86	9.01	21,059.20	2.96
Minimum	2000.54	−1.76	5982.20	−3.51	7594.49	−2.60	9268.66	−3.38	2697.44	−4.43	20,169.98	−1.74
Std. Dev.	34.02	1.65	185.29	2.19	155.49	1.85	295.75	2.88	95.78	3.58	313.68	1.43
	India			Japan	Korea		Australia		Canada		South Africa	
	NIFTY50	RNIFTY	NKY	RNIKKEI	KOSPI	RKOSPI	AS51	RASX	SPTSX60	RSPTX	TOP40	RTOP
Mean	8203.09	−0.22	15,677.07	−0.10	1963.53	−0.19	5201.95	−0.21	813.33	−0.21	45,764.60	0.04
Median	8204.00	−0.49	15,599.66	−0.68	1970.35	−0.49	5233.38	−0.33	814.92	−0.24	45,732.46	−0.19
Maximum	8328.35	2.22	16,238.35	8.25	1992.58	3.14	5280.68	3.22	829.10	1.91	47,015.52	3.18
Minimum	8088.60	−1.02	14,952.02	−2.36	1925.24	−1.41	5103.27	−1.81	796.31	−1.39	44,142.75	−2.16
Std. Dev.	77.80	0.92	400.74	2.92	25.26	1.20	70.06	1.35	9.02	1.11	811.73	1.86
Panel B	Underlying volatility index and returns [11-days window]											
	USA		UK		Swiss		Germany		Europe		Hon Kong	
	USVIX	RVIX	VFTSE	RVFTSE	VSMI	RVSMI	VDAX	RVDAX	VSTOXX	RVSTOXX	VHSI	RVHSI
Mean	19.10	2.00	26.12	3.65	24.68	4.42	25.93	2.99	33.16	3.74	24.21	1.45
Median	18.48	5.66	27.09	7.15	25.64	5.65	25.39	0.04	35.00	4.80	24.52	2.08
Maximum	25.76	24.06	31.27	16.82	29.71	15.39	30.90	13.38	39.90	12.10	28.20	11.05
Minimum	14.77	−40.10	19.93	−12.01	18.07	−6.08	22.01	−1.08	25.02	−9.99	21.23	−12.28
Std. Dev.	3.36	17.55	3.70	9.04	3.86	7.32	2.19	5.21	5.00	6.95	1.95	6.40

(continued)

Table 6.1 (continued)

Panel A	Underlying index and returns [11-days window]											
	USA		UK		Swiss		Germany		Europe		Hon Kong	
	SPX	RSPX	FTSE	RFTSE	SMI	RSMI	DAX	RDAX	STOXX	RSTOXX	HSI	RHSI
	India			Japan	Korea		Australia		Canada		South Africa	
	NVIX	RNVIX	VXJ	RVXJ	VKOSPI	RVKOSPI	VASX	RVASX	VIXC	RVIXC	SAVI	RSAVI
Mean	17.40	0.98	33.50	2.28	16.91	3.27	20.90	0.54	16.55	1.52	23.08	0.01
Median	17.52	0.91	33.57	4.45	16.71	5.39	20.46	2.12	16.20	2.80	23.04	0.60
Maximum	18.63	9.27	41.31	13.29	22.53	17.01	23.73	7.94	20.06	21.17	23.81	3.22
Minimum	15.74	−5.22	28.29	−16.63	12.91	−21.51	18.92	−9.06	13.07	−28.20	22.17	−7.05
Std. Dev.	0.97	3.89	3.63	8.68	2.68	11.07	1.54	5.02	2.26	14.94	0.60	3.01

Table shows the descriptive measures on 12 prominent financial market followed by Brexit event. The summary statistics are calculated for the event window, 11-days, and presenting the performance of index level (stock and volatility) and associated returns

Table 6.2 Correlation matrix

		USA	UK	Swiss	German	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
		SPX	FTSE	SMI	DAX	STOXX	HSI	Nifty	Nikkei	KOSPI	ASX	SPTX	Top40
USA	VIX	−0.7437											
UK	VFTSE		−0.7872										
Swiss	VSMI			−0.5297									
Germany	VDAX				0.1134								
Europe	VSTOXX					−0.1421							
Hon Kong	VHSI						−0.6187						
India	NVIX							−0.7199					
Japan	VXJ								−0.3738				
Korea	VKOSPI									−0.6377			
Australia	VASX										−0.5573		
Canada	VIXC											−0.7387	
S. Africa	SAVI												−0.3098

Table shows correlation between stock index and volatility index. All statistics are significant at 5% and 10% level

$$r_{t_{vix}} = ln\left(\frac{VIX_t}{VIX_{t-1}}\right) * 100 \tag{6.2}$$

The investors' sentiment gauged in the fear index (e.g. Whaley 2008) examined followed by the Brexit event. Therefore, the normal and abnormal returns are being calculated as,

Normal returns on volatility index

$$= N(r_{t_{vix}})$$

and, the expected returns on the volatility index is estimated via its underlying stock index (see e.g. Fleming et al. 1995).

$$E(r_{t_{vix}}) = \hat{\varphi}_0 + \hat{\varphi}_1 R_{t_m} \tag{6.3}$$

$\therefore$ Abnormal Returns

$$\begin{aligned} AR &= N(r_{t_{vix}}) - E(r_{t_{vix}}) \\ &= r_{t_{vix}} - \{\hat{\varphi}_0 + \hat{\varphi}_1 R_{t_m}\} \end{aligned} \tag{6.4}$$

The abnormal returns (AR) and cumulative abnormal returns (CAR) have been calculated for the 11-days window (i.e. ± 5, and 0—the poll announcement day).

6.2.3 Model Description and Hypothesis

Under rational expectation and market efficiency the option prices impound important market wide information. The Brexit event is one of the well scheduled political events of EU's 28-member countries started early February of 2016 and concluded on 24 June 2016. The implied volatility is the market expectation for the future stock market volatility (e.g. Giot 2005; Whaley 2008). The expected stock market volatility rises significantly before the event and goes normal after the scheduled event become publicly available (e.g. Nikkinen and Sahlström 2004). Below are some of the important hypotheses to be tested on the Brexit event connected with the investors' fear and excitement index.

H_1: *On Brexit, returns on the implied volatility index (stock index) should be positive (negative)*:

If implied volatility is the gauge of investors' fear on the uncertain events to occur then the returns associated with such event should be reported negative. Hence, pre-Brexit and on the day of Brexit decision returns on volatility index should be positive.

H_2: Does Brexit have asymmetric effects across 12 equity markets under study?

In order to determine, does Brexit contain market related information, then median values of AR and CAR across the 12 markets should appear different and statistically significant.

H_3: Abnormal and Cumulative abnormal returns should be positive:

If the market regards the Brexit event then around the event window (11-day) the values of AR and CAR should be positive and statistically significant.

6.3 Empirical Results and Discussion

6.3.1 Descriptive Statistics on Abnormal Returns and Cumulative Abnormal Returns

Table 6.3 summarizes the descriptive statistics returns volatility index around the event window. Starting with Panel A which shows the summary of abnormal returns across 12 equity markets. The mean, in majority of the cases abnormal returns on implied volatility indices appear to positive as hypothesized. If Brexit hold some forward-looking information then AR should be positive, the results are quit in line with the stated hypothesis. The hypothesis is also valid for the CAR (See Panel B), reported on an average positive for all stock markets. It is noticed that AR and CAR of UK appears to be negative. The origin of the Brexit event is Britain; hence the market players of FTSE have already conceived the consequences of Brexit in their portfolio selection. Looking at the variability of abnormal returns Canadian and US market have shown highest concern followed by UK and Eurozone. The similar evidences are observed in case cumulative abnormal returns. The European markets have reported highest overreaction with 18.15 volatility, and next Switzerland 13.64 and in Asian counterpart Japan (11.14) and Korea (11.14).

Table 6.4 explains the effects of Brexit across the 12-equity market under the null that Brexit does have symmetric effects. To test the null a summary of non-parametric tests has been reported in Table 6.4. In case of tests of median of AR among 12 equity market the null is accepted while median CAR is not accepted. The non-parametric tests allow us to conclude that Brexit does have asymmetric effects across the global equity markets.

6.3.2 Brexit And Investors' Sentiment

Table 6.5 displays the abnormal and cumulative abnormal returns on the investors' fear gauge index of samples stock markets. The table reports the AR and CAR for

Table 6.3 Descriptive measures on AR and CAR

Panel A: abnormal returns (AR)												
	USA	UK	Swiss	Germany	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
	ARVIX	ARVFTSE	ARVSMI	ARVDAX	ARVSTOXX	ARVHSI	ARNVIX	ARVXJ	ARVKOSPI	ARVASX	ARVIXC	ARSAVI
Mean	1.5223	−0.6508	2.5014	2.7877	3.1485	0.0076	0.1280	1.7620	2.0573	−0.3800	0.4358	0.1726
Median	−0.1904	−1.6354	1.8370	0.3784	2.7189	−1.5778	0.2102	2.1223	1.3130	−0.6652	1.8095	0.4777
Maximum	20.9672	25.8448	15.0284	15.3047	24.0902	11.3141	5.7852	13.4703	14.0410	5.6199	15.3229	3.3834
Minimum	−13.6052	−12.8150	−8.2806	−4.2432	−11.6959	−6.0384	−4.6295	−5.5596	−6.7393	−9.4075	−19.0048	−4.6743
Std. Dev.	10.1972	9.9739	6.7357	5.9544	9.1191	5.1283	3.7041	5.8450	6.6778	4.5813	12.4694	1.9888
Panel B: cumulative abnormal returns (CAR)												
	USA	UK	Swiss	Germany	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
	CARVIX	CARVFTSE	CARVSMI	CARVDAX	CARVSTOXX	CARVHSI	CARNVIX	CARVXJ	CARVKOSPI	CARVASX	CARVIXC	CARSAVI
Mean	13.5173	−4.2398	35.2037	15.6560	23.9324	4.6131	3.1991	17.5161	20.0918	5.1686	0.4547	−0.6887
Median	15.3507	−3.9272	32.1242	9.9590	22.1060	3.2186	3.2047	19.3821	22.6304	5.2277	−1.3079	1.0434
Maximum	32.8035	11.2672	56.7667	30.6642	50.1622	14.5327	9.8553	35.2278	38.2258	15.0388	17.6970	2.4818
Minimum	−0.3043	−19.4905	17.2535	0.3784	2.7189	−4.0023	−3.9166	2.1223	1.7456	−4.1798	−19.3908	−4.6743
Std. Dev.	11.5551	10.4779	13.6409	11.1217	18.1490	5.9612	3.9266	11.1423	12.3093	6.1498	10.2193	2.9037

Table 6.4 Summary of non-parametric test

		Abnormal returns		Cumulative abnormal returns	
Non-parametric method	D.F.	Test-statistics	p-value	Test-statistics	p-value
Med. Chi-square	11	7.64	0.746	50.55	0.000*
Adj. Med. Chi-square	11	4.00	0.970	37.82	0.000*
Kruskal-Wallis	11	6.04	0.871	70.26	0.000*
Kruskal-Wallis (tie-adj.)	11	6.04	0.871	70.26	0.000*
van der Waerden	11	4.94	0.934	71.53	0.000*

Significant at *1%, **5%, ***10%

the event window along with t-statistics. If Brexit event impounds important information about the future stock market volatility and inject the market uncertainty among the market participants then, on 24 June 2016 the AR and CAR should be reported positive.

It is hypothesized that t-statistics ofAR and CAR should appear statistically significant if Brexit hold some effects across the global equity markets. Here, we calculate AR and CAR on volatility index hence the expected sign of AR and CAR should be positive on the poll announcement day. The AR and CAR values in the pre-Brexit window should be positive and in post-Brexit window should be at normal level. Panel A of Table 6.5 show that on the poll day all the equity market has shown positive AR on volatility index but only 6 markets out of 12 has reported significant overreaction to the Brexit event. While we consider CAR values and their t-statistics as shown in Panel B. It is seen that 11 markets have reported positive CAR with significant t-statistics except to UK and South Africa. The plausible reason that CAR of UK appears negative that it has already impound the information in terms of equity trading and options pricing. In many cases the values of AR and CAR in Table 6.5 appears as hypothesized for the pre and post Brexit window.

The values shown with bold letters and † signifies that results are in line with the stated hypotheses. One of the important observation from Panel B is that all the values of CAR appears to be positive for Switzerland, Germany and Eurozone. This signifies that market participant from SMI, DAX and STOXX are more worried about their market holding, the reason they relied more on options to hedge market holdings.

The decision of exit of Britain from EU caused great amount of fretfulness among the market stakeholders and hence implied volatility increased exponentially and exceeded its normal range. The anxiety and concern about this historical event propel to the investors to more buying pressure on options, which ultimately resulted into higher level of premium and higher expected volatility.

It is known that due to uncertainty about the Brexit decision expected stock market volatility increased significantly. One can clearly examine from the table that CAR appears to be positive (pre-event window) and statistically significant.

Table 6.5 Investors' sentiment and Brexit

Panel A: abnormal returns for volatility index

E-window	USA	UK	Swiss	Germany	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
	ARVIX- t-stat	ARVFTSE- t-stat	ARVSMI- t-stat	ARVDAX- t-stat	ARVSTOXX- t-stat	ARVHSI- t-stat	ARNVIX- t-stat	ARVXJ- t-stat	ARVKOSPI- t-stat	ARVASX- t-stat	ARVIXC- t-stat	ARSAVI- t-stat
−5	0.32†	−0.73	−0.28	1.46†	−1.14	−0.64	−0.97	−0.59	−0.15	−2.01**	0.20†	−0.24
−4	−0.58	−1.56	−0.79	−0.39	0.15†	−0.36	0.54†	−0.45	0.29†	−0.16	1.17†	0.20†
−3	−2.86*	−1.89***	−2.17**	−0.30	−3.00*	−1.37	−1.08	−1.01	−1.49	−1.25	−2.09**	0.07†
−2	2.55**†	0.08	2.52***†	0.64†	1.02†	−0.80	−0.51	−0.83	−1.48	−0.69	1.53†	0.23†
−1	−3.16*	5.86*†	3.94*†	3.75*	6.19*†	−0.11	1.17†	2.45**†	−0.63	0.83†	−2.51**	0.09†
0	4.87*	0.70	1.30	1.65***†	3.07*†	2.56**†	0.05†	0.81†	3.10*†	0.40†	0.99	1.38†
1	2.65*†	0.34	1.19	−1.04	0.86†	0.64†	0.69†	1.27†	1.85***†	1.20†	2.02**†	0.26†
2	−0.04	−2.91*	−1.09	−0.33	−0.50	1.00†	1.38†	1.22†	2.38**†	1.02†	0.24	0.67†
3	−0.79	−1.15	2.01**†	−0.38	1.16†	−1.05	−1.11	−0.19†	0.24†	−0.37	1.64***†	−0.45
4	1.00†	−0.37	0.48	2.35**†	0.39	−0.75	0.38†	0.46†	0.49†	0.28†	−2.19**	0.47†
5	−0.07	0.01	0.10	0.09	0.70	0.89†	−0.21	0.39†	0.39†	−0.14	−0.37	−1.91

Panel B: cumulative abnormal returns for volatility index

	USA	UK	Swiss	Germany	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
	CARVIX- t-stat	CARVFTSE- t-stat	CARVSMI- t-stat	CARVDAX- t-stat	CARVSTOXX- t-stat	CARVHSI- t-stat	CARNVIX- t-stat	CARVXJ- t-stat	CARVKOSPI- t-stat	CARVASX- t-stat	CARVIXC- t-stat	CARSAVI- t-stat
−5	3.89*†	−1.62	**11.63*†**	**7.51*†**	**8.90*†**	0.02†	0.34†	3.52*†	5.00*†	−0.89	0.63†	0.78†
−4	3.57*†	−0.89	**11.91*†**	**6.04*†**	**10.03*†**	0.65†	1.31†	4.11*†	5.15*†	1.12†	0.43†	1.02†
−3	4.14*†	0.66†	**12.70*†**	**6.43*†**	**9.88*†**	1.01†	0.76†	4.56*†	4.86*†	1.28†	−0.74	0.82†
−2	7.01*†	2.56**†	**14.87*†**	**6.73*†**	**12.89*†**	2.38**†	1.85***	5.57*†	6.35*†	2.53**†	1.35†	0.75†
−1	4.46*†	2.48**†	**12.35*†**	**6.09*†**	**11.87*†**	3.18*†	2.35**	6.40*†	7.82*†	3.22**†	−0.17	0.52†
0	7.62*†	−3.39*	**8.41*†**	**2.34**†**	**5.68*†**	3.29*†	1.19†	3.95*†	8.45*†	2.39**†	2.34**†	0.43†

(continued)

Table 6.5 (continued)

Panel A: abnormal returns for volatility index

E-window	USA	UK	Swiss	Germany	Europe	Hon Kong	India	Japan	Korea	Australia	Canada	South Africa
	ARVIX- t-stat	ARVFTSE- t-stat	ARVSMI- t-stat	ARVDAX- t-stat	ARVSTOXX- t-stat	ARVHSI- t-stat	ARNVIX- t-stat	ARVXJ- t-stat	ARVKOSPI- t-stat	ARVASX- t-stat	ARVIXC- t-stat	ARSAVI- t-stat
1	2.75*†	−4.09*	**7.11*†**	**0.70†**	**2.61*†**	0.73†	1.14†	3.14*†	5.35*†	1.99**†	1.35†	−0.96
2	0.10†	−4.42*	**5.92*†**	**1.73***†**	**1.74***†**	0.09†	0.45†	1.87***†	3.50*†	0.79†	−0.68	−1.21
3	0.14†	−1.51	**7.01*†**	**2.06**†**	**2.24**†**	−0.91	−0.93	0.65†	1.12†	−0.23	−0.92	−1.88***
4	0.93†	−0.36	**5.00*†**	**2.44**†**	**1.09†**	0.15†	0.17†	0.84†	0.88†	0.14†	−2.56**	−1.44
5	−0.07	0.01†	**4.52*†**	**0.09†**	**0.70†**	0.89†	−0.21	0.39†	0.39†	−0.14	−0.37†	−1.91***

Significant at *1%, **5%, ***10%; † signifies that values on AR and CAR are as hypothesized

If the market has adjusted for this information at that momentafter the event the returns on the volatility index should be negative. The empirical results show that most of the markets recovered from this event by +2 and +3-day after the Brexit poll. More specifically, if we look at Table 6.5, the FTSE specific results are unusual from the other markets. One of the important observations is that the CAR value appears negative on the Brexit decision day and post event i.e. +1 to +4-day expected stock market volatility keeps on decreasing with significant t-statistics. This gives an insight that UK market was more uncertain on this event and goes normal as stock prices reflected its fair values.

6.4 Conclusion

Due to Brexit pronouncement on the Friday 24, 2016, the expected stock market volatility closed worldwide between 20 and 36%. The FTSE market reported VFTSE about 26% and Eurozone STOXX volatility VSTOXX reached at 36%. The high level of VIX as reported on Brexit day indicates the high degrees of market turmoil, and greater fear among the market players. The paper demonstrated the investors' sentiment on the Brexit events that took place on 24 June 2016. We sampled 12 international equity markets encompassed Europe, UK, Asia-pacific, US, Canada and Africa. The event window consisted of 11-day and estimation window ranged from January 2015 to July 2016. The empirical findings clearly show that implied volatility index is the investors' fear and greed index and regarded the Brexit event in the portfolio assortment. The event window evidently exhibited that abnormal and cumulative volatility returns appear to be positive and significant. This indicates that stock prices reflect its fair value due to such event. On the pre-announcement of Brexit, the overall equity market was in greater tension and once the poll declared fear was gauged in the volatility returns. The results are consistent with the market efficiency, and options trading contain enough information to explain future stock market volatility. Now-a-days volatility became an asset class for trading. For the hedging of volatility CBOE has introduced volatility product called volatility futures and options on VIX. Definitely, the work has practical implications to volatility traders and portfolio managers. This empirical attempt provides a good opportunity for researchers in financial economics to examine global linkages of financial markets, more specifically gives an insight how EU's financial system and equity markets will perform in future. The Brexit events will change the way of risk management and assets management in the Europe and neighbor countries.

References

Äijö, J. (2008). Implied volatility term structure linkages between VDAX, VSMI and VSTOXX volatility indices. *Global Finance Journal, 18*(3), 290–302.

Antonakakis, N., Chatziantoniou, I., & Filis, G. (2013). Dynamic co-movements of stock market returns, implied volatility and policy uncertainty. *Economics Letters, 120*(1), 87–92.

Blair, B. J., Poon, S.-H., & Taylor, S. J. (2001). Forecasting S&P 100 volatility: The incremental information content of implied volatilities and high-frequency index returns. *Journal of Econometrics, 105*(1), 5–26.

Chen, E.-T. J., & Clements, A. (2007). S&P 500 implied volatility and monetary policy announcements. *Finance Research Letters, 4*(4), 227–232.

Christensen, B., & Prabhala, N. (1998). The relation between implied and realized volatility. *Journal of Financial Economics, 50*(2), 125–150.

Fleming, J., Ostdiek, B., & Whaley, R. E. (1995). Predicting stock market volatility: A new measure. *Journal of Futures Markets, 15*(3), 265–302.

Giot, P. (2005). Relationships between implied volatility indexes and stock index returns. *The Journal of Portfolio Management, 31*(3), 92–100.

Hamao, Y., Masulis, R. W., & Ng, V. (1990). Correlations in price changes and volatility across international stock markets. *Review of Financial Studies, 3*(2), 281–307.

Hansen, C. S. (2001). The relation between implied and realized volatility in the Danish option and equity markets. *Accounting and Finance, 41*(3), 197–228.

Kearney, A., & Lombra, R. (2004). Stock market volatility, the news, and monetary policy. *Journal of Economics and Finance, 28*(9), 252–259.

Nikkinen, J., & Sahlström, P. (2001). Impact of scheduled U.S. macroeconomic news on stock market uncertainty: A multinational perspecive. *Multinational Finance Journal, 5*(2), 129–148.

Nikkinen, J., & Sahlström, P. (2004). Impact of the federal open market committee's meetings and scheduled macroeconomic news on stock market uncertainty. *International Review of Financial Analysis, 13*(1), 1–12. https://doi.org/10.1016/j.irfa.2004.01.001.

Padhi, P., & Shaikh, I. (2014). On the relationship of implied, realized and historical volatility: Evidence from NSE equity index options. *Journal of Business Economics and Management, 15*(5), 915–934.

Shaikh, I. (2017). The 2016 US presidential election and the stock, FX and VIX markets. *The North American Journal of Economics and Finance, 42,* 546–563.

Shaikh, I. (2018). Investors' fear and stock returns: Evidence from National Stock Exchange of India. *Engineering Economics, 29*(1), 4–12.

Shaikh, I., & Padhi, P. (2014). The forecasting performance of implied volatility index: Evidence from India VIX. *Economic Change and Restructuring, 47*(4), 251–274.

Shaikh, I., & Padhi, P. (2016). On the relationship between implied volatility index and equity index returns. *Journal of Economic Studies, 43*(1), 27–47.

Wagner, N., & Szimayer, A. (2004). Local and spillover shocks in implied market volatility: Evidence for the US and Germany. *Research in international Business and Finance, 18*(3), 237–251.

Whaley, R. E. (2000). The investor fear gauge. *The Journal of Portfolio Management, 26*(3), 12–17.

Whaley, R. E. (2008). Understanding VIX. *Available at SSRN 1296743*. http://ssrn.com/abstract=1296743, 1–12.

Chapter 7
Credit Crunch Testing in Iranian Banking System

Mahshid Shahchera, Fatemeh Noorbakhsh and Homa Monfared

Abstract There are many economic factors related to credit crunch, which includes structure of banking system, private sector, investment and government. Among these factors structure of banking system in Iranian banking system known as the most important one. They consider it as a continuous decline in credit demand. However, number of economists minimized the important factors, which have reduced the ability of credit supply by banks. The credit crunch indicates reduction in credit demand and the weaknesses of balance sheets in banking system. Data analysis is also important to study the credit crunch, and this phenomenon would be develop at the state level, however, economic shock at the national level could decline bank capital. We aim to test the existence of credit crunch in Iranian banking system. We also examine the effective factors, which have significant impact on credit crunch. The purpose of this study is to investigate the main reasons of credit crunch in Iranian banking system including economic and balance sheet structures by GMM econometric model. In order to test credit crunch in Iranian banking system, we use dummy variable. In this case we consider credit crunch dummy variable by capital ratio as an effective variable on growth of loan. The multiplied credit crunch dummy by capital ratio is significantly negative and this result show that the capital ratio could be affected on credit crunch in Iranian banking system.

Keywords Banking system · Credit crunch · Credit supply · Liquidity

JEL Classification G21 · G32 · G28 · C23

M. Shahchera (✉)
Assistance of Monetary and Banking Research Institute,
Central Bank of Iran, Tehran, Iran
e-mail: mahshidshahchera@yahoo.com

F. Noorbakhsh · H. Monfared
Research Assistant of Monetary and Banking Research Institute,
Central Bank of Iran, Tehran, Iran
e-mail: sfnoorbakhsh@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_7

7.1 Introduction

Financial imbalances and shock components are considered to be among the main causes of financial crises. The global financial crisis has showed an important debate related to credit crunch, which is broadly defined as a situation where banks are reluctant to grant loans to the economy. This issue has attracted many economists, politicians and the public because it has important implications on the economy and financial stability. In this regard when firms' liquidity is low and there is a decrease in investment spending a credit supply contraction would particularly harmful and increase the dampening effects of the recession on production and employment.

One important related factor to contraction in credit supply is the difficulties that banks may confront on the liability side of their balance sheets, in maintaining an adequate level of capital. When Lehman Brothers failed, financial panic intensified in the whole world because the credit growth collapses in all developed economies. Although, public authorities largely intervene in order to consider credit crunch, there is no definite evidence for the existence of credit crunch.

In this paper we intend to consider robust evidence of a credit crunch, by using detailed data on Iranian banking system. For this reason, we will consider the Iranian banking data to test whether there is probability of credit crunch in Iran. Our approach is to control for firm's special risk and credit demand by using multiple lenders in Iranian banking system, which allows us to use fixed effects capturing all firms' unobservable characteristics. Also, we will look for changes in bank lending during 2006–2015. In this paper we survey the linkages between bank's lending growth and capital ratio in order to calculate the effect of capital requirements on level of credit crunch. It is important to investigate whether the (capital) credit crunch had a diversified impact across firms.

Erdinç (2009) provides a new approach in order to identify different factors of rapid credit growth in Bulgaria and evaluate the effect of credit boom on banks. She used fixed effects and GMM estimation techniques to explore the link between credit and capital on 30 Bulgarian banks. In this study, we intend to test the occurrence of credit crunch in Iranian banking system. We also examine the effective factors, which have significant impact on credit crunch in this survey. Recent studies simply demonstrate the various factors, which could affect the credit crunch in banks. The purpose of this study is to investigate the main causes of occurring credit crunch in Iranian banking system including: economic and balance sheet structures.

The next section presents the definition of credit crunch and credit supply and the key factors, which are effective on credit crunch incident. In Sect. 7.3 we review the recent studies regarding credit crunch. Section 7.4 describes our dataset on Iranian banking system and the empirical model and the main evidence of a bank capital and credit crunch according to dynamic Panel data. Finally, Sect. 7.5 draws some conclusions.

7.2 Credit Crunch and Credit Supply

There are number of studies related to credit crunch. Many economists provide different definitions about credit crunch and they state that a continuous decline in credit demand would cause credit crunch. In order to consider the credit crunch, there is a hypothesis that the bank capital shortage could decrease the ability of banks in lending. Low capital banks tend to increase their lending level more than high capital banks. It is important to consider type of banks in capital in balance sheet and capital measure in order to study credit crunch.

According to the obtained evidence, there is a significant correlation between capital ratio and lending growth in banking system (Woo 1999). Important economic factors related to credit crunch include structure of banking system, private sector, investment and government. The most important issue among other factors could be the structure of banking system and balance sheet in Iranian banking system. Also, Bayoumi (1998), point out that the main reason for the deterioration of loan in Japanese banking system is the eroded capital position in banks. Capital bank position and non-performing loans could affect the credit crunch incident. According to Syron (1991), credit crunch is defined as the change of lending through business cycles. Since economy fluctuations could affect borrowers and lenders, lending behavior could change through business cycle. Also, credit crunch could be defined as credit availability which is restrictive to business cycles. According to Bernanke and Lown (1991), credit crunch could be defined as a decline in credit supply, which is large and continuous. Also, they consider that supply and demand factors are related to credit crunch. Reduction in loan's demand is related to bank's balance sheet and their capital level. This issue approve by Clair (1989). However, these economists minimized the important factors, which have reduced the ability of credit supply by banks.

On the other hand, Owens and Schreft (1992) consider that the historical background of restrictions on credit regulators and credit controls could also lead to credit crunch incident. Both studies (Bernanke and Lown, Owen and Schreft) define the credit crunch as reduction in credit demand and the weaknesses of balance sheets in banking system. Data analysis is also important for considering credit crunch, and the credit crunch would be develop at the state level, however, economic shock at the national level could decline bank capital (Samolyk 1991). Both studies mentioned above, emphasize that the lack of credit supply is the substitute from nonbank sources of credit. According to Pavel and Rosenblum (1985), credit sources of nonbank institutes are growing increasingly. Keran (1992), states that financial intermediaries in line with banks, influenced by capital reduction resulted from real estate and loan losses.

Reduction in lending is associated with credit crunch. The evidences show that banking sector problems could transmit to the real economy. Banks influence on small- medium size businesses and private sector and also the funding of project which is undertaken banking system. In fact, banks are the main source of debt financing (Gertler and Gilchrist 1993). Peek and Rosengren (1995), cite that the main reason for credit crunch is the capital. The structure of bank capital could lead to bank credit reduction. Banking regulation and binding capital requirement could pressure on measure of capital. They conclude that capital crunch could cause a decline in lending.

According to Berger and Udell (1995), the effect of risk based standards is important and they find that capital could be the reason for credit crunch, which is defined as a significant reduction in credit supply for banks. They find that the large proportion of aggregate assets held by troubled banks, could cause strong credit allocation influenced by capital. They consider that without capital standards, large banks with one-fourth of total US assets would face the increasing ratios of capital to risk-weighted assets. However, there has been little empirical evidence on the investigation of risk based requirements effect on bank lending.

Brinkmann and Horvitz (1995), consider reasons for slow improvement after 1990–91 recession, and they cite that the failure to respond to the low interest rates are effective. Also a decline in willingness of banks to lend is associated with the sluggish recovery from 1990 to 91 recessions. In the past, the economists consider credit crunch as the situation where borrowing is lower than market-clearing interest rates. They find that there are number of reasons for decreasing in willingness to lend by banks, such as increased risk aversion and increased criticisms from bank examiners. Dollar and Hallward-Driemeier (2000) study the credit crunch in Thailand and show that related factors on output expansion appeared to have weak perceived demand and a sharp increase in price of imported inputs resulting from large nominal exchange rate depreciation, which occurred in months' prior to the crisis.

Nehls and Schmidt (2003), consider the probability of credit crunch in Germany and evaluate whether restrictions on loan supply which is not in line with market interest rates are the main reason for credit crunch. They calculate and compare both demand and supply function in lending and they find that there is an excess demand in the second half of 2002.

The lending behavior of banks is important for balance sheets items. Loans rise by banks belonging to the capital measure in balance sheets. Banks' capital is statistically variable in lending decisions. Also, Banks are relying on capital ratio and the measures of levels of risk. Considering banks' capital adequacy, could help to compare the health and soundness of different groups of banks with each other.

Capital ratio measure can be considered for their lending decisions. There is a dynamic effect of banking capital on lending. The structure of capital is more essential because this structure differ from other financial institutions. Generally banks hold more capital than capital requirements and they tend to operate more prudential manner against unexpected shocks.

The structure of liabilities and capital determine central banking regulations. These regulations are most important factors for determining capital structure in Iranian banking systems. Trade between benefits and cost of debt is determined structure of capital in banking systems. Credit reduction in banks could cause reduction in macroeconomic activity. Credit crunch can be created since borrowers substitute source of funding in other markets.

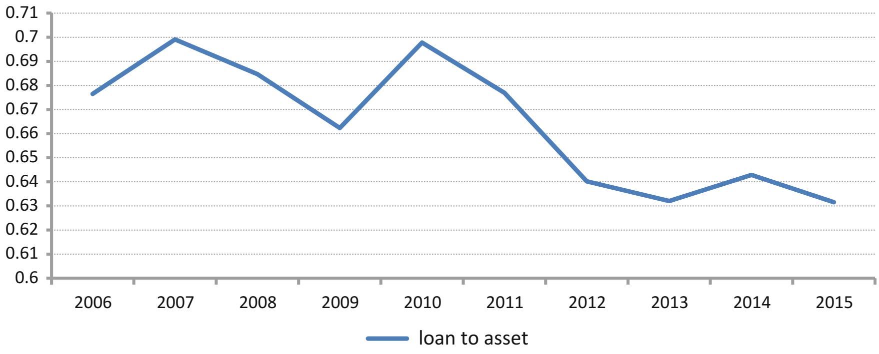


Fig. 7.1 The trend of loan asset ratio changes during 2006–2015 in Iranian banking systems. *Source* Finding of research according to the Iranian banking dataset

Figure 7.1 Points out that after periods of credit expansions, a gradual reduction in banking credit occurs, which is a proof for existence of credit crunch. A reduction in loans can be observed since 2012 (Fig. 7.1), and this reduction continued up to 2015.

The main reason for credit crunch incident is the high level of non-performing loans in Iranian banking system. The Iranian banking system has a high level of non-performing loans. The continued deterioration of the banking system soundness has led to a decrease in credit to the private sector which has affected economic growth. Although, Iranian banking system is affected by its economic environment, both suffer from recession.

In addition to regulatory and operational changes, financial restructuring including capital investigation and liquidity are required. However, this should be completed in line with wider changes otherwise lending to companies would increase, which could bring credit risk to the financial market.

7.3 Literature Review

Recent survey attempts to identify credit crunch in different countries which is resulted from supply or demand factors. Number of studies has used different evidence in bank lending and borrowing to find out the credit crunch. Benauer and Koubi (2004), compare banking crisis with credit crunch. They find out that there is a significant difference between countries behavior toward credit crunch. In US and Japan banking system, bank capital is related to economic variables and bank capital would cause credit crunch and banking instability. The policy makers would focus on capital requirements and cyclical behavior. However, there is no relationship between business cycle and bank capital and therefore, policy makers in such countries could be less concern about banking crisis.

Bijapur (2010) considers the impact of reduction in interest rate on GDP growth which cause credit crunch in US economy. In this research, they estimate a simple vector auto regression on macroeconomic variables to find the key factors, which are related to credit crunch. This survey finds out that the monetary policy become less effective during credit crunch. Also their results show that more aggressive monetary policy would have impact on banking and fiscal stabilization. On the other hand, Albertazzi and Marchetti (2009) analyze the effectiveness of financial crisis on credit supply. This survey use data on Italian banks after Lehman's failure in order to consider whether there is an impact on credit supply after financial crisis in US. This survey controls the unobservable factors by operating multiple lending. They find out that there is a relationship between declining credit supply with lack of bank capital and liquidity. Considering the effect of credit crunch on different types of firms, they conclude that larger banks with lower capital would lend less to riskier firms. This is related to Basel II capital regulation on large and small banks. Presbitero et al.[1] (2014) study data on lending in Italian banking sector during recent financial crisis. The safe and soundness of firms affect the credit markets and troubled firms suffered from credit crunch regardless of their size. During financial crisis firms could be harm by instability in banking system. This paper evaluates the structure of banks that affects the strength of credit crunch. This study looks for the type of firms that one more exposed to credit tightening. Borensztein and Lee (2002) analyze the credit crunch in Korea using enterprise level data. They claim that the credit crunch which happened in Korea in 1997, stemmed from the changes in the structure of financial sector, so banks and all other enterprises, should adapt themselves with those changes. They suggest that the impact of Changes and adjustments on this crisis is much more than tight monetary policies. They also discover that after the currency crisis, the interest rate rose rapidly and this could happen temporarily because of defending the exchange rate and preventing the increase in prices. Agenor et al.[2] (2004) consider reasons for East Asian Crisis by employing two-step approach. First of all they estimate the demand function for excess liquid assets by commercial banks and secondly, they consider the projections for the incidents after crisis. They finally find out that the contraction in lending in Thailand, which is accompanied with crisis, was resulted from supply. Watanabe (2007) in his study relates the changes of capital flow to the economic stagnation of 1990s in Japan, by analyzing the aggregate data. This survey analyses the aggregate data to see whether Japanese banks face problems because of "overbanking". He finds out that the number of banks and branches is almost low considering the size of Japan's economy. Also, Barone et al. (2016) estimate the exact impacts of reduction in credit supply in 2008 financial crisis in Italy. They conclude that the shock in credit supply is different in different economies.

[1]Presbitero, A. F., Udell, G. F., and Zazzaro, A.

[2]Agenor, P., Aizenman, J., and Hoffmaister, A. W.

In this study, we intend to test the occurrence of credit crunch in Iranian banking system. We also examine the effective factors which have significant impact on credit crunch in this survey.

Recent studies simply demonstrate that various factors could affect the credit crunch. The purpose of this study is to investigate the main causes of credit crunch in Iranian banking system including: economic and balance-sheet structures.

7.4 Regression Model

In our study the data includes active banks in Iranian banking system over the period of 2005–2016. This financial information is retrieved from central bank dataset. All financial and banking variables are illustrated in Table 7.1. As can be seen through this table, banking and economic variables are illustrated, and the mean of asset growth and loan growth are accordingly 0.3029 and 0.373. The mean of Liquid asset ratio represent 0.23 of total asset. The bank size is measured by the logarithm of total asset in Iranian banking system, which has the mean of 20.72.

This paper estimates the models which survey the effect of variables that indicates the reduction of credit supply in Iranian banking system. The regression shows the effect of following variables that influences on credit crunch.

$$
\begin{aligned}
(Growth\,loan)i,t = {} & \alpha 0 + \alpha 1(Growth\,loan)i,t-1 + \alpha 2\,profitability + \alpha 3\,capital\,ratio \\
& + \alpha 4\,Crunch\,Dummy + \alpha 5\,Deposit\,ratio + \alpha 6\,size + \varepsilon
\end{aligned}
$$

This equation describes the relationship between capital and lending focusing on credit crunch. In this study the dependent variable is the ratio of loan's growth to asset which measures total loans as a proportion of total assets. This ratio could measure the relationship between banks' loan portfolio to total assets. The high amount of this ratio indicates the probability in which banks operate in default risk. This means that banks have low liquidity and they lend while their interest rates rise suddenly. The first factor which determines the capital structure of banks is the ratio of deposit in their assets. This ratio could also be defined as the ratio of banks' liabilities to total assets. In banking studies this ratio is an important variable, because it could be used to assess banks' liquidity through dividing total loan of

Table 7.1 Summary of statistic

Variables	Mean	Median	Stdv.
Asset growth	0.3029	0.2722	0.6562
Deposit growth	0.0265	0.04556	0.3773
Loan growth	0.3730	0.5293	0.066
Inflation	20.72	21.5	7.395
Liquid asset ratio	0.2385	0.2183	0.13203
Size of banks	5.1532	5.2322	0.5822

Source Finding of research

banks by their total deposits. We expect a positive relationship between deposit ratio and loan's growth. The profitability variables in this survey are represented by return on asset and return on equity. Return on asset indicates the ability of a bank's management to generate profits from assets depending on balance sheet activities. Return on equity indicates the return to shareholders on their equity. Liquidity means the availability of cash while banks are intend to convert their assets into cash in short term. Higher amount of liquid assets illustrates higher liquidity for firms. Usually, liquidity is used to measure liquidity efficiency. The ratio of liquid assets to deposits and short term funds ratio clear the position of deposits and short term funds which meets the requirements of sudden withdrawals.

In this study inflation is a macroeconomic variable which is known as an important determinant of banks' lending. Inflation usually disrupts business planning of banks. Banks would face different difficulties due to the uncertainties created by fluctuations in services' price and inputs' costs which could reduce investment spending in banks. Furthermore, these uncertainties affect loans' policy and banks' performance as a result of deposit withdrawals from banking system. This incident reduces bank resources thereby decreasing a large proportion of their profitability. In other words, it reduces the inflow and outflow of loans since banks might not want to lend except at a higher interest rate which discourages borrowing deficit spending unit.

In order to test the existence of credit crunch, we employ the equation for crunch dummy variable. This dummy variable is 1 since 2012 otherwise 0. It is possible that the coefficient of credit crunch dummy variable being negative. The negative coefficient of credit crunch dummy shows credit crunch occurrence in Iranian banking system.

Since unit root variables generate quasi regression problem for both time series data and panel data, it is necessary to examine the unit root for all applied variables in our estimations. Levin, Lin and Chu test, Im, Pesaran, Shin W-stat test, Fisher test and Hadri stat are used to study common unit root of variables. Results are represented in Table 7.2.

Dynamic relations are displayed by presence of interrupted dependent variables among explanatory variables of the research. Autocorrelation problem is exposed because of interrupted dependent variables among explanatory variables and heterogeneous sectional effects among the sections. GLS estimator will be biased due to the random effects for dynamic pooling data. Generalized method of moments for dynamic panel models that has been developed by Arellano and Bond is used to estimate our model. Matrix Tools is applied to eliminate correlation of disturbed variable and other explanatory variables. In this method Arellano and Bond represented a two-step GMM estimator. Validity of matrix tools in this estimation is examined by Sargan-test. In the estimation, the null hypothesis is to test non-correlation of tools with disturbing elements. Measurements of probability of Sargan test's statistic is calculated as indicated in Table 7.3. Therefore, the null hypothesis could not be rejected. We employ Hansen's J statistic, which is robust to heteroskedasticity and autocorrelation issues. *P*-values of Hansen's J statistic show that we cannot reject the null hypothesis which indicates that the instruments are uncorrelated with the error term. So, these results show the validity of instruments.

Table 7.2 Results of common unit root test

Variable	Levin, Lin, Chu t.	Im, Pesaran, Shin W-stat	ADF – Fisher Chi square	PP-Fisher Chi_square	Hadri Stat.
Growth of loan	−8.69 (0.000)	−5.18 (0.000)	68.051 (0.000)	198.632 (0.000)	5.57 (0.000)
Deposit ratio	−8.19 (0.000)	−1.33 (0.092)	66.057 (0.0636)	154.69 (0.000)	6.59 (0.000)
Liquid asset ratio	−15.198 (0.0002)	−3.7022 (0.0001)	79.552 (0.0001)	127.014 (0.000)	6.07 (0.000)
NPL	−3.66 (0.0002)	−3.29 (0.0005)	95.75 (0.0001)	64.47 (0.0820)	6.67 (0.000)
Capital adequacy ratio	15.17 (0.000)	−2.332 (0.007)	67.97 (0.046)	68.06 (0.045)	8.58 (0.000)
Size	−29.88 (0.000)	−6.53 (0.0057)	121.43 (0.0007)	132.68 (0.000)	6.97 (0.000)
ROA	−4.73 (0.000)	−1.67 (0.0471)	74.5 (0.0139)	112.93 (0.000)	4.127 (0.000)
ROE	−14.64 (0.000)	−1.34 (0.088)	84.74 (0.0016	143.88 (0.000)	8.35 (0.000)
Inflation	−12.27 (0.000)	−1.61 (0.053)	68.42 (0.0427)	84.84 (0.0015)	11.18 (0.000)

Source Finding of research

As can be seen through the table, the effect of lagged loan's growth is negative and significant. Consequently, the increase in lagged loan's growth leads to decrease in loan's growth. On the other hand, profitability has positive effect on loan's growth, and also return of asset is positive and significant in all estimations. Therefore, profitability is positively correlated with lending. Non-performing loan has negative coefficient in the whole Estimations. Banks with high non-performing loans would face uncertainty and cannot allocate resources. Non-performing loans determine the risk of portfolio in banking system. It is necessary that all related variables to credit crunch, have a high degree of inter correlation. According to the results, that impact of non-performing loans on credit crunch is negative. Furthermore, Non-performing loans represent the performance of banks' borrowers and condition of economic environment. A high non-performing loan would decrease the ability of lending in banking system. Non-performing loans could limit the loan's supply by economic condition on borrowers' impact.

The results show that the profitability variables (return on asset and return on equity) always have significant positive coefficient, which indicates that increasing profitability leads to higher loans' growth. This paper investigates the impact of deposit on bank lending. The coefficient of deposit ratio on loans' growth is always positive, which shows that deposit could increase lending in banking systems.

Table 7.3 The effect of banking variable on credit crunch (dependent variable: growth of loan)

Variables	Estimation 1	Estimation 2	Estimation 3	Estimation 4
Growth of loan (−1)	−0.2447 (−7.64)	−0.2163 (−6.94)	−0.1115 (−1.92)	−0.223 (−1.97)
Capital ratio	−0.4045 (−5.08)	–	–	−0.377 (−6.66)
Roe	–	–	0.1536 (2.44)	–
ROA	0.797 (2.103)	1.89 (2.45)	–	–
NPL	−0.4424 (−2.35)	−0.2543 (−3.21)	−0.178 (−1.66)	−0.2628 (−4.41)
Size	0.1697 (4.98)	0.0971 (3.07)	0.0452 (1.74)	–
Deposit ratio	0.4212 (6.37)	0.3192 (2.77)	0.1624 (1.77)	0.248 (4.93)
Liquid asset ratio	–	–	–	−0.558 (−2.28)
inflation	−0.0024 (−4.93)	−0.00231 (−2.58)	−0.00182 (−1.87)	−0.00137 (−5.21)
J-stat.	11.37	14.015	13.92	14.81
J stat. prob.	0.497	0.373	0.391	0.319

Source Finding of research

Capital ratio indicates the measure of risk in banking systems. These risks are able to change banks' behavior. The coefficient of capital ratio in our model is negative and significant. Banks' behavior during credit crunch is sensitive to reduction in credit supply. Low capitalize banks always tend to lend less, and the decision to infuse banks with more capital could reduce their lending capacity. Banks' capital is statistically important variable in lending decisions. Banks are evaluated based on their capital ratio and measure of risk and these measures play an important role in banks' decision and central bank regulations. The banks' decision in the context of recapitalizing raises their capital to asset ratio by decreasing their assets.

Although, decreasing banks' assets is less harmful for shareholders, however, it is more painful for borrowers. Therefore, banks would face loan losses by impact of bank capital. This survey mainly focuses on capital ratio in the model. The results of the estimation are shown in Table 7.3.

In Iranian banking system, if the standard capital adequacy ratio is eight percent, there are 78% of banks which have capital adequacy below 8%. The relationship between capital adequacy and non-performing loans is more important. The capital adequacy ratio and non-performing loans are negatively correlated with approximate amount of 0.32. Banks with a high share of non-performing loans have lower capital adequacy. In the model, inflation as a macroeconomic variable has negative effect on growth of lending in Iranian banking system. Increasing in inflation could

Table 7.4 Testing credit crunch in Iranian banking systems

Variables	Estimation 1	Estimation 2	Estimation 3	Estimation 4
Growth of loan (−1)	−0.215 (−6.57)	−0.2022 (−4.61)	−0.226 (−9.42)	−0.1198 (−4.43)
Liquid asset	−0.4622 (−4.66)	−0.5568 (−6.33)	−0.782 (−3.13)	–
Capital ratio	−0.344 (−7.13)	−0.3309 (−6.07)	–	–
ROA	–	–	0.579 (1.75)	0.5602 (1.87)
Size	–	0.0966 (6.62)	0.0816 (2.19)	0.0225 (1.91)
Deposit ratio	0.2080 (1.97)	–	0.0323 (1.92)	0.295 (4.13)
Crunch dummy	−0.01887 (−1.93)	–	–	–
Crunch dummy * deposit ratio	–	−0.0388 (−1.835)	–	–
Crunch dummy * capital ratio	–	–	−0.3058 (−3.73)	–
Crunch dummy * liquid asset ratio	–	–	–	−0.213 (−4.12)
Inflation	−0.00252 (−1.79)	−0.001221 (−1.98)	−0.001484 (−2.617)	−0.000176 (−1.69)
J-stat.	15.16	12.86	10.10	13.36
J stat. (prob.)	0.23	0.379	0.52	0.34

Source Finding of research

lead to a decrease in lending. Holding liquid asset in banking system could be the main reason of credit crunch incident. The excess liquidity creates strong credit crunch and decreases lending. The coefficient of liquid asset on loans' growth is negative and significant in our estimations. The bank size has a significant impact on credit crunch in Iranian banking system. This impact is positive and is shown in Tables 7.3 and 7.4.

In Iranian banking system, bigger banks tend to give higher loans; therefore, bank size could affect the balance-sheet and assets.

We assess the effect of credit crunch on loans' growth by dummy variables. According to Fig. 7.1, the dummy variable is 1 since 2012 otherwise 0. We use this variable to indicate credit crunch in Iranian banking system. According to our results, the coefficient of credit crunch dummy is negative; therefore, credit crunch incident in Iranian banking system is approved.

The main reason for credit crunch incident could be liquidity and capital structure in banking system. For these reasons, we use multiplied credit crunch dummy variable to illustrate the credit crunch incident in Iranian banking system. Credit crunch dummy multiplied by capital ratio considered as a variable which could influence loans' growth. These results are shown in Table 7.3. Credit crunch dummy multiplied by capital ratio has significantly negative effect and this can be considered that capital ratio could affect credit crunch in Iranian banking system. Credit crunch dummy multiplied by deposit ratio could influence the loans' growth which can be seen through Table 7.4. Credit crunch dummy multiplied by deposit ratio has significantly negative effect and this result illustrate that deposit ratio affect the credit crunch in Iranian banking system. The credit crunch dummy multiplied by capital ratio could influence loans' growth. The credit crunch dummy multiplied by liquid asset ratio has significant and negative effect on credit crunch. Liquid assets' holding by banks could increase credit crunch in Iranian banking system. Credit crunch is correlated with reduction in credit demand and the weaknesses of balance sheets in banking system. Data analysis is also important to study credit crunch, and credit crunch incident would develop at the state level, however, economic shock at the national level could decline bank capital.

The credit crunch dummy multiplied by mentioned variables used to indicate credit crunch in Iranian banking systems. Credit crunch dummy multiplied by capital ratio could be used as a variable which is able to influence the loans' growth. Credit crunch dummy multiplied by capital ratio has significantly negative effect and this result show that capital ratio could affect the credit crunch in Iranian banking system.

7.5 Conclusions

There are several reasons for credit crunch incident, different definitions for credit crunch show that this incident considered as a complex phenomenon. There are number of reasons, which are structural and will not be eliminated to recover the economy. Some reasons refer to monetary policies and regulations in banking system. The situation of banks shows that it is necessary to find a quick solution.

Numbers of studies related to credit crunch refer to monetary policies, bank failures, community development, credit discrimination, and access to the courts. According to the results, the coefficient of credit crunch dummy is negative. So, it is certain that credit crunch in Iranian banking system would occur. The behavior of banks during credit crunch and reduction in credit supply is sensitive. Low capital banks always tend to lend less than other banks. The decision to infuse banks with more capital could be reducing their lending capacity. Banks' capital is statistically variable and could affect lending decisions. Based on capital ratio and measure of risk banks are evaluated, therefore, this ratio is important for banks and central banks for regulations. The decision, which is recapitalizing banks, raises capital to asset ratio by shrinking their assets.

The main reason for credit crunch incident could be liquidity and capital structure in banking system. For this reason, we used credit crunch dummy multiplied by the mentioned variables to indicate credit crunch in Iranian banking system. Credit crunch dummy multiplied by capital ratio could influence the loans' growth, and it has significantly negative effect. Therefore, we conclude the capital ratio could affect the credit crunch in Iranian banking system.

The foregoing analysis suggests several policies for dealing with possible credit crunch in Iran. First, banking system's situations like other countries should be evaluated especially in the context of all types of risks. Second, it is crucial to consider credit supply and demand in economics overview. Third, credit crunch is likely to appear when asset valuations grow and then collapse. Therefore, policy-makers should be cautious when they intend to embark instituting changes, which increase risk regardless of prevailing economic conditions. Fourth, policy coordination is required between monetary authorities and regulatory authorities. If regulatory authorities strengthen supervision during a credit crunch, the impact of monetary policy could be successful. Fifth, the government requires establishing a well-balanced financial system in order to avoid credit crunch situations. It is important for Iranian banking sector to consider the key role of capital ratio in banking institutions, also describe their own strategies to reduce their reliance on governmental support. This would develop better relationships between large counterparties, whose decisions on whether or not to continue funding the bank can be critical in determining the banks' funding position.

References

Albertazzi, U., & Marchetti, D. J. (2009). Credit crunch, flight to quality and evergreening: An analysis of bank-firm relationships after Lehman. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.364.4664&rep=rep1&type=pdf.

Barone, G., de Blasio, G., & Mocetti, S. (2016). The real effects of credit crunch in the great recession: Evidence from Italian provinces. Temi di discussione della banca d'italia no. 1057, Bank of Italy.

Bayoumi, T. (1998). Monetary policy issues. *Japan, Selected issues*, 80–100. IMF: Staff Country Report.

Benauer, T., & Koubi, V. (2004). Banking crisis vs. credit crunch? A cross-country comparison of policy responses to dilemmas in banking regulation. *Business and Politics, 6*(2), Article 2.

Berger, A., & Udell, G. F. (1995). Relationship lending and lines of credit in small firm finance. *Journal of Business, 68,* 351–381.

Bernanke, B. S., & Lown, C. S. (1991). The credit crunch. *Brookings Papers on Economic Activity, 2,* 205–247.

Bijapur, M. (2010). Does monetary policy lose effectiveness during a credit crunch? *Economics Letters, 106*(1), 42–44. January, Elsevier.

Borensztein, E., & Lee, J. W. (2002). Financial crisis and credit crunch in Korea: Evidence from firm-level data. *Journal of Monetary Economics, 49*(4), 853–875.

Brinkmann, E. J., & Horvitz, P. M. (1995). Risk-based Capital standards and the credit crunch. *Journal of Money, Credit and Banking, 27*(3), 848–863.

Clair, R. T. (1989). Credit shortage slows texas recovery. *Federal Reserve Bank of Dallas Southwest Economy,* January.

Dollar, D., & Hallward-Driemeier, M. (2000). Crisis, adjustment, and reform in Thailand's industrial firms. *The World Bank Research Observer, 15*(1), 1–22. https://doi.org/10.1093/wbro/15.1.1.

Erdinç, D. (2009). *From credit crunch to credit boom: Transitional challenges in Bulgarian banking, 1999–2006.*, MPRA Paper 10735 Germany: University Library of Munich.
Gertler, M., & Gilchrist, S. (1993). Monetary policy, business cycles, the behavior of small manufacturing firms, Finance and Economic Discussion Series No. 93-4, Board of Governors of Federal Reserve System.
Keran, M. W. (1992). The regulatory recession? *Economic Review*. The Prudential Insurance Company of America, October.
Owens, R. E., & Schreft, S. L. (1992). Identifying credit crunches. Federal Reserve Bank of Richmond Working Paper No. 92–1, March.
Pavel, C., & Rosenblum, H. (1985). Banks and nonbanks: The horse race continues. *Federal Reserve Bank of Chicago Economic Review*, May/June, 3–17.
Peek, J., & Rosengren, E. S. (1995). Bank regulation and the credit crunch. *Journal of Banking and Finance, 19*, 679–692.
Presbitero, A. F., Udell, G. F., & Zazzaro, A. (2014). The home bias and the credit crunch: A regional perspective. *Journal of Money, Credit and Banking, 46*(s1), 53–85. https://doi.org/10.1111/jmcb.12078.
Samolyk, K. A. (1991). A regional perspective on the credit view. *Federal Reserve Bank of Cleveland Economic Review,* Second Quarter, 27–38.
Syron, R. F. (1991). Are we experiencing a credit crunch? *Federal Reserve Bank of Boston New England Economic Review,* July/August, 3–10.
Watanabe, W. (2007). Prudential regulation and the credit crunch: Evidence from Japan. *Journal of Money, Credit and Banking, 39*(2–3), 639–665.
Woo, D. (1999). In search of "Capital Crunch": Supply factors behind the credit slowdown in Japan. *IMF Working Papers, 99*(3), 1.

Chapter 8
The Philanthropy Tree of Community Foundations from Ancient to Contemporary Times. Roots and Branches of US and Italian Foundations

Angela Besana, Annamaria Esposito and Martina Treu

Abstract Democracy, theatre and khoregia are key-words of classical Athens, where performing arts were combining creativity with the efficient management and matching grants of private sponsors, who were communities. From ancient to contemporary times, community foundations play the same role of khoregia for the survival of big and small communities in different geographies, from US to Italy. Community foundations are grant-makers whose aim is to engage citizens and communities, develop and improve their quality of life. Their fundraising has roots in relationships within relevant territories and communities. Their fund-giving has branches in any leading projects for their communities. They supply resources, and, above all, they support the creation of networks that put together main stakeholders in a specific territory with the classical benchmark of khoregia. The aim of this paper is to highlight the role of khoregia in ancient times and community foundations in contemporary times, both of them supporting development and, foremost, culture: from education to heritage. The methodology includes the analysis of mission statements and reports, and a cluster analysis of 2013's accounting data of the biggest USA and Italian community foundations. Thanks to cluster analysis, economic performances are highlighted together with fundraising and fund-giving. The result consists of the comparison between USA and Italian foundations for different performances and focus on culture.

Keywords Khoregia · Community foundations · Marketing · Economics
Cluster · Culture

Martina Treu wrote the first paragraph. Angela Besana wrote paragraphs 2 and 4. Annamaria Esposito wrote paragraph 3. Angela, Annamaria and Martina wrote together paragraph 5.

A. Besana (✉) · A. Esposito · M. Treu
IULM University, Milan, Italy
e-mail: angela.besana@iulm.it

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_8

8.1 Ancient Athens and Beyond: A Sponsor for Theatre

The ancient Greek city of Athens is the birthplace of many practices, concepts and ideas we still use and care of, today, even if they have changed a lot in the past millenniums. “Democracy”, “Theatre” and “Khoregia” are perfect examples: these three terms were created and used by Greeks in various ways, mostly intertwining, since the so-called ‘Golden Age’ of classical Athens (after the Persian Wars, i.e. approximately from 479 B.C.). Their meanings are more complex than they may seem at first sight, and they have varied a lot over the centuries (on ‘Democracy’, in particular, see Canfora 2004). Today, of course, the first two (Democracy and Theatre) are more common in use. The third one (Khoregia) is not currently heard, but it is worth a short survey: in the following pages, we will briefly recall this institution, its historical background, the possible connections to modern times.

The dramatic festivals of Athens were born thanks—ironically—to a family of tyrants (Peisistratides) in the sixth century B.C. (well before the first ‘theatre’ ever created, still visible, was carved into the side of the Acropolis hill). Tyrants knew well how to gain consent by giving people games and entertainment (see Lanza 1977: 33–35). In Athens, a great budget was spent in culture and ‘cults’ (two strictly related areas) including many feasts and expensive mass event, such as processions, competitions, and performances dedicated to one or more City Gods. Among them, Athena, the city patron, Demestra and Dionysus. Here, the third one deserves a special attention considering the focus of our research: he was the God of theatre (not to mention wine, sex and many other forms of art, performances, loss of conscience and ecstasy, which go far beyond the limits of this paper). A great budget too was dedicated to the epic poems known as *Iliad* and *Odyssey*: this was a crucial age for their metamorphosis from oral compositions to written texts.

At the end of sixth century B.C., Athens was free from tyrants and became a *Polis* (in Greek “Autonomous City i.e. State”). The city wealth kept increasing in the fifth century, thanks to the flourishing sea commerce, to abundant natural resources such as the silver mines of Laurion, to heavy taxes yearly paid (willingly or under threat) by all allies of Athens in the Delio-Attic League. The polis started a process towards a major participation of citizens in politics (simplifying we may call it ‘democracy’) to all related issues of common interest: on this controversial subject see Canfora (2004). Athens created a government of several members (*archontes*) elected at turn every year. Among their major duties, all year round, they organized mass events (processions, dramatic festivals, competitions and performances) at a high cost (considered the average cost of life): for a complete and clever introduction on the festival, see Pickard Cambridge (1968) and Lanza (1997, esp. pages 33–35, 79–80).

Cults and culture, still intertwined, became more and more ‘political’ matters, literally, because the organization of these mass events involved the entire community of the *polis*. The budget for arts and theatre was in average quite high, especially in peaceful times, and it was partly covered by the city, partly by the richer part of the population: families, clans or individuals who offered as volunteers (or were asked by the city) to cover, each year, the so-called 'liturgies': see Davies (1967, 1981), Gauthier (1985) and Gernet (1999).

These were exceptional expenses, of common interest, which the city could not afford, and yet reputed necessary: in wartime the most important was the equipment of a warship (*triremes*), in all other occasion the budget for festive celebrations including cult and culture aspects (especially in peace, but also in wartime, even if reduced in period and in budget). An ancient Greek citizen probably did not see the liturgies strictly as 'taxes' but rather contributions which rich families or individuals offered to the city more or less 'willingly': actually, as far as we know, the value of 'culture' was assumed by Athens as a sign of prestige, and power, especially in the so-called "classical" period (fifth century B.C.) but also in the following centuries. We focus on one of these liturgies, the above-mentioned institution of *Khoregia*, an archetype of modern sponsors (for a detailed description, with bibliography see Wilson 2003).

The term, as etymology shows, is tightly connected with 'chorus', which is a key-term in ancient Greece (see Foley 2003 and Treu 2007a, b). It was, basically, the beating heart and common thread of many collective rites, not only in ancient Athens, but in many other Greek cities. It was, as far as we know, the original, primitive and essential requirement of ancient theatre. Collective performances varied a great deal over centuries and also at the same time, depending on the place, occasion and god praised; they generally included song and dance (each *genre* had strict, specific codes, terms and practices). They usually had a large audience, and they normally were part of a festival or competition (such was the case of dramatic genres of tragedy, comedy, satyr drama, all born from a chorus, according to our information). Each genre had a specific, different number of members, generally men or boys: a tragic chorus grew from 12 to 15 members, but ancient Attic comedy ('*Archaia*') could count on 24, while each chorus performing the ritual song to Dionysus once known as 'Dityrambus', whose large production is almost entirely lost, displayed 50 members (for a complete survey on the festivals, see Pickard Cambridge 1968, especially pages 75–8, 86–93).

Therefore, it may be calculated that in Athens, in the classical period at its maximum flourishment, basically all male citizens (with very few exceptions) at least once in their lifetime took part into a chorus, as well as they served their city as sailors, or soldiers during the war. Such a huge mass of people needed to be trained, in songs and dance, and the Khoregos paid the trainers. Moreover, he had to pay for rich costumes and gorgeous masks: the more beautiful, the more they could impress the audience, and the judges, who should select the winner of the competition. Finally, a great feast with plenty of food and wine, should have been offered to all crew and cast by the Khoregos (for exceptions, such as Antimachus, see below).

Of course, each Khoregos donated, more or less generously, in reason of his wealth and his purposes: the counterpart, apparently, was a gain in personal prestige, and fame, especially when a tragic trilogy won. We may see today some monuments (tripods) erected by the winners, and we know of political leaders who clearly had personal interests at stake, and were not at all disinterested. They aimed at gaining public credits and political power when they financed a chorus, especially a tragic chorus, and most of all regarding delicate matters such as recent facts, symbolic issues, recent historical episodes. This was the case, for instance, of two tragedies regarding the conflict with Persia: soon after the battle of Salamina the political leader of Themistocles was significantly Khoregos of the lost tragedy *Phoenician Women* (476 B.C.) by Phrinicus, regarding the Persian war as far as we know. Four years later, the most famous leader of the political party Pericles was Khoregos of Aeschylus' *Persians*, the first dated extant tragedy regarding the Greek victory over Persia (472 B.C.), with a huge impact on the following centuries, and one of the most played since the conflict between West and East has kept growing (see Kennedy 2017).

On the other hand, the bright stars of these tragedies are balanced by less honourable examples: someone, selected among the richest citizens, could refuse to pay a liturgy, claiming that he could not afford it. But he had to indicate publicly someone richer than him, and involve him in a trial, in order to demonstrate that the other citizen could better sustain the financial burden of the liturgy. The defendant had the choice of accepting the liturgy, making an exchange of wealth or submitting to the trial. The wealth of both citizens was confronted, and if the first selected man could not prove to be poorer than the other, they had to exchange their patrimonies. This legal action was called *antidosis* ("exchange"): see Christ (1990, 2006).

Many studies regarding the liturgies and the Khoregoi concentrate on tragedy, but we must not forget that in the same years of Fifth and Fourth century B.C. another genre, ancient comedy (*Archaia*), was even more "political" in a strict sense (i.e. concerning the actual citizens of Athens and facts taking place in the polis in those days) Aristophanes whose comedies we may read and see on stage nowadays (see Treu 2013) in Acharnians, his first extant comedy, depicts a certain Antimachus (a poet and historian of his times) as an awful man. Besides the sins of writing bad poetry and dull histories, as a Khoregos he is accused of being mean, cheap, stingy. Apparently (Aristophanes is not trustworthy, and programmatically exaggerated, for the sake of a laughter) Antimachus mistreated the chorus members, he did not pay them the lunch, as he ought to do. So the chorus of *Acharnians* sends him a comic 'curse': may he starve, without meal, may he encounter bad companies and an excrement bullet, and fall badly into the obscure night (Mitchell 1920: 125–129):

> *(Semi –chorus)* I am a man of few words / Nor long speeches I make;/ So at once may the devil/ Antimachus take / That scurvy contriver/ That son of Saliva/ Who late when he led / Our troop sent them to bed / Without waste to his brewing/ Or meat or his meal(…)

After the classical era, the Khoregia slowly lost importance, and was substituted by private initiatives of sponsorship variously known as philanthropy or 'euergetism', not only in the Hellenistic and Roman period, but also in modern Europe. If we look back to the reception of ancient drama and literature since the Renaissance we may find a common thread, quite surprisingly, among the most important productions which marked the re-birth of classical theatre. Here, we may at least cite in Italy *King Oedipus* (*Edipo Tiranno*) which opened in 1585 the Teatro Olimpico (Vicenza): see (Treu 2007a, b) and Mazzoni (2013). The production and the building of this gorgeous theatre, designed by Andrea Palladio and completed, after his death, by Vincenzo Scamozzi, were entirely sponsored by the local Accademia Olimpica: a club of noble gentlemen fond of classical culture who wanted to recreate ancient tragedy and enliven it on stage. The heir of that first performance, in modern times, is the Festival d'Autunno: today is sponsored by the municipality of Vicenza, but the Accademia Olimpica is still existing, and promoting culture events. With analogue intent, in 1913 a group of noble gentlemen from Siracusa (Sicily) formed a committee for classical productions: one year later, Aeschylus' *Agamemnon* (*Agamennone*) re-opened after centuries of silence, the ancient Greek Theatre in Siracusa. And the classical festival of Siracusa is still taking place, every year, with private and public sponsors (for past productions and current season see indafondazione.org).

A few years later the Sicilian committee, in Greece, Angelos Sikelianos and his wife Eva Palmer re-opened the Greek theatre in Delphi, at their expense, with two editions of a theatre festival (1927, 1930). A precious collection of original photos of the performances (more than a hundred) is stored at the Benaki Museum in Athens (see https://www.stratagemmi.it/le-feste-delfiche-1927-1930-di-angelos-sikelianos-ed-eva-palmer-nelle-fotografie-del-museo-benaki-di-atene/).

Originally, these productions were born from a private initiative, and sponsored by noble gentlemen who were inspired by the classical heritage: however, the community was soon involved in those projects, which needed artists and workers, scene designers and builders, costume makers, dancers, actors, and chorus members (as said before, the most evident, strong collective component of the Greek drama was the chorus of citizens). The private enterprise may become a community project when a city (or Nation) aims at increasing its social status with culture projects, for example by recreating the prestige of ancient drama "at home". Such experiments easily gave way to public initiatives, and they were soon endorsed by local and national governments: these happened in Vicenza, in Siracusa, in Delphi, all over Italy and Greece (see Malcangio et al. 2007)

Such forms of community theatre were born not only in ancient and modern theatres and archeological sites, but also in modern towns: for instance in the town of Gibellina in the Belice valley (Western Sicily) destroyed by a terrible earthquake fifty years ago (January 1968). The city Mayor Ludovico Corrao a few years later promoted an innovative kind of philanthropy: he called not only for financial aids, but for public and private sponsors. Architects and artists from all over the world answered to Corrao and took part into this community project; some donated their artworks or projects, some created artworks or building on site, with the aid of local workers, private citizens and artists. When a new town (Gibellina Nuova) was built, in the early Eighties, the municipality commissioned and funded a few dramas by the sicilian poet Emilio Isgrò (including a trilogy, *L'Orestea di Gibellina*, inspired by Aeschylus' *Oresteia*): see Isgrò (2011). The community participated into the productions with a massive participation: spectators, extras, musicians, workers and chorus members (as in ancient Athens). This collective feature was dominant in all productions, but especially in the above mentioned *Orestea* (1983–1985) which gave birth and name to a theatre Festival, "Le Orestiadi di Gibellina", still taking place every year at the local cultural centre (Baglio di Stefano) just outside the new town of Gibellina. This community project, however, is still menaced by lack of funds and seeks today new forms of sponsorship and philanthropy.

8.2 The Economics of Contemporary Khoregia in US and Italian Community Foundations

Community foundations are contemporary grant-makers whose aim is to empower communities and improve their quality of life both in the United States and in Italy. In Italy, Community Foundations are an emerging phenomenon that in recent years has grown rapidly. In fact, from the beginning, in 1997, until today, there are active, in Italy, 35 Community Foundations. After studying the positive experiences of the Foundations of American communities, Fondazione Cariplo, one of the world's main philanthropic organizations established from Cassa di Risparmio delle Provincie Lombarde, has helped to start Community Foundations in Italy. Afterwards, community foundations are born mainly in northern Italy, even if over recent years some of important organizations have been founded in southern Italy.

The mission of Community Foundations is to be closer to the community in a specific area, engaging stakeholders, who have awareness of the community needs, and wish to be involved in the solution of problems thanks to networks and partnerships. Economics, welfare, history, and culture, material and immaterial heritage, are elements that have the opportunity to be preserved and promoted thanks to Community Foundations, which firstly care the place in which they operate. As concerns culture, education is one of the main focus of their grant-making.

If culture is a main area, education is well supported by community foundations: from scholarships to specific and joint projects about research, employment and lifelong learning, from school and university programs of different sectors to education for philanthropy, in order to stimulate and enhance philanthropy of younger generations, still at school. Arts and humanities are an important target of US community foundations. In Italy, with a much older history of arts than in the United States, heritage conservation and promotion, they are both a salient focus.

Community foundations are a unique type of organization, as they differ from private philanthropic foundations in a few key ways. First, community foundations must focus mainly on issues and needs in a specific geographic area (often a city or region) and must make a certain percentage of grants to organizations in that area. Additionally, members of that geographic area help to govern community foundations as members of their board. Related organizations like trusts, public administrations and ancillary associations are supporting and playing complementary roles both in USA and Italy. According to Conn (2013), community foundations seek donations and partnerships from private and public donors, as opposed to being fully funded by a corporation or the estate of a single person. As a consequence, they can be depicted as a tree, whose roots are in citizens, corporate, public administrations, other nonprofits and any relevant stakeholders within specific geographic areas and whose branches deliver, thanks also to ancillary organizations, to several projects within specific geographic areas. These connections as roots and branches do not avoid them from being independent, and transparent organizations, and, furthermore, to have a strong relationship marketing in order to gain public and private trust, and support, especially through social media communication.

Most of literature tends to have an Anglo-American bias, main because Community Foundations were first established in the United States and then, since the mid-1990s, spread to Canada, and Europe especially to the United Kingdom (Hodgson et al. 2012), Germany, France, and Italy. There is little literature available on the subject, and only few Italian scholars and professionals have started to study Community Foundations (Esposito and Besana 2018; Bandera 2013; Violini and Vittadini 2012; Franzon and Pezzi 2010; Ferrucci 2010). Today Italian Community Foundations are very few (Kilmurray 2014; Knight 2013; Barbetta et al. 2012) in comparison with US community foundations, at the end of 2011 more than 750 and including some very large institutions such as the Tulsa Community Foundation (the largest one, with more than $4 billion in assets), the Silicon Valley Community Foundation, the New York Community Trust and the Chicago Community Trust, all of them with assets more than $49.5 billion and paid grants exceeding $4 billion in 2010.

Where do community foundations find their resources? Their roots are in communities where they connect with multiple stakeholders. Contributions and gifts are prevailing resources. Next to them, assets are invested in financial markets and interests, dividends, incomes and other financial revenues can be added to contributions in order to prolong their 'philanthropic branches'. Branches of US community foundations are targeting several projects, from community to greater community (Greater Atlanta, Greater Memphis, Greater Kansas, Greater Houston, …). Geographical boundaries are much larger than in Italy, more than a county and within a State.

Italian Community Foundations are a very small universe in comparison with the US one: 35 versus 750. As a consequence, their assets and grants are comparatively fewer and the grant-making has not been so mature like the US for 18 years of life. At their start-up phase, community foundations were nurtured by foundations of banking origin. Roots are, therefore, in fundraising from foundations of banking origin in the same province or region; branches are restricted to local projects with matching grants of public administrations, local sponsors and foundations of banking origin, above all. Nevertheless, this small universe looks at the US benchmark and some similarities can be found.

Assets of Italian foundations are mainly of a financial nature: investments and financial assets that are not investments. Financial assets can rarely generate revenues and incomes for 50% of total revenues. Fundraising can be so efficient that Italian foundations raise donations from local partners for greater amounts than financial revenues (Fondazione della Provincia di Lecco, Fondazione comunitaria del Varesotto, Fondazione della comunità bresciana, Fondazione comunitaria della provinciale di Pavia, Fondazione di comunità del centro storico di Napoli, Fondazione della comunità della Valle d'Aosta, Fondazione Nord Milano, etc.). Most of revenues get into grants and, though most of these foundations suffer of small losses and mostly zero gains, they courageously deliver grants that can be more than 50% of their revenues. Though the latest global crisis (still ongoing in Italy) is negatively affecting gains, net assets are always prevailing as debts are not more than 25% of total assets. For 2013's available data, these foundations have assets for 240 millions euro, deliver 2500 grants for more than 20 millions euro and they match their grants for the common goals of local communities who are next to each other and walk on the same growth-path.

After Martina Treu has enlightened about the classical background, the aim of the paper is to highlight the role of community foundations in supporting a process of economic, but more often, cultural, social or environmental territorial development, and to support the idea of marketing and communications strategies as Community Foundations lever to enhance philanthropic culture, increase the attractiveness of "places", enhance the excellence of territories, and stimulate networking. Above all, the attractiveness of tangibles and intangibles heritages in communities, where education is one of their main focus, too. Then, thanks to the analysis of reports and mission statements of USA and Italian biggest Community Foundations with emphasis on their performances in 2013, and to parallel clustering of Contributions/Total Revenues, Investment Income/Total Revenues, Net Gain or Loss/Total Revenues, Grants/Total Revenues, Investments/Total Assets, Net Assets/Total Assets for 2013's data of 100 biggest USA Community Foundations and an Italian sample, the paper highlights separating features for community foundations and their involvement in cultural projects, from education to heritage. The comparison will allow emphasize strategies, results and next evolution in the United States and Italy.

8.3 Marketing and Communication of US and Italian Community Foundations

To establish a Community Foundation that leads the development of local areas and can be an effective node of the philanthropy network promoting the culture of giving, it is important to plan a coherent marketing & communication strategy.

Marketing, and especially Relationship Marketing (Grönroos 1994) stimulates to cultivate individual donors, and identify prospects, as well as start and reinforce relationships with loyal donors.

There are different issues related to marketing & communication for Community Foundations. First of all, Community Foundations connect with multiple stakeholders, because they deal with different audiences, such as donors, prospect, communities, territorial actors, etc. Then, citizens, donors, prospect, and organizations, might not know exactly the opportunities available in their community, and mostly they are not able to properly evaluate, which organizations is worthy of donations. Often, they are not aware of the fact that, even limited resources, if properly combined, can achieve significant results. Finally, individual donors are not always able to see how their contributions are spent, because the recipient institutions do not always remember to express their gratitude and illustrate with the necessary accuracy and speed how they have been actually used the money collected.

Marketing & Communication help Community Foundations understanding its target audiences and, in turn, helping those audiences understand community foundations. Relationship Marketing helps to screen the most important and empathic stakeholders and to maximize philanthropy for the best projects.

In fact, according to ASSIFERO (Associazione Italiana Fondazioni ed Enti di Erogazione- Italian Foundations and Grantmakers Association), the communication strategies have to be radically different from the communication for fundraising in Italian foundations. For example, the mailing campaigns are like to be totally ineffective if promoted by community foundations, because their purpose is very complex and not easy to understand. Furthermore, many times, giving is a rational and weighted decision, even if, sometimes, it may be an emotional choice donors make, based on a connection to a story, or to an issue they have experienced first-hand.

Ultimately, unlike advertising, communication of Community Foundations has as its objective, not only the contact, but, first of all, donors' involvement. The goal is not to raise money, but to build strong relationships, community empowerment and engagement, which generate donations (Mazany and Perry 2014). In a nutshell, communication is focused to engage stakeholder around the goal of inspiring them to invest in community. Communication should allow donors, and generally all stakeholders, to better understand how Community Foundations are impacting on communities and territories. In philanthropy, people can give to feel good, and give based on good information.

According to the James Irvine Foundation report (2011), also accepted by ASSIFERO, the most important communication activities to promote community foundations, both in the United States and in Italy, are widening personal contacts making use of already existing networks to gain new relationships; involving professional advisors to connect to new donors through the people already engaged in planned giving; building partnerships to access target audiences gaining public awareness and recognition of the identity and impact of community foundations.

According to Carnelli and Vittori (2015), Italian Community Foundations are becoming aware that social reporting is not a powerful tool to engage audience and to get in touch with the real world, and they are moving toward web- and social-communication. USA community foundations are also using social media, but not on a regular routine, in order to strengthen relationships and build dialogue (Carnelli and Vittori 2015; Lovejoy and Saxton 2012; Esposito and Besana 2018).

8.4 Performances of the Philanthropy Tree of US and Italian Foundations

The sample includes 100 US biggest community foundations and 16 Italian ones, whose reports are available at their own websites. Above all, US Community Foundations of the sample are classified by the Guidestar database as the US Community Foundations with the highest 2013 Total Revenues, www.guidestar.org as for available 990 Forms. 990 Forms of this sample are investigated for the following accounting lines of fiscal year 2013: Contributions and Grants received, Investment Income, Total Revenues, Contributions, gifts and grants paid, Net Gain or Loss, Total Assets, Net Assets and Investments.

Though the sample is one seventh of the universe of US community foundations in absolute number, it includes 61.65% of total assets and 74.46% of grants paid of the whole universe. Investments are the main asset of this sample, more than 85.56% of Total Assets and they include state government obligations, corporate stocks and bonds, mortgage loans and other investments like interests, receivable or accrued investment incomes. Both in the US sample and Italian one investor relations are very important and managers of both American and Italian foundations, they are constantly monitoring trends of financial markets. Otherwise, investments are not the main source of money for paid grants. Resources of these foundations derive of contributions and grants they receive. With all connections within communities, cities and regions, received contributions can top 85% of their revenues. The Investment Income can top 34% of their revenues, instead.

For each US and Italian community foundation of the sample following ratios are firstly calculated: Contributions/Total Revenues, Investment Income/Total Revenues, Net Gain or Loss/Total Revenues, Grants/Total Revenues, Investments/Total Assets, Net Assets/Total Assets. Grants/Total Revenues weights the philanthropic role and potential for all resources the foundation is able to collect: what and how much the community foundation can support now and in the very next future. Contributions/Total Revenues is an estimate of their ability to raise funds. At the same time, both of these ratios are signalling the amount of relationships and also the strength of their communication, both offline and online. If Investments/Total Assets is an estimate of the involvement in financial markets, Investment Income/Total Revenues refers to financial revenues. Gain or Loss/Total Revenues is a signal of their efficiency or inefficiency. Increasing gains allow more many grants. Net Assets/Total Assets gives evidence of financial soundness and solvency.

Secondly, k-means clustering (normal mixture) of these ratios allows to separate, and classify three main groups. Clustering before-mentioned ratios of these US and Italian community foundations with JUMP Statistical Software, three main groups were obtained. Average performances can be read in the Table 8.1 of Final Cluster Centres. The analysis was further implemented with the analysis of websites and reports of every foundation, in order to appreciate their engagement and involvement for culture. Roots and branches were investigated for number of cultural projects, the amounts of grants delivered to cultural projects, number of networks

Table 8.1 2013's average economic performances of US and Italian foundations

Clusters	The best and most solvent philanthropist for education—60 foundations	The investor—18 foundations	The Fundraiser for heritage—38 foundations
Contributions/total revenues	64.22	35.91	88.00
Investment income/total revenues	33.02	43.34	10.68
Net gain or loss/total revenues	27.38	19.62	26.05
Grants paid/total revenues	58.48	43.22	57.12
Investments/total assets	88.65	53.66	62.24
Net assets/total assets	91.24	89.43	83.14

Cluster means
Source Elaboration with JUMP Statistics Software

and partners for cultural projects, number of links and brands for cultural projects, implementation of social media (from facebook to instagram) in order to show their philanthropic connections and events (photos of fundraising events, for example). This qualitative analysis allowed label clusters according to profiles as for cultural focus next to economic performances.

The most crowded cluster is the Best Grant-maker and the most solvent for Education. With the second highest percentage of contributions and more than 90% of net assets, this cluster shows the highest grants ratio of the sample, 58.48%. This cluster includes only two Italian foundations. Most of them are American. Micro and macro projects are referring to different good causes and the US education system is a prevailing focus. Especially, their grant-making can be related to community colleges in order to mitigate the increasingly high costs of experimenting with college for both those who enter the community college directly and those who start but do not complete a degree at a four-year college. Their grant-making includes vouchers in order to stimulate education from primary schools to universities, charter schools against poverty and for the regeneration of suburban areas. These grants imply big and small donations, permanent and spot collaborations in order to satisfy an increasing number of organizations. Their online communication shows the most relevant exploitation of links, brands and social media.

Arts and humanities are not excluded as it is for Fellowships for visual artists of California Community Foundation. If only 2% of all arts funding goes to individual artists in California, California Community Foundation has been supporting arts for many decades. Since 2000 this foundation has granted more than $17 million for arts education and organizations. The Delaware Community Foundation gave birth to the Kent County Fund for the Arts in order to foster the growth of art organizations. This is usual in USA foundations: in certain areas, the focus is on arts and ancillary funds and foundations are given birth in order to concentrate efforts and resources on culture.

To sum up, this is the US cluster with focus on education. These US foundations represent a solid Private Welfare State for education, from primary schools to universities and life-long learning, in the United States.

The second most crowded Fundraiser for Heritage cluster count ‘greater communities’ and the biggest share of Italian foundations. If revenues of these foundations include financial revenues, contributions, revoked grants and extra-ordinary revenues, revenues usually equal expenses. Contributions are prevailing and they are signalling how many roots and branches these foundations count thanks to networks in their communities. Community welfare is the ultimate focus, as it is for all community foundations. Education is not excluded from their philanthropic commitment with multiple initiatives: labs, internships, stages and work-placements are supported by Italian community foundations in an administrative and economic environment, which is quite different in comparison with United States. Nezt to education and often, the most important target, heritage is being paid attention and dedication of resources: from conservation to promotion and management within local territories and with heritage trails, out of local boundaries. In this cluster we can find community foundations of Naples and Salerno, whose projects range from restoration of tangible heritages to revival of intangibles heritages like goldworking. In Brescia and Pavia community foundations are particularly involved in projects for ‘landscape beauty’: in Valcamonica or the river Ticino long, heritages are restored together with landscapes, with focus on beautification both of tangible heritages and territories where these heritages are located. In the United States community foundations cannot emphasize such implications as their heritage is younger than in Italy and more dispersed in a wider landscape than in Italian provinces.

The Investor is the smallest cluster. These foundations focus on projects they can pool and diversify different resources for. Goals are very different and with a long-term commitment. Culture is not prevailing. Education can be supported if it is related to skills and jobs local communities need. With this goal, they constantly try to understand the underlying causes of the problems of the job market and the evolution of job opportunities. They have a long-term strategy, hoping to find deep solutions to big problems and they tend to support local economies with a deep engagement in projects they are co-funding or funding exclusively. Both US and Italian foundations are here present. Communication has improved both offline and online for at least one decade. Communications is important both for US and Italian foundations of this cluster, as the range of objectives and projects is related to different businesses, from social housing to environmental protection and the connections with multiples stakeholders must be constantly monitored and enhanced, via social media included.

Figure 8.1 shows the tree of community philanthropy. Roots like Contributions, Investment Income, revenues of fundraising events, revoked grants, other revenues are collected by community foundations. These foundations select projects according to grant-making standards and best practices. Multiple and merit projects

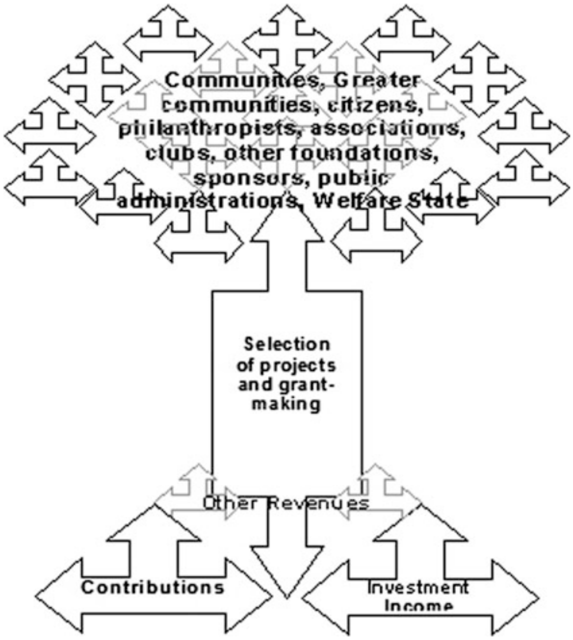


Fig. 8.1 The philanthropy tree of community foundations. *Source* Own elaboration

are then financed thanks to networks with multiple stakeholders like communities, citizens, philanthropists, associations, clubs, other foundations, sponsors, public administrations and the Welfare State of national and regional administrations. Communication flows from roots to branches and from branches to roots offline and online. Relationships marketing is essential at roots, with partners, contributors and investors. Relationship marketing is leading branches of their grant-making. The impact of all these branches can be amplified by time and place, when and where projects are sustainable and they impact more than local boundaries and more than initial terms and duration. US community foundations give evidence of multiple roots, above all in financial markets and branches with a specific focus on education, as concerns cultural issues. Italian foundations still rely on public administrations, local foundations and other grant-makers, with focus on heritage and culture, education included.

8.5 Conclusion

Khoregia is the historical background and benchmark of a society, which is evolving and growing thanks to the engagement and empowerment of communities. If US community foundations are an old and mature khoregia of community philanthropy in USA, these foundations are a recent phenomenon in Italy. They play a key role in addressing community needs, and build endowments to ensure that grants are available to support the community. Furthermore, they are involved in the strategic development culture and heritage.

From a marketing & communication point of view, they are maturing their strategies. Relationship marketing takes place on the web, too. Social media allow Community Foundations to build online communities, to promote initiatives, and sharing of information. At the best social media marketing & communication may generate benefits for both the Foundations, and their stakeholders.

In any case comparing Italian and US Community Foundations from a marketing & communication perspective, it appears that strategies of American foundations are more explicit, detailed and mature than those adopted by the Italians, and this is also confirmed surfing Community Foundations' websites. Considering social media strategies, websites and Facebook are popular media for both Italians, and US Community Foundations. Facebook pages of US, and Italian Community Foundations, they are proportionally alike crowded of friends, and likes. Also in this field, US Community Foundations use many social media, like YouTube, Vimeo, and Twitter, as part of their social media marketing & communication strategies.

In this field, storytelling would deserve a special mention, because it is probably the meaningful way through which Community Foundations may explicit their essence. Storytelling takes into account values, identity and mission of Community Foundations, and interprets the vision and the culture, and share donor stories with local community.

Then, the paper has also analysed economics and performance of US, and Italian Community Foundations, so that these foundations are confirmed as a fundamental node and link of the philanthropy tree of contemporary communities. As the cluster analysis confirmed, US foundations are older than Italian ones. Nevertheless, they project on a younger heritage, so that their focus remains on education, and then, modern and contemporary heritage. Italian foundations are younger and they concentrate on a much older heritage than US foundations. Education is not neglected in their projects. It is connected with the heritage conservation and transmission to next generations.

Both US and Italian foundations perform a tree of philanthropy whose roots and branches are always connected and amplified by growing connections. Communication is supporting connections though steps of life cycles are different: Italian foundations growing for magnitude of their relationships and philanthropy; US ones seem mature as concerns fundraising and fund-giving and they are now focused on social media, as for further engagement of present and upcoming partners.

References

Bandera, L., (2013). La filantropia comunitaria negli Stati Uniti: dalla Cleveland Foundation ai giorni nostri, «Percorsi di secondo welfare» in www.secondowelfare.it/autori/lorenzo-bandera. 11 April 2015.

Barbetta, G.P., Colombo, L., & Turati, G. (2012). The impact of Fiscal rules on the grant-making behavior of American foundations. Atti online della Riunione Scientifica Annuale della Società Italiana degli Economisti (Matera, 18–20 ottobre 2012) in www.siecon.org/online/convegni. 11 April 2015.

Canfora, L. (2004). *La democrazia. Storia di un'ideologia*. Bari: Laterza.

Carnelli, L., & Vittori, F. (2015). La comunicazione delle fondazioni al tempo dei social media in http://www.ilgiornaledellefondazioni.com/content/la-comunicazione-delle-fondazioni-al-tempo-dei-social-media. 11 April 2015.

Christ, M. R. (1990). Liturgy avoidance and antidosis in classical Athens. *Transactions of the American Philological Association, 120,* 147–169.

Christ, M. R. (2006). *The bad citizen in classical Athens*. Cambridge: Cambridge University Press.

Conn, D. (2013). Social Media Marketing for Community Foundations: Analyzing Engagement and Determining Best Practices in https://urbanstudies.stanford.edu/sites/default/files/conn-full_paper-webvers.pdf. 11 April 2015.

Davies, J. K. (1967). Demosthenes on liturgies: A note. *The Journal of Hellenic Studies, 87,* 33–40.

Davies, J. K. (1981). *Wealth and the power of wealth in classical Athens*. North Stratford, NH: Ayer Reprints.

Esposito, A., & Besana, A. (2018). US community foundations: Building a generous society in challenging times. *Journal of Nonprofit & Public Sector Marketing, 30*(2), 200–227.

Ferrucci, F. (2010). *Capitale sociale e partnership tra pubblico, privato e terzo settore. Il caso delle fondazioni di comunità*. Milano: Franco Angeli.

Foley, H. (2003). Choral identity in Greek tragedy. *Classical Philology, 98*(1), 1–30.

Franzon, M., & Pezzi, E. (2010). Le fondazioni comunitarie in Italia: sviluppo e tendenze. *Queste istituzioni, 158–159,* 136–157.

Gauthier, P. (1985). Les cités grecques et leurs bienfaiteurs (IVe-Ier siècle avant J.-C): contribution à l'histoire des institutions (Bulletin de correspondance hellénique, supp., 12.) Paris: École Française d'Athènes.

Gernet, L. (1999). Les nobles dans la Grèce antique. In: Droit et institutions en Grèce antique. Paris: Flammarion.

Grönroos, C. (1994). From marketing mix to relationship marketing: Towards a paradigm shift in marketing. *Management Decision, 32*(2), 4–20.

Hodgson, J., Knight, B., & Mathie, A. (2012). The New Generation of Community Foundations, Coady International Institute and Global Fund for Community Foundations, with support from the International Development Research Center, Canada, in www.globalfoundationcommunityfoundations.org. 11 April 2015.

Isgrò, E. (2011). L'Orestea di Gibellina e gli altri testi per il teatro, In M. Treu (Ed.). Firenze: Le Lettere.

Kennedy, R. F. (Ed.). (2017). *Brill's companion to the reception of Aeschylus*. Leiden: Brill.

Kilmurray, A. (2014). *Literature Review of Community Foundations*. Johannesburg: Global Fund for Community Foundations.

Knight, B. (2013). *The case for community philanthropy: How the practice builds local assets, capacity and trust- and why it matters*. London: Global Alliance for Community Philanthropy.

Lanza, D. (1977). *Il tiranno e il suo pubblico*. Torino: Einaudi.

Lanza, D. (1997). La disciplina dell'emozione. Un'introduzione alla tragedia greca, Milano: Il Saggiatore.

Lovejoy, K., & Saxton, G. D. (2012). Information, community and action: How nonprofit organizations use social media. *Journal of Computer-Mediated Communication, 17*(3), 337–353.

Malcangio, L., Treu, M., & Trimarchi M. (Eds.) (2007). Archeologia, turismo e spettacolo, Strumenti per la valorizzazione dei Teatri Antichi del Mediterraneo sul mercato del turismo culturale, Quaderni Formez, n. 56.

Mazany, T., & Perry, D. C. (2014). *Here for good: Community foundations and the challenges of the 21st century*. London: Routledge.

Mazzoni, S. (2013). *Edipo Tiranno all'Olimpico di Vicenza (1585)* (pp. 280–301). IV: Dionysus Ex Machina.

Mitchell, J. (1920). *The comedies of Aristophanes, Acharnians*. London: John Murray.

Pickard Cambridge, A. W. (1968). *The dramatic festivals of Athens*, 2nd edition. Revised and updated by J. Gould and D. M. Lewis. Oxford: Oxford University Press.

Treu, M. (2007a). Vicence à la grecque: Oedipe Roi et le Théâtre Olimpico. In D. Foucault, & P. Payen (Eds.), *Les Autorités. Dynamiques et mutations d'une figure de référence à l'Antiquité* (pp. 327–335). Grenoble: Éditions Jérôme Millon.

Treu, M. (2007b). Poetry and politics. Advice and abuse. The Aristophanic chorus on the Italian Stage. In: E. Hall, & A. Wrigley (Eds.), *Aristophanes in performance 421 BC-AD 2007: Peace, birds and frogs* (pp. 255–266). Oxford: Legenda.

Treu, M. (2013). Who's afraid of Aristophanes? The troubled life of ancient comedy in 20th-century Italy. In D. S. Olson (Ed.), *Ancient comedy and reception* (pp. 945–963). Berlin: De Gruyter.

Treu, M. (forthcoming). The tell-tale chorus. In S. Caneva, & M. Reig (Eds.), *Choralities in ancient Greece: New approaches*. Berlin/Boston: DeGruyter.

Violini, L., Vittadini, G. (2012). *La sfida del cambiamento: Superare la crisi senza sacrificare nessuno*. Milano: Bur.

Wilson, Peter. (2003). *The Athenian Institution of the Khoregia: The chorus, the city and the stage*. Cambridge: Cambridge University Press.

Chapter 9
Potential Implications of Brexit: The Case of the Slovak Republic

Gabriela Dováľová, Boris Hošoff and Erika Stracová

Abstract The shape of the future arrangement of bilateral relations between the United Kingdom and the European Union will also depend on the ability of both partners to find a general agreement throughout the process of negotiations. Considering the exports of goods, Britain represents a relatively important trade partner for Slovakia. The growing importance of the United Kingdom as a trading partner of Slovakia is indicated by the turnover of Slovakia's foreign trade with the United Kingdom, which has almost doubled over the last decade. The results of the analysis carried out so far indicate that the impact of Brexit on the economic growth of Slovakia should be relatively small. With respect to the short-term migration of Slovaks to work abroad, the decline of the importance of United Kingdom has been observed in recent years. On the contrary, the long-term migration of Slovaks has seen a growing trend with a rising share of Slovak citizens employed in the United Kingdom that have achieved higher than secondary education. At present, we cannot say what kind of bilateral relations between United Kingdom and European Union will be established in the area of labor force movements. The impact of Brexit on the labor market in Slovakia is therefore questionable. The results of our analysis show that approximately 62,000 jobs are directly and indirectly linked to Slovak exports to the United Kingdom, accounting for about 2.8% of the total employment. Exports to the United Kingdom generate most jobs directly and indirectly in the services sector, accounting for 61% of the total number of jobs linked to the exports from Slovakia to the United Kingdom, while the dominating industries are the automotive, mechanical engineering and electrical engineering sectors.

G. Dováľová (✉) · B. Hošoff
Institute of Economic Research SAS, Bratislava, Slovakia
e-mail: gabriela.dovalova@savba.sk

B. Hošoff
e-mail: boris.hosoff@savba.sk

E. Stracová
University of Economics in Bratislava, Bratislava, Slovakia
e-mail: erika.stracova@euba.sk

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_9

Keywords Brexit · Input-output analysis · Labour market · Foreign trade
Value added

JEL Classification F13 · F14 · F16

9.1 Introduction

The impacts of the United Kingdom leaving the EU (Brexit) on the Slovak economy are still not clear, but a number of analytical studies describing the alternative scenarios of further development have been performed and they also reveal the possible impacts on future economic development in EU countries including Slovakia. Most of the existing studies focused on assessing the impact of Brexit on EU countries came to the conclusion that the UK leaving the European Union will lead to economic losses for both parties, with greater losses expected for the United Kingdom. An impact study recently published by the European Parliament (Emerson et al. 2017) showed that the cumulated losses of EU-27 until 2030 in case of Brexit would be relatively low, ranging from 0.11 to 0.52% of GDP depending on the optimistic or pessimistic scenario, which would represent annual losses of roughly 0.011–0.052% of GDP. For the Great Britain, higher cumulated losses were estimated, ranging from 1.31 to 4.21% GDP depending on the type of scenario, which represents annual losses of 0.13–0.41% of GDP. Many impact studies include optimistic and pessimistic scenarios of the possible development, as it is still not clear what the contents of the trade agreement between the UK and the EU countries will be. In the optimistic scenarios, authors usually expect that Brexit will lead only to a relatively negligible increase of barriers to trade between the two parties. On the other hand, the pessimistic scenarios expect the so-called hard Brexit, which would mean especially a new implementation of tariff and non-tariff barriers to trade between the UK and the EU.

So far, only a relatively small number of impact studies have offered a disaggregated view of the impacts of Brexit on individual EU member states. The study by Aichele and Felbermayr (2015) can serve as an example. The authors of this study estimated the UK's costs connected with Brexit at 0.6–3% of GDP per capita depending on the type of scenario. Industries that should experience the largest losses (in case of hard Brexit) are the chemical industry, mechanical engineering and automotive industry, i.e. industries most integrated into the European value chain. In the services sector, it is especially the financial services that should be negatively affected. In EU-27, these losses should range roughly form 0.1 to 0.36% of GDP per capita depending on the assumed scenario. The authors expect a relatively significant increase of costs for some of the other EU member states. One of the reasons why this should be the case is the fact that the United Kingdom has been one of the largest net contributors to the EU budget. Therefore, this shortfall in receipts will have to be compensated from other sources. Moreover, the access of European companies to markets in the UK can be restricted as well. These costs should differ depending on the intensity of economic relations with the United Kingdom. According to the estimations made by the authors of the above-mentioned study, Ireland, Malta and Luxembourg should be affected the most, as they have strong economic relations with the UK in the financial sector. Their losses should be roughly equal to the losses of the UK. In Germany, one of the most affected sectors should be the automotive industry. In case of Brexit and increased barriers to foreign trade, this sector would suffer losses as a result of the existence of strong supplier links with the UK. More substantial losses should affect German metalworking, electrical engineering, and food industry. According to the results of the authors' static simulations, losses for Slovakia should be relatively mild, ranging from 0.1 to 0.3% of GDP per capita.

In his work, Rojas-Romagosa (2016) focused on the long-term impacts of Brexit especially on the Dutch economy (by 2030), but the study includes results for other EU member states as well, including Slovakia. The author pointed out that Brexit will decrease the bilateral trade between the UK and the EU, which should lead to a decrease in the GDP and the real per capita income on both sides. However, the negative impact of Brexit should be asymmetric within the EU. Except for Ireland, Malta and Luxembourg, countries like the Netherlands, Spain and Portugal will suffer big losses as well. In this study, the decrease in Slovakia's GDP has been estimated at 0.5–0.6% depending on the scenario of development. The average decrease in GDP of EU-27 ranged from 0.6 to 0.8%. The decrease in the GDP of the UK should be more significant, ranging from 3.4 to 4.1%, depending on the scenario.

Brexit should affect especially the automotive industry, and not only from the perspective of Germany but also the UK. This fact was pointed out for example in a study by authors from the UK (Treasury 2016). They argued that the UK's automotive industry is the fourth largest in Europe with an annual production of 1.6 million vehicles, accounting for 1.9% of the global production. Authors claim that the automotive industry in the country sustains roughly 147,000 jobs directly and around 300,000 more jobs indirectly. Its share on the creation of value added is roughly 0.7%. Authors of another study (Deloitte 2017) reached the conclusion that the effect of a hard Brexit on the German automotive industry would be similar to that of the recent financial and economic crisis, i.e. the production of cars would decrease from 3.07 million in 2006 to 2.28 million cars in 2019 (this number would be very close to the 2009 number, when it reached 2.19 million cars). The analysis showed that the 2019 sales of cars in the UK would decrease by roughly 550,000 cars in the case of hard Brexit as compared to no Brexit (−19%), which is a result of an increase in prices. The Slovak automotive industry will be affected by Brexit not only directly through direct trade links of Slovakia with the United Kingdom but also indirectly through the trade and supplier relations with other EU countries.

Only marginal attention has been paid to assessing the impacts of Brexit on the economy of Slovakia in analytical studies. One example is the analytic commentary of the National Bank of Slovakia (2016), where the authors claim already in the introduction that it is hard to assess the complex impacts as they will depend on: (1) possible financial market turbulence; (2) outcome of negotiations about the technical procedure of the UK leaving the EU; (3) the impact of Brexit on the outflow of financial services or on mobility and migration. The calculations allowed for the impacts of Brexit on foreign trade, on the exchange rate and on uncertainty in the financial markets. The authors estimated that Brexit could slow down the growth of the Slovak economy by around 0.3% by 2020, which would lead to a decreased job creation by roughly 5300 jobs. Another example is the analytic commentary of the Institute of Financial Policy at the Ministry of Finance of the Slovak Republic (Melioris et al. 2016), where a cumulative GDP loss in Slovakia is expected at 0.1–0.9% by 2019, depending on the scenario. Thus, in four years, the number of created jobs should be lower by around 7 thousand. However, Brexit should decrease the growth of the Slovak economy only to a relatively small extent.

The aim of this paper is to describe the possible implications of Brexit for the Slovak economy from the perspective of foreign trade and labour market. The paper includes a more detailed analysis of foreign trade and labour market with a goal to identify the importance of the United Kingdom as Slovakia's trade partner and a target destination of the migration of Slovaks to foreign countries. The paper describes the short-term migration of Slovaks seeking jobs in the UK and the position of Slovak citizens in the British labour market. The final part of the paper includes an assessment of the UK's importance as Slovakia's export partner from the perspective of value added and employment generated by Slovakia's exports to the UK.

9.2 Methodology

For the analysis, data from the Statistical Office of the Slovak Republic and from the UK Office for National Statistics were used. For the analysis of potential effects of Brexit on employment and value added, data from the World Input-Output Database (WIOD), containing the world input-output tables, socio-economic accounts and environmental accounts, were used. These data about employment in the Slovak economy were supplemented by the data from the Statistical Office of the Slovak Republic and then adapted to the aggregation used in the world input-output tables. The advantage of using this database is the possibility to capture the complex flows of intermediates and final products among countries in a detailed division by industry for the years 2000–2014.

For analyses of the relations between Slovakia and the UK from the perspective of employment and value added, we used the multi-regional input-output model (MRIO model). One of its assets is the ability to capture complex linkages among industries and countries, which arise from the use of intermediates in individual industries and from the international trade with intermediates. Thus, the model makes it possible to capture not only the direct, but also the indirect effects, which is an advantage when compared to other macro-economic models.

The MRIO model is an extended version of an open static input-output model for one economy. While in the case of aggregate models, we examine the total production in an economy in the form of one product, the Leontief model is based on the assumption that the output of the production process includes different goods and services intended either for further processing or for final use. A detailed description of the model can be found e.g. in the monograph by Miller and Blair (2009). In this paper, we use the version of international input-output tables composed using the so-called model D for industry x industry.

The international input-output tables are composed of three basic sections—the intermediate consumption matrix (**Z**), the value added vector (**p**) and the matrix of final use (**Y**). Moreover, we will also work with the vector of total production **x** and the employment vector **e**. Matrix **Z** captures the flows of intermediates among individual industries i (i = 1…N, where N equals the number of industries) and countries k (k = 1…K, where K equals the number of countries in the international input-output table). It can be expressed as

$$\mathbf{Z} = \left\{ z_{ij}^{pu} \right\} = \begin{bmatrix} \mathbf{Z}^{11} & \cdots & \mathbf{Z}^{1K} \\ \vdots & \ddots & \vdots \\ \mathbf{Z}^{K1} & \cdots & \mathbf{Z}^{KK} \end{bmatrix} \tag{9.1}$$

The individual elements in matrix **Z** indicate the production of industry i from the country of origin p intended for intermediate consumption in industry j in the target country u. Sub-matrices on the main diagonal indicate the flows of domestic intermediates among industries in the national economy. All other sub-matrices include elements that are a part of trade in intermediates on the world scale. Similarly, matrix **Y** includes information about where the final products produced by industries in individual countries are used. This matrix also includes e.g. the exports of cars from Slovakia for the final use in the UK. The total production vector $\mathbf{x} = \left\{ x_i^k \right\}$ includes information about the production of industry i in country k. When deducing the MRIO model, we start from the input coefficients matrix **A** which is calculated as

$$\mathbf{A} = \mathbf{Z}\hat{\mathbf{x}}^{-1} \tag{9.2}$$

The elements of this matrix indicate the production of industry i in country p necessary for the production of one unit of production in industry j in country u. These are the direct linkages between industries and countries, which result in producing one unit of production. Using vectors **x** and **y** and matrix **A**, it is possible to construct a system of balance equations and deduce the Leontief model, in this case for several regions,

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{L}\mathbf{y} \tag{9.3}$$

where matrix **L** (Leontief inverse matrix) is the basis of the model and includes complex linkages among industries and countries. As opposed to the input coefficients matrix, its individual elements express the relationship to one unit of final demand and include the direct and also indirect production necessary to meet it.

The extension of the model by value added and employment vectors allows us to analyse the effects of final demand and its changes on these variables. The row employment vector $\mathbf{e}'$ includes data about employment in industry i in country k.

$$\mathbf{e}' = \begin{bmatrix} \mathbf{e}'^1 & \dots & \mathbf{e}'^K \end{bmatrix} = \begin{bmatrix} \mathrm{e}_1^1 & \dots & \mathrm{e}_n^1 & \dots & \mathrm{e}_1^K & \dots & \mathrm{e}_n^K \end{bmatrix} \tag{9.4}$$

By dividing the individual elements of vector $\mathbf{e}'$ by the respective production of an industry, we get the so-called direct employment coefficients $\mathbf{e}_c$ showing what employment in industry i in country k is needed for one unit of production of this industry in the given country, formally $\mathbf{e}_c = \mathbf{e}'\hat{\mathbf{x}}^{-1}$. The main thing needed to link final use with the generated employment is the Leontief inverse matrix constructed for several countries. By multiplying it by the diagonalized direct employment coefficients vector from the left, we get the cumulative employment coefficients matrix. Its elements capture all complex linkages between the employment in individual industries and countries connected with the final use of specific commodities in specific countries of the world. Formally, the calculation can be written as

$$\mathbf{E} = \hat{\mathbf{e}}_c\mathbf{L} = \begin{bmatrix} \hat{\mathbf{e}}_c^1 & \cdots & \mathbf{0} \\ \vdots & \ddots & \vdots \\ \mathbf{0} & \cdots & \hat{\mathbf{e}}_c^K \end{bmatrix} \times \begin{bmatrix} \mathbf{L}^{11} & \cdots & \mathbf{L}^{1K} \\ \vdots & \ddots & \vdots \\ \mathbf{L}^{K1} & \cdots & \mathbf{L}^{KK} \end{bmatrix} \tag{9.5}$$

By multiplying matrix $\mathbf{E}$ by the final demand vector, we calculate its effects on employment generated in individual countries and in corresponding industries. When examining the effects on Slovak economy, it is necessary to select the relevant elements of this matrix indicating the employment created in individual industries of the Slovak economy. It is possible to analyse the effects of final demand on value added in a similar way.

9.3 Results and Discussions

The most important trade partner of the UK among the EU countries is Germany, which was the target country of as much as 22.7% of the UK's total exports to EU-27 in 2016. Other important export partners of the UK are France (13.8%), the Netherlands (12.8%), Ireland (11.8%), Belgium (8.1%), Italy (6.9%) and Spain (6.7%). These top seven export partners of the UK accounted for a total of 83% of the UK's total exports to EU-27. In 2016, Slovakia with its 0.4% share ranked eighteenth in the importance of the UK's export partners within the EU. Thus, Slovakia is not among the important EU export territories of firms from the UK.

Similarly to the UK, European countries are Slovakia's most important export partners in the long term. In 2016, as much as 85.2% of Slovakia's total exports was directed to EU-28, while imports from EU-28 to Slovakia reached 67.3%. The orientation of Slovakia's export activities on the so-called third markets is only

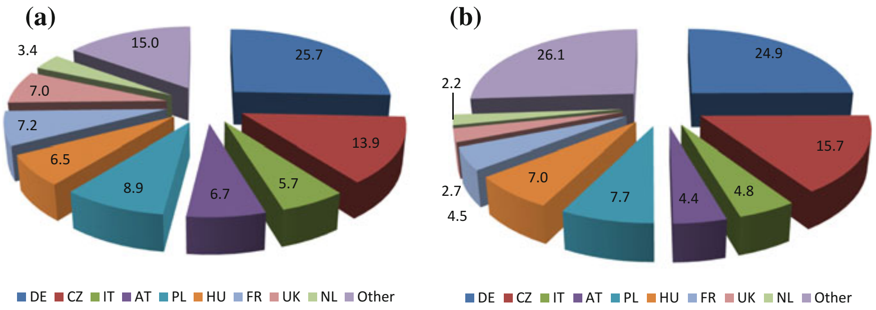


Fig. 9.1 Slovakia's exports and imports from the perspective of the EU, 2016. *Source* Composed using data from the Statistical Office of the Slovak Republic. *Note* Expressed as a share on Slovakia's total exports to EU-28

Fig. 9.2 Slovakia's total balance of trade with the UK (in EUR thousand). *Source* Composed using data from the Statistical Office of the Slovak Republic

minimal. Among the EU-28 countries, our most important export partners are Germany, V3 countries and France, whose shares on the 2016 total exports reached 21.9, 25 and 6.1% respectively. In 2016, the UK was the target of roughly 7% of Slovakia's total exports to the EU (Fig. 9.1a), and so represents a relatively important trade partner for Slovakia.

Slovakia's total imports from the UK amounted to EUR 1.2 billion, which meant a 1.9% share of the UK on Slovakia's total imports (i.e. a share of around 2.7% on Slovakia's imports from the EU–Fig. 9.1b).

International trade with goods between Slovakia and the UK (i.e. the sum of exports and imports) amounted to roughly EUR 5.4 billion in 2016 (Fig. 9.2). To compare, the foreign trade turnover of Slovakia and the UK reached EUR 2.9 billion in 2007, thus it almost doubled in the last decade. As can be seen in Fig. 9.2, in the last decade, Slovakia maintained a balance of trade surplus with the UK. The annual balance of trade surplus with the UK amounted to roughly EUR 2.9 in 2016,

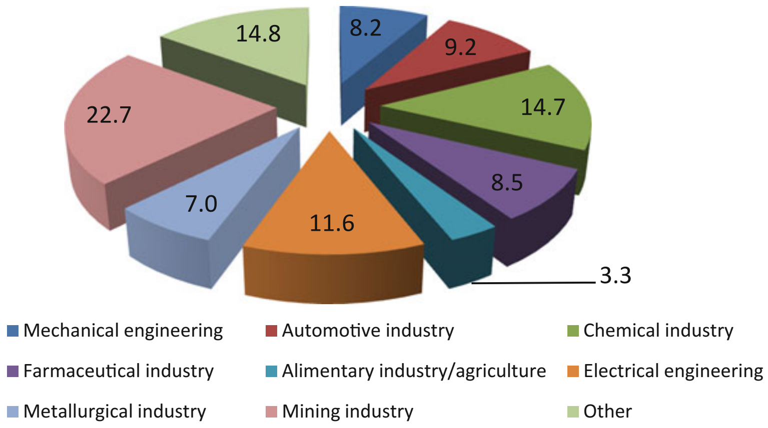


Fig. 9.3 Structure of Slovakia's imports from the UK by manufacturing industries, average for 2012–2016. *Source* Composed using data from the Statistical Office of the Slovak Republic

while the balance of trade with the UK has been continually increasing since 2010. Automotive industry, mechanical engineering and electrical engineering are the key industries within the Slovak economy, which is also reflected in the positive balance of trade with the UK.

From the perspective of imports from the UK to Slovakia in the examined period, the mining industry was the dominant one and its share on the total imports from the UK was 22.7% (Fig. 9.3). Within the mining industry, the imports from the UK are dominated by two categories: HS270900—Crude petroleum oils and oils obtained from bituminous minerals and HS271121—Natural gas. The renewed implementation of tariff and non-tariff barriers for Slovak importers from the UK could thus increase the costs of enterprises for inputs needed for the production of final products. In the examined period, the chemical industry had a relatively high share on Slovakia's total imports form the UK as well (14.7%). In the given period, the share of imports of automotive industry, electrical engineering and mechanical engineering reached 29% of the total imports from the UK. The UK is one of the countries from which Slovakia imports to a relatively small extent. UK's share on Slovakia's total imports in 2016 amounted to roughly 1.9%.

In the field of exports to the UK, the dominant industries are automotive industry, electrical engineering and mechanical engineering. In the examined period, as shown in Figure 9.4, the share of automotive industry on Slovakia's total exports to this country reached as much as 46.1%, followed by electrical engineering (25.3%) and mechanical engineering (6.7%). The position and weight of automotive industry in the structure of our foreign trade and GDP creation require an increased attention.

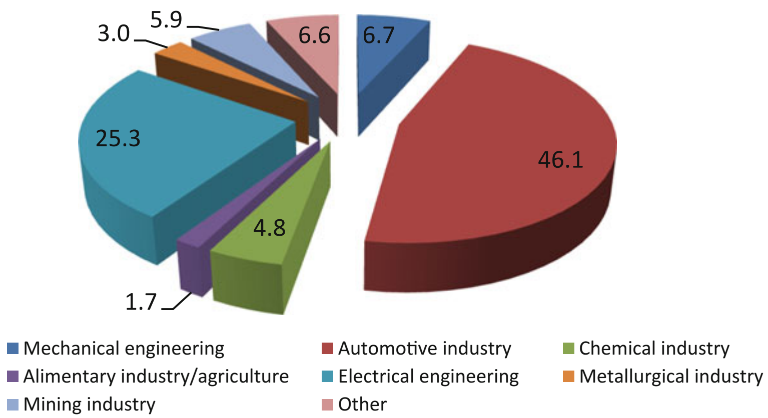


Fig. 9.4 Structure of Slovakia's exports to the UK by manufacturing industries, average for 2012–2016. *Source* Composed using data from the Statistical Office of the Slovak Republic

Slovakia is one of the leading car producers in Central Europe. In 2016, the global production of cars amounted to 94.9 million vehicles, out of which 18.8 million were produced in EU 27,[1] 1.8 million in the UK and 1.04 million in Slovakia (OICA 2017). The importance of automotive industry for the Slovak economy will increase even further after a new factory of the British-Indian car producer Jaguar Land Rover (Nitra) will be added to the three established global car producing companies Volkswagen (Bratislava), PSA Peugeot Citroen (Trnava) and Kia Motors (Žilina). Automotive industry is important for the British economy as well, as its share on GDP creation is as much as 4% and it is one of the biggest export sectors in the UK with a 10% share on the total exports of the country. Around a half of the UK's exports in the automotive industry is directed outside Europe. In the last years, the sales of British cars have been increasing especially in developing markets. For instance, the exports of British cars to China increased more than sixfold between 2008 and 2013 (KPMG 2014). China is one of the biggest destinations for the exports of British cars outside Europe, followed by Russia and the USA. The fact that the UK would focus more on emerging economies in the future could partly influence negotiations about the future form of trade relations with the EU.

As far as the possible impacts on the exports of car producers active in Slovakia are concerned, two factors will play an important role. The first one is the interests and strategies of mother companies. For instance, the French car producer PSA owns the British brand Wauxhall (direct competitor for Peugeot and KIA cars). Similarly, Volkswagen owns the British brand Bentley and also the last car producer that came to Slovakia, Jaguar Land Rover, has its interests and production capacities in the UK. This can mean that these car producers could solve possible

[1]Figure published as a total without including Croatia.

difficulties with exports caused by the implementation of new tariff measures by strengthening their activities and production capacities in the UK. The only car producer active in Slovakia without any production capacities in the UK is KIA. Another factor with a possible impact on our car exports to the UK is the production and exports from other factories of the mother companies located throughout Europe. In this regard, it is again KIA, whose only European production facility is in Slovakia.

9.3.1 Labour Market in the Context of Brexit

The UK's government plans to implement a visa obligation for EU citizens seeking work. For now, the extent to which this rule will be applied to the EU citizens is not clear. However, one study (IPPR 2017) shows that this plan could have a significantly negative impact on the British sector of services. In this sector, many of the jobs are taken by low-skilled workers from EU countries. We cannot say now what the future bilateral relations between the UK and the EU will be like in the field of labour force mobility. If the future arrangement is similar in this regard to that between the EU and Norway (the European Economic Area arrangement), we can assume that free movement after Brexit will remain virtually unchanged.[2] However, it is likely that the arrangement and the access of EU citizens to the UK will become stricter. Most of them come to the UK for work and so requirements for granting work visa might become an important point in the negotiations.

After the EU gets to the status of third countries, it is likely that just like in the case of these countries today, the UK will pay great attention to the applicant's qualifications when granting work visa. Based on this, it is possible to roughly identify the industries, jobs and British regions most influenced by implementing the new visa obligations for EU citizens. In the process of granting work permits, UK's immigration policy towards the third countries emphasises the level of skills and qualifications of the applicants. It also makes a very narrow room for exceptions, and only in those fields of labour market that face or could face a lack of labour supply. At present, work visa granted on the basis of qualifications (Tier 2 visa) are intended for workers on positions requiring a university degree (graduate-level jobs) with a minimum annual income of 20,800 lb. In 2015, most of the jobs in the British labour market did not meet these requirements for granting work visa. According to Vargas-Silva (2016), in 2015, only 25% of all employees in the UK worked in jobs with an annual income of at least 20,000 lb (roughly equal to the limit for Tier 2 visa).

The selection criteria on the basis of qualifications can influence some sectors and industries in the UK more than others. The sectors of agriculture, forestry and

[2]The free movement of labour would be retained, i.e. the right to become employed, but not the right to come with family or use the social welfare system.

fishing, and hotel and restaurant services have the lowest share of employees in graduate-level positions with annual income exceeding 20,000 lb (only around 5%). The sector of hotel and restaurant services is generally the biggest source of jobs for EU citizens but only 6% of them met the requirements for being granted work visa (Tier 2 visa) in 2015. On the other hand, most people in graduate-level jobs work in the sector of public services, education and healthcare (33% of all employees in the sector) and in the sector of finance and banking (34%). The consequences of such an arrangement in the selection of immigrants seeking work will not only be sector-specific but also have a geographic dimension. In the London area and the South East of the UK, there is a larger number of graduate-level jobs with an annual income exceeding 20,000 lb. On the other hand, Wales and North East of the UK have a lower share of jobs of this type (Vargas-Silva, 2016). In the next part of the paper, we will point out the importance of the UK from the perspective of the short-term and long-term migration of Slovaks abroad.

As can be seen in Table 9.1, the share of the UK on the total short-term migration of Slovaks has been gradually decreasing over the last years. While in 2007, roughly 16.4% Slovaks headed for work to the UK as a part of short-term migration, in 2016 this share dropped to 4.6%.

Knowledge acquired through the analysis of data about short-term migration of Slovaks seeking work abroad corresponds to the data gained by the Office for National Statistics (ONS) in the UK. It is difficult to determine the number of Slovak citizens working in the UK. Such data is not available in Slovak statistics. For this reason and upon our request, the Office for National Statistics from the UK provided us with data from a sample survey called "Annual Population Survey". The numbers of men and women from Slovakia employed in the UK remain roughly on the same level throughout the examined period. As can be seen in Table 9.2, the last years have seen a rapid increase in the total number of Slovak citizens living in the UK, while the difference between those participating in the labour force and those not participating deepened by 2016. Between the years 2013 and 2016, the number of employed men from Slovakia increased by 80%, which is almost twice as much as the number of women working in the UK. Thus, between 2013 and 2016 Slovak men caught up with and overcame the number of Slovak women working in the UK. In 2016, the most numerous group from the total number of Slovaks employed in the UK were two age groups, namely the age

Table 9.1 Short-term migration for work from Slovakia to the UK

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
UK total (in thousand persons)	29	20.2	14.1	10.6	9.7	7.5	10.6	10.1	8.6	7.4
UK share (in %)	16.4	12.1	10.9	8.4	8.4	6.2	7.8	7.5	5.8	4.6

Source Composed using data from the Statistical Office of the Slovak Republic, LFS

Table 9.2 Number of Slovak citizens in the UK

	2007	2010	2013	2016
Number of Slovaks living in the UK	50,411	50,468	55,258	100,933
Persons employed				
Total	37,583	34,385	36,065	57,439
Men	19,178	17,330	16,381	29,507
Women	18,405	17,055	19,684	27,932
Unemployed persons				
Total	3,162	1,973	2,461	4,109

Source Composed using data from ONS (2017)

Table 9.3 Number of Slovak citizens employed in the UK by occupation

Performed occupation	2007	2010	2013	2016
Managers and senior officials	641 (2%)	1,822 (5%)	2,568 (7%)	3,320 (6%)
Professionals	1,717 (5%)	2,745 (8%)	1,537 (4%)	4,557 (8%)
Technical and professional workers	1,474 (4%)	1,912 (6%)	2,961 (8%)	3,026 (5%)
Administrative workers	2,474 (7%)	2,410 (7%)	2,743 (8%)	3,615 (6%)
Workers in services and trade[b]	2,861 (8%)	4,139 (12%)	2,510 (7%)	6,111 (11%)
Personal services	3,460 (9%)	2,359 (7%)	3,665 (10%)	3,237 (6%)
Sales and customer service	3,276 (9%)	1,767 (5%)	[a]	4,819 (8%)
Plant and machine operatives	6,129 (16%)	4,306 (13%)	5,280 (15%)	7,906 (14%)
Auxiliary and unskilled staff	15,268 (41%)	12,925 (38%)	14,229 (39%)	20,511 (36%)

Note
[a]Sample too small
[b]Skilled Trades Occupations in the English original
Percentage values for individual categories in brackets
Source Composed using data from ONS (2017)

category of 25–34 (44%) and 35–44 (34%). The 45+ age group accounted only for 8% of the total number of Slovaks employed in the UK.

From the perspective of occupation, the biggest number of Slovaks works long-term as auxiliary and unskilled staff, accounting for 36% of the total number of persons employed in 2016 (Table 9.3). It can be stated that there are no significant changes in the structure of division of employed Slovaks in the compared occupations in the long-term.

During the examined period, the composition of Slovak citizens working in the UK changed rather significantly from the point of view of education. From the perspective of completed education, it can be stated that the total number of Slovaks employed in the UK has been experiencing a gradual increase in the share of people with secondary and higher education, which is documented also by the fact that while their share in 2007 reached 17%, it grew to 53% by 2016. Although in 2017, the second largest group of employed Slovaks from the perspective of completed education were people with no qualifications, in 2016 the opposite was true, and this group of Slovaks became the least numerous in the British labour market (not including those who couldn't answer).

9.3.2 *Effects on Employment Generated by Exports to the UK*

In 2014, exports to the UK generated almost EUR 3 billion of value added in Slovakia directly and indirectly, which represents almost 4% of the total value added in the domestic economy. This is the highest share in the last 15 years, and it documents the increasing importance of the UK as Slovakia's trade partner. The total generated value added continually increased throughout the whole examined period, whether it be in absolute terms or relative to the total value added created in Slovakia. A decrease was recorded only in the years following the crisis, which was followed by a period of rapidly growing generated value added (Fig. 9.5). It can be stated that Slovakia exported mainly final products to the UK throughout the examined period. Since 2012, this share has been equalising, and in 2014, final products accounted only for 54% of the total value added generated by the exports to the UK, or 1.64% of the gross value added created in Slovakia.

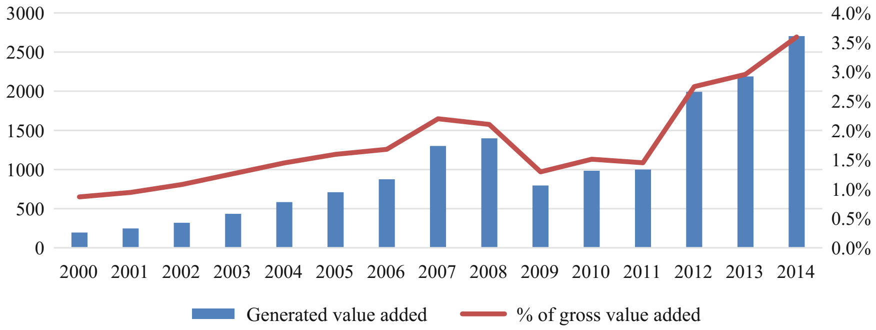


Fig. 9.5 Value added generated in Slovakia by exports to the UK. *Source* Composed using WIOT (wiod.org) in 2005 prices

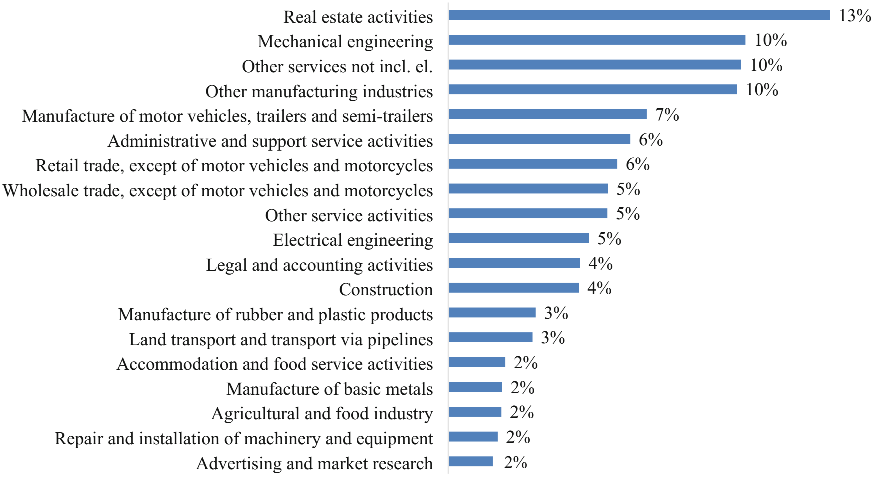


Fig. 9.6 Structure of employment generated by exports to the UK (2014). *Source* Composed using WIOT (wiod.org)

A more detailed input-output analysis showed that according to the Statistical Office of the Slovak Republic, around 2.2 million citizens worked in Slovakia in 2014, out of which roughly 62 thousand jobs (2.8%) were directly and indirectly linked to the exports to the UK. The exports of intermediates to the UK have a positive influence especially on employment in services; the dominating sector in the number of jobs generated by exports of final products is manufacturing. The most jobs were generated directly and indirectly by the exports to the UK in services, which represented as much as 61% of the total number of jobs linked to the exports to the UK. The most significant sectors from the perspective of the structure of generated employment in services were real estate activities, administrative and support service activities and trade composed especially of retail and wholesale trade. As far as manufacturing sectors are concerned, the most important industries were mechanical engineering, automotive industry and electrical engineering (Fig. 9.6). These are all sectors with high value added, which is reflected also in the structure of value added generated by the exports to the UK.

9.4 Conclusion

From the perspective of exports and imports of goods, Slovakia is not an important trade partner for the UK. In 2016, Slovakia accounted only for 0.4% of UK's exports to EU-27. In the same year, Slovakia's share on UK's total imports from EU-27 was on a relatively low level as well, accounting for only 1.1%. In contrast, as far as exports of goods are concerned, the UK is a relatively important trade partner for Slovakia, especially in automotive industry, mechanical engineering and electrical engineering. In 2016, the UK's share on Slovakia's total exports in automotive industry and electrical engineering reached 10 and 6% respectively, while in mechanical engineering, this share was 2.3%. Thus, we can assume that in the case of hard Brexit and a renewed implementation of tariff and non-tariff barriers, these sectors would be affected the most. Foreign trade turnover with the UK has almost doubled over the last 10 years. International trade with goods between Slovakia and the UK (i.e. the sum of exports and imports) amounted to roughly EUR 5.4 billion in 2016. Slovakia managed to maintain an active balance of trade with the UK throughout the whole period.

As far as the short-term migration of Slovaks seeking work is concerned, the importance of the UK has been decreasing over the past years. While in 2007, roughly 16.4% Slovaks headed for work to the UK as a part of short-term migration, in 2016 this share dropped to 4.6%: In contrast, Russia and Germany have seen an increase in importance for the short-term migration of Slovaks seeking work over the last years. Yet, the number of Slovak citizens living in the UK as well as the number of Slovaks working in the UK have seen a growing trend. The numbers of men and women from Slovakia employed in the UK remain roughly on the same level throughout the examined period (2007–2016). Between the years 2007 and 2016, the biggest increase in the number of Slovaks working in the UK was recorded in the 35–54 age category. In 2016, most Slovaks worked as auxiliary and unskilled staff, accounting for 36% of all employees. In 2010, this share reached 38%. A similar development can be observed also in other categories of jobs and thus it can be stated that from the long-term point of view, there are no significant changes in the structure of division of Slovaks employed in the compared occupations.

Around 62 thousand jobs in Slovakia are directly and indirectly linked to the exports to the UK, which represents roughly 2.8% of total employment. The most jobs are generated directly and indirectly by the exports to the UK in services, which represents around 61% of the total number of jobs linked to the exports to this country. The most significant sectors from the perspective of the structure of generated employment in services are real estate activities, administrative and support service activities and trade composed of retail and wholesale trade. As far as manufacturing sectors are concerned, the most important industries are mechanical engineering, automotive industry and electrical engineering. In 2014, exports to the UK generated almost EUR 3 billion of value added in Slovakia directly and indirectly, which represents almost 4% of the total value added in the domestic economy. This is the highest share in the last 15 years, and it documents the increasing importance of the UK as our trade partner. Nevertheless, it is supposed that Brexit should decrease our economic growth only to a relatively small extent.

Acknowledgements The research was supported by VEGA 2/0109/16 and by APVV-15-0765.

Literature

Aichele, R., & Felbermayr, G. (2015). *Costs and benefits of a United Kingdom exit from the European Union*. Guetersloh: Bertelsmann Stiftung.

Deloitte. (2017). *Break block Brexit—How a hard Brexit would impact the German automotive industry*. Available on: https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Brexit/Brexit-Briefings_Pt5_Hard-Brexit-German-car-industry.pdf.

Emerson, M., Busse, M., Di Salvio, M., Gros, D., & Pelkmans, J. (2017). An assessment of the economic impact of Brexit on the EÚ27. Available on: http://www.europarl.europa.eu/RegData/etudes/STUD/2017/595374/IPOL_STU(2017)595374_EN.pdf.

Institute for Public Policy Research. (2017). *Striking the right deal*. Available on: https://www.ippr.org/files/publications/pdf/striking-the-right-deal_April2017.pdf.

KPMG. (2014). *The UK automotive industry and the EU*. Available on: https://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT-KPMG-EU-Report.pdf.

Melioris, L., Pécsiová, M., Vasiľ, R., & Žúdel, B. (2016). *What will Brexit bring*? Bratislava, Slovakia: Institute for Financial Policy. Available on: http://www.finance.gov.sk/Default.aspx?CatID=11174.

Miller, R. E., & Blair, P. D. (2009). *Input-output analysis: Foundations and extensions* (2nd edn.). Cambridge University Press.

NBS. (2016). *Brexit—An illustrative calculation of the impact on the Slovak economy*. Analytical comment no 36.

OICA. (2017). *World motor vehicle production by Country and type*. Available on: http://www.oica.net/wp-content/uploads//Total-2016.pdf.

ONS. (2017). Slovakians in employment broken down by occupation, qualifications, gender, age and employment length. Reference Number: 007890. Data available on request.

Rojas-Romagosa, H. (2016). *Trade effects of Brexit for the Netherlands*. CPB Netherlands Bureau for Economic Policy Analysis.

Treasury, H. M. (2016). *HM treasury analysis: The long-term economic impact of EU membership and the alternatives*. London. ISBN: 978-1-4741-3089-9.

Vargas-Silva, C. (2016). *Potential implications of admission criteria for EU nationals coming to the UK*. Available on: https://migrationobservatory.ox.ac.uk/wp-content/uploads/2016/05/Report-Admission_Criteria.pdf.

Chapter 10
R&D Activities in a Differentiated Goods Duopoly with Quadratic Cost Function

Jacek Prokop

Abstract The purpose of this paper is to assess the relationship between the firms' behavior in the differentiated product market and the decisions regarding the R&D investments. The comparison is made between the case of the Stackelberg-type duopolistic competition in the final product market and the situation of a cartelized industry under the assumption of quadratic cost functions. On the one hand, different levels of product differentiation are considered. And, on the other hand, the impact of the extent of research spillovers is analyzed. The numerical analysis leads to the conclusion that, under the assumption of quadratic cost functions, it is always beneficial for both firms to form an industry cartel. This result is similar to the case of the linear cost functions with one exception: the threat of cartelizing the industry was not present when the final products were homogenous.

Keywords R&D activities · Industry cartelization · Stackelberg competition Heterogeneous products · Quadratic cost functions

10.1 Introduction

The purpose of this paper is to assess the relationship between the firms' behavior in the differentiated product market and the decisions regarding the R&D investments when the production is characterized by the quadratic cost function. Recently, Prokop and Karbowski (2018) analyzed the case of differentiated products in the industries characterized by the linear production costs. They concluded that as long as the final products are even slightly differentiated, it is always beneficial to firms competing in the Stackelberg fashion to fully cartelize the industry. It was shown that the threat of industry cartelization is not present only in the case of competition in homogenous goods.

J. Prokop (✉)
Department of Business Economics, Warsaw School of Economics,
Al. Niepodległości 162, 02-554 Warsaw, Poland
e-mail: jacek.prokop@sgh.waw.pl

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_10

The basic framework of the analysis has been set by d'Aspremont and Jacquemin (1988). Following these authors, two-stage games have been used in the literature to analyze the relationship between the research activities and the behavior of firms in the final product market. In the first stage firms simultaneously choose the size of R&D investments and in the second stage they decide about their conduct in the final product market.

An important element of the analysis are technological spillovers, i.e., R&D investments made by one company generate positive externalities for the remaining firms in the industry. The extent of the knowledge spillovers could vary due to the type of industry and due to the behavior of firms (see, e.g., Geroski 1995). The maximum level of research externalities is known to be achieved when companies form a joint venture.

In addition to the varying size of research externalities, also product differentiation is a significant factor affecting the firm conduct in the final goods market (see, e.g., Symeonidis 2003). It is usually observed that greater homogeneity of products leads to more fierce competition. However that does not exclude possibility for the firms to create a cartel.

The decision regarding research investments could be made independently, or it may be a result of cooperation by companies. Also, the production decisions could be a result of competition, or they may be set by firms in a coordinated way. These possibilities have been pointed out by Kamien et al. (1992).

In this paper, the focus is on the impact of R&D spillovers and product differentiation on the firm research activities and performance. The comparison is made between the case of Stackelberg-type competition and the situation of an industry cartel when the marginal costs of production are increasing.

Due to the difficulties in obtaining algebraic form of equilibrium solutions, the numerical analysis is applied.

The rest of the paper is organized as follows. In the following section, the case of a Stackelberg leadership duopoly in the final product market is analyzed. Section 10.3 is focused on the conduct and performance of companies in the cartelized industry. Based on the comparison of the above two cases, the evaluation of firm behavior and performance is given in Sect. 10.4. Concluding remarks close the paper.

10.2 Quantity Leadership in a Differentiated Product Market

We consider an industry composed of two firms, denoted 1 and 2. Firms produce q_1 and q_2 units of a heterogeneous product, respectively. The market demand for the product is given as a linear price function:

$$p_i = a - q_i - sq_j, \tag{10.1}$$

where p_i is the market price, q_i denotes the production supplied by firm i, while a is a given demand parameter and s captures the extent of substitutability between different goods. Clearly, both goods are perfect substitutes when $s = 1$, and each firm becomes a monopolist when $s = 0$.

Each of the firms produces at the total costs given by the following quadratic function:

$$C_i\left(q_i, x_i, x_j\right) = \frac{q_i^2}{c + x_i + \beta x_j} \tag{10.2}$$

where c is an initial level of efficiency of firm i, x_i denotes the amount of research investments made by firm i, and x_j denotes the level of research investments made by company j. Following the previous literature, parameter $\beta\,(0 \le \beta \le 1)$ measures the extent of R&D spillovers, i.e. the benefits for a given firm resulting from the research investments undertaken by the competitor. Greater size of parameter β means that the research undertaken by one firm reduces the manufacturing costs of the other firm by a bigger amount.

It is assumed that the entry barriers to the industry are high, so there is no issue of new competitors in this market.

Each company i incurs the costs of research investments according to the following quadratic function:

$$\gamma \frac{x_i^2}{2}, \tag{10.3}$$

where $\gamma\,(\gamma > 0)$ is a given parameter.

First, we consider the case when the competition of firms in the final product market is characterized by quantity leadership, i.e., company 1 assumes the role of the Stackelberg leader, and company 2, is the follower. Thus, firm 1 is the first to decide about the quantity of its production level, q_1, and firm 2, knowing the output level chosen by the leader, chooses its own amount of supply, q_2.

There are two stages of decision making by firms. At the first stage, both of them simultaneously and independently choose their levels of research investments, x_i. These decisions affect the manufacturing costs of both companies. At the second stage, the firms compete in the final product market according to the Stackelberg leadership model.

We use backward induction to find the equilibrium of the presented game with the two companies as players. Consider the profit of the follower firm at the second stage of the game for a given amount of R&D investments, x_1 and x_2:

$$\pi_2 = (a - q_2 - sq_1)q_2 - \frac{q_2^2}{c + x_2 + \beta x_1} - \gamma \frac{x_2^2}{2}. \tag{10.4}$$

Given the output level of the leader q_1, the follower maximizes its own profit by setting the production level at:

$$q_2 = \frac{(a - sq_1)(c + \beta x_1 + x_2)}{2(1 + c + \beta x_1 + x_2)}, \tag{10.5}$$

which is calculated by solving the first order optimality condition $\frac{\partial \pi_2}{\partial q_2} = 0$ with respect to q_2.

Taking into account the reaction function of the follower given by (10.5), the leader maximizes its own profit for given levels of research investments x_1 and x_2:

$$\pi_1 = (a - q_1 - sq_2)q_1 - \frac{q_1^2}{c + x_1 + \beta x_2} - \gamma \frac{x_1^2}{2}. \tag{10.6}$$

From the first order condition for profit maximization, $\frac{d\pi_1}{dq_1} = 0$, the optimal output level for the leader is given as:

$$q_1 = \frac{a(2 + (2 - \mathrm{s})(c + \beta x_1 + x_2))(c + x_1 + \beta x_2)}{2(2(1 + c + \beta x_1 + x_2)(1 + c + x_1 + \beta x_2) - \mathrm{s}^2(c + x_1 + \beta x_2)(c + \beta x_1 + x_2))}. \tag{10.7}$$

By substituting (10.7) into (10.5), we obtain the optimal output level of the follower as a function of R&D investments, x_1 and x_2:

$$q_2(x_1, x_2). \tag{10.8}$$

The production levels q_1 and q_2 given by (10.7) and (10.8) constitute the Nash-Stackelberg equilibrium.

After substituting (10.7) and (10.8) into (10.4) and (10.6), we obtain the equilibrium profits of both firms as functions of R&D investments, x_1 and x_2:

$$\pi_1(x_1, x_2), \tag{10.9a}$$

$$\pi_2(x_1, x_2). \tag{10.9b}$$

The Nash equilibrium strategies at the first stage of the game are found as a solution to the following system of two equations with two unknowns x_1 and x_2:

$$\frac{\partial \pi_1}{\partial x_1} = 0, \tag{10.10a}$$

$$\frac{\partial \pi_2}{\partial x_2} = 0. \tag{10.10b}$$

Under certain restrictions on the values of parameters a, c, β, γ, and s, the above system has exactly one solution; denote it by x_1^* and x_2^*.

Substituting x_1^* and x_2^* into (10.9a) and (10.9b), we obtain the equilibrium profits of the leader and the follower; denote them by π_1^*, and π_2^*.

Since the algebraic solution of our model is practically hard to present due to the quadratic cost function, we will use a numerical analysis in order to show possibilities of certain outcomes. For the purpose of this paper, we will restrict our considerations to the case when three parameters of the model are: $a = 100$, $c = 10$, and $\gamma = 20$. The results of the calculations for $s = 0.5$ and various levels of parameter β are given in Table 10.1.

Based on Table 10.1, let us consider the impact of parameter β, i.e. the size of research externalities, on the equilibrium conduct of firms. The size of R&D investments of both companies is a declining function of the extent of research externalities measured by the parameter β. It can also be observed that the quantity leader invests in R&D more than the follower.

The supply of the final product offered by the firms behaves nonmonotonically with respect to the level of research spillovers. The largest output offered by the leader takes place for the parameter $\beta = 0.5$, but the highest production of the follower is observed for $\beta = 0.6$. The lowest prices are offered by both suppliers for parameter $\beta = 0.6$. Thus, the medium extent of research spillovers generates the highest gains for the consumers in this industry.

The profits of each firms are an increasing function of the size of technological externalities. Thus, both competing firms are interested in the largest extent of technological spillovers.

Table 10.1 Quantity leadership for $a = 100$, $c = 10$, $\gamma = 20$, $s = 0.5$ and $\beta \in [0, 1]$

β	x_1^*	x_2^*	q_1^*	q_2^*	p_1^*	p_2^*	π_1^*	π_2^*
0.0	0.68000	0.64665	39.3860	36.7059	42.2611	43.6012	1514.62	1469.69
0.1	0.64764	0.61116	39.3944	36.7126	42.2493	43.5902	1515.27	1470.33
0.2	0.61622	0.57654	39.4010	36.7181	42.2399	43.5814	1515.84	1470.90
0.3	0.58564	0.54267	39.4059	36.7224	42.2329	43.5746	1516.33	1471.41
0.4	0.55581	0.50943	39.4090	36.7256	42.2282	43.5699	1516.74	1471.85
0.5	0.52664	0.47672	39.4104	36.7277	42.2257	43.5671	1517.08	1472.25
0.6	0.49806	0.44445	39.4102	36.7287	42.2255	43.5662	1517.35	1472.59
0.7	0.47000	0.41252	39.4082	36.7286	42.2275	43.5673	1517.55	1472.88
0.8	0.44240	0.38083	39.4045	36.7275	42.2317	43.5702	1517.69	1473.12
0.9	0.41519	0.34930	39.3991	36.7253	42.2383	43.5752	1517.75	1473.31
1.0	0.38833	0.31784	39.3918	36.7221	42.2472	43.5820	1517.75	1473.46

Table 10.2 Quantity leadership for $a = 100$, $c = 10$, $\gamma = 20$, $\beta = 0.2$ and $s \in [0, 1]$

s	x_1^*	x_2^*	q_1^*	q_2^*	p_1^*	p_2^*	π_1^*	π_2^*
0.0	0.86294	0.86294	45.8456	45.8456	54.1544	54.1544	2284.83	2284.83
0.1	0.78938	0.78904	43.9002	43.8035	51.7194	51.8064	2088.22	2087.80
0.2	0.72926	0.72665	42.3057	41.9144	49.3115	49.6245	1916.25	1913.12
0.3	0.68094	0.67237	41.0314	40.1323	46.9289	47.5583	1765.26	1755.09
0.4	0.64339	0.62325	40.0627	38.4146	44.5714	45.5603	1632.46	1609.05
0.5	0.61622	0.57654	39.4010	36.7181	42.2399	43.5814	1515.84	1470.90
0.6	0.59972	0.52922	39.0668	34.9939	39.9369	41.5660	1414.05	1336.76
0.7	0.59512	0.47752	39.1059	33.1816	37.6670	39.4443	1326.41	1202.64
0.8	0.60513	0.41607	39.6027	31.1981	35.4388	37.1197	1253.07	1063.96
0.9	0.63505	0.33639	40.7075	28.9179	33.2664	34.4453	1195.32	915.04
1.0	0.69532	0.22415	42.6929	26.1319	31.1752	31.1752	1156.42	748.27

Now, we look at the effect of changes in the substitutability (parameter s) on the behavior of both companies in the leader-follower setting. Table 10.2 reports the Stackelberg equilibrium for various levels of s, and the R&D spillover parameter $\beta = 0.2$.

It follows from Table 10.2 that the biggest size of research investments by both firms is observed when there is maximum product differentiation. However, the growing level of substitutability (increasing parameter s) induces the follower to reduce the R&D spendings by more than the leader. The decline is monotonic for the follower, and nonmonotonic for the leader. When the product substitutability becomes relatively high ($s \geq 0.7$), the research investments of the leader start growing with an increasing s.

A decline in product differentiation reduces the profits of both companies. It is not surprising that both firms enjoy the highest profits when product differentiation is maximal, i.e., $s = 0$; the lowest profits are observed when products are homogenous, i.e., $s = 1$. An increase in product substitutability reduces the follower's profit faster than the leader's.

The consumers enjoy the lowest prices when the product differentiation is minimized, i.e., s = 1.

We move on to analyze the cooperation of firms in the industry cartel.

10.3 Industry Cartel

Let us consider a model in which the firms form a cartel both at the R&D stage, and at the final product market. We assume that the demand function as well as the cost functions of the firms stay the same as in the case of Stackelberg competition.

At the second stage of the game, the companies decide about their production levels q_1 and q_2 to maximize the joint profit, given the size of research investments, x_1 and x_2:

$$\pi = (a - q_1 - sq_2)q_1 - \frac{q_1^2}{c + x_1 + \beta x_2} - \frac{\gamma x_1^2}{2} + (a - q_2 - sq_1)q_2 - \frac{q_2^2}{c + x_2 + \beta x_1} - \frac{\gamma x_2^2}{2}. \tag{10.11}$$

In the case of the symmetric equilibrium, i.e., $x_1 = x_2 = x$, the optimal production level of each cartel member is:

$$q_1 = q_2 = q = \frac{a(c + (1+\beta)x)}{2(1 + c + cs + (1+s)(1+\beta)x)}. \tag{10.12}$$

After substituting (10.12) into the market demand function described by (10.1), we arrive at the symmetric equilibrium price of the final product:

$$p_1 = p_2 = p = \frac{a(2 + c + cs + (1+s)(1+\beta)x)}{2(1 + c + cs + (1+s)(1+\beta)x)}. \tag{10.13}$$

When companies simultaneously choose the levels of R&D investments x_1 and x_2 at the first stage of the game, their joint profit becomes:

$$\pi = \frac{1}{2}\left(\frac{a^2(c + (1+\beta)x)}{1 + c + cs + (1+s)(1+\beta)x} - 2\gamma x^2\right). \tag{10.14}$$

When the companies form a cartel at the research stage and in the final product market, the symmetric equilibrium takes place when the R&D investments of each of the firms (x) satisfy the following first order condition for profit maximization:

$$\frac{\partial \pi}{\partial x} = 0. \tag{10.15}$$

Under certain restrictions on the values of parameters a, c, β, γ, and s, the above equation has exactly one solution; denote it by $\tilde{x}$. After substituting $\tilde{x}$ for x into (10.12), we obtain the production level of each of the firms; denoted by $\tilde{q} = \tilde{q}_1 = \tilde{q}_2$.

The equilibrium price of the final product offered by each company is obtained by substituting $\tilde{x}$ for x into (10.13); denote it by $\tilde{p}$.

Next, by substituting $\tilde{x}$ for x into (10.14), we obtain the equilibrium joint profit of the companies; denote it by $\tilde{\pi}$. Thus every company earns:

$$\tilde{\pi}_1 = \tilde{\pi}_2 = \frac{1}{2}\tilde{\pi}. \tag{10.16}$$

Table 10.3 Full industry cartel for $a = 100$, $c = 10$, $\gamma = 20$, $s = 0.5$ and $\beta \in [0, 1]$

β	$\tilde{x}$	$\tilde{q}_i$	$\tilde{p}$	$\tilde{\pi}_i$
0.0	0.44958	31.3343	52.9986	1564.69
0.1	0.48697	31.3496	52.9756	1565.11
0.2	0.52267	31.3657	52.9515	1565.55
0.3	0.55667	31.3824	52.9265	1566.02
0.4	0.58901	31.3995	52.9008	1566.51
0.5	0.61971	31.4170	52.8745	1567.01
0.6	0.64882	31.4348	52.8478	1567.53
0.7	0.67639	31.4527	52.8209	1568.06
0.8	0.70248	31.4708	52.7938	1568.60
0.9	0.72716	31.4889	52.7666	1569.16
1.0	0.75049	31.5070	52.7395	1569.72

For the sake of a comparison with the equilibria obtained in the previous section, we will restrict our numerical calculations to the case when the four parameters are $a = 100$, $c = 10$, $\gamma = 20$, and $s = 0.5$. The equilibrium results for various levels of parameter β have been presented in Table 10.3.

Based on Table 10.3, let us consider the impact of technological spillovers in research and development on the equilibrium conduct and performance of firms in the cartelized industry. In this case, we find positive correlation between the size of R&D externalities and research investments aimed at the cost reduction. It should be observed that it is exactly opposite relationship than the one observed in the case of Stackelberg competition in the final product market reported in Table 10.1, where that relationship was negative. The lowest level of cost-reducing investments is observed when there are no research externalities $(\beta = 0)$.

This result is different from the case of a cartelized industry with homogenous product $(s = 1)$ discussed by Prokop (2016). When the final products are homogenous, the R&D spending of every cartel member is declining together with the larger extent of technological spillovers. Thus the highest investments in research in a fully cartelized industry are expected when there are no technological externalities.

Together with the growing research investments, each company supplies a higher amount of final output as a result of greater size of externalities. That leads to the reduction of market price. However, it should be noticed that the prices are still significantly higher than those in the noncollusive case. Despite the declining price, the profits of each cartel member are increasing with the higher level of research spillovers. These results are similar to the case of a cartelized industry with linear production costs analysed by Prokop and Karbowski (2018).

Additional regularities can be observed by changing the degree of product differentiation measured by parameter s. Table 10.4 reports the calculation of cartel equilibrium for various size of s, and for $\beta = 0.2$.

Table 10.4 shows that the R&D investments by a cartel member $(\tilde{x})$ are a declining function of the extent of product differentiation (parameter s). Similar

Table 10.4 Full industry cartel for $a = 100$, $c = 10$, $\gamma = 20$, $\beta = 0.2$ and $s \in [0, 1]$

s	$\tilde{x}$	$\tilde{q}_i$	p	$\tilde{\pi}_i$
0.0	1.00651	45.9043	54.0957	2285.08
0.1	0.86800	41.9968	53.8035	2092.31
0.2	0.75575	38.7091	53.5491	1929.74
0.3	0.66355	35.9034	53.3255	1790.77
0.4	0.58696	33.4802	53.1277	1670.56
0.5	0.52267	31.3657	52.9515	1565.55
0.6	0.46821	29.5041	52.7935	1473.01
0.7	0.42169	27.8523	52.6511	1390.84
0.8	0.38167	26.3766	52.5221	1317.37
0.9	0.34700	25.0501	52.4049	1251.30
1.0	0.31678	23.8511	52.2978	1191.55

relationship was observed about the behavior of Stackelberg follower reported in Table 10.2. However, the Stackelberg leader's investment in R&D was nonmonotonic.

Using Table 10.4, it can be concluded that the production levels, prices, and profits of each cartel member are declining with an increasing homogeneity of the final product. These results do not differ from the case of linear cost function discussed by Prokop and Karbowski (2018).

10.4 Evaluation of Firm Behaviour and Performance

Now, we may use the equilibria obtained in the previous two sections to compare the decisions of firms and their performance under the quantity-leadership competition and in the cartelized industry.

First, consider the decisions of companies regarding the investments in research and development when the final products offered by firms have a medium level of differentiation ($s = 0.5$). A cartel member invests less in R&D activities than a firm in the non-cartelized industry for the relatively low levels of technological spillovers. When parameter β is below 0.4, the cartel is expected to generate a smaller amount of R&D investments than the non-cartelized industry. For the values of parameter β not smaller than 0.4, the amount of research investments by a single firm is higher in the cartelized industry. Thus, it can be claimed that cartels speed up technological development for a sufficiently large size of research spillovers. Unfortunately, the prices offered by the cartel members are significantly higher than the price levels expected in the non-cartelized industry.

Next, compare the performance of companies in the cartelized and non-cartelized industries characterized by product differentiation. It can be seen from Tables 10.1 and 10.3 that the profit of cartel members is always higher than the profit of non-colluding firms. Thus, the incentives for cartel formation under the quadratic cost function are the same as under the linear cost functions analyzed by Prokop and Karbowski (2018).

The numerical analysis shows that under the quadratic cost functions for any extent of product differentiation, it is always better for both firms to create a cartel in order to maximize profits rather than compete according to the quantity-leadership pattern. This conclusion is different from the results of Prokop and Karbowski (2018) for the case of linear cost functions. These authors showed that the industry cartelization is better for both firm only when products are differentiated. Under the linear cost functions, when products are homogenous, the Stackelberg leader prefers not to form a cartel.

10.5 Concluding Remarks

In this paper, we considered the relationship between the research and development activities and the behavior of firms in the differentiated product market under the assumption of quadratic cost functions. Two types of firms' conduct in the final product market were investigated: quantity leadership and industry cartel. On the one hand, the effect of different levels of product differentiation was analyzed. And, on the other hand, the impact of the extent of research spillovers was considered.

The numerical analysis led to the conclusion that, under the assumption of quadratic cost functions, it was always beneficial for both firms to form an industry cartel. This conclusion is different from the results of Prokop and Karbowski (2018) for the case of linear cost functions. These authors showed that the threat of industry cartelization was not present when the final products were homogenous (i.e. $s = 1$). Thus, the existence of increasing marginal costs of production generates a serious risk of collusion among the duopolists and creates negative consequences for consumers.

Acknowledgments This research was supported by National Science Centre, Poland (grant number UMO-2017/25/B/HS4/01632).

References

d'Aspremont, C., & Jacquemin, A. (1988). Cooperative and noncooperative R&D in Duopoly with spillovers. *American Economic Review, 78,* 1133–1137.

Geroski, P. (1995). Do spillovers undermine the incentive to innovate? In S. Dowrick (Ed.), *Economic approaches to innovation*. Aldershot: Edward Elgar.

Kamien, M. I., Muller, E., & Zang, I. (1992). Research joint ventures and R&D cartels. *The American Economic Review, 82,* 1293–1306.

Prokop, J., & Karbowski, A. (2018). *R&D spillovers and cartelization of industries with differentiated products*. *Journal of International Studies*, *11*, 44–56.

Prokop, J. (2016). Firm performance and research and development. In A. Vlachvei, O. Notta, K. Karantininis, & N. Tsounis (Eds.), *Factors affecting firm competitiveness and performance in the modern business world* (pp. 108–128). IGI Global.

Symeonidis, G. (2003). Comparing Cournot and Bertrand equilibria in a differentiated duopoly with product R&D. *International Journal of Industrial Organization, 21,* 39–55.

Chapter 11
Internationalization Indices and Success Perception of Polish Born Globals

Tomasz Sikora and Ewa Baranowska-Prokop

Abstract The main goal of this study is to identify and evaluate relationship between internationalization indices and success perception by owners and/or managers of Polish Born Globals (BG). The applied research method is statistical analysis (multiple regression) of data obtained through questionnaire (CATI or mixed mode: CATI + CAWI) on three representative samples of Polish BG-type enterprises. The main findings of the research show the lack of coherent pattern of correlations between the degree of internationalization measured by simple indices (number of foreign markets, foreign market entry strategy, scope) and success perceived by managerial staff. The only positive relationship—in two samples—has been observed for "international competences of executive board" and success on foreign markets. The analysis of non-linear relationships revealed that the least favourable evaluations of success were in the case of firms depending on a single export market.

Keywords Born globals · Internationalization · Performance

11.1 Introduction

The process of the firm's internationalization is complex in its character and the research of this phenomenon requires more and more variables explaining its specificity and nature. As a consequence, in the literature one cannot find uniform and accepted methodology of internationalization's survey which involves its scale, scope, forms, speed and effects. Furthermore, there are differing views as to whether or not the construction of such a general index is feasible in the foreseeable future (Sullivan 1996; Ramaswamy et al. 1996). In traditional models the firm is perceived

T. Sikora (✉) · E. Baranowska-Prokop
SGH Warsaw School of Economics, Institute of International Management and Marketing, Al. Niepodległości 162, 02554 Warsaw, Poland
e-mail: tsikora@sgh.waw.pl

E. Baranowska-Prokop
e-mail: ebarano@sgh.waw.pl

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_11

as an autonomous entity and the analysis is concentrated on its inner resources: knowledge, managerial skills, urge for internationalization, financial resources etc. Whereas, in inter-organizational network models which take cognisance of growing inter-dependence of business entities in globalisation era—the stress has been put on search of relations in business networks (Ebers 1997; Glaum and Oesterle 2007).

However, in the classification literature numerous methods and indices of firm's internationalization are presented (Sullivan 1994; Ietto-Gillies 1998; Johanson and Vahlne 2009; Doryń 2011). One of the most frequently discussed is Dörrenbächer (2000), classification, which indicates: structural indices, performance indices, attitudinal indices, indicators of management style, regional concentration, network expansion, geographical and cultural distance and composite indices of transnationality or transnational activity spread index. An interesting list of indices has been presented in Karasiewicz (2013). They are subdivided into following groups: simple rates, indices based on the scope of activities, indices capturing the degree of regional concentration (e.g., Herfindahl, geographical entropy or Pangarkar index), indices describing the activities in the value chain.

The analysis of selected papers published in 2011–2016 leads to the conclusion that the research on the consequences of firm internationalization are conducted to a larger extent in the sector of SMEs, and in particular for the BG-type companies (Pera 2017). Nonconventional internationalization models are related to the increasing process of market globalization which creates new opportunities for the firms to leapfrog certain internationalization stages, and to operate on numerous foreign markets, simultaneously. These companies develop international activities from the time of their formation, and view the global market as their target (Cavusgil 1980).

This paper continues the research on the phenomenon of early internationalization of SMEs. The main methodological obstacle has been pertinently pointed out by Cieślik (2010). He stated that the considerations had been focused exclusively on the successful companies which entered the internationalization phase very early. The remaining firms which experienced the stagnation or even stopped exporting are not taken into the analysis.

The research on the specificity of Polish BGs have been undertaken since late 1990s, e.g., Nowakowski (1999), Gorynia (2007), Kowalik and Baranowska-Prokop (2013), Baranowska-Prokop and Sikora (2014, 2017) and Danik and Kowalik (2015). It covers numerous conceptual, strategic, and operational aspects of BGs' functioning.

The focus of this study is to identify and evaluate the relationships between simple internationalization indices and managerial success perception of Polish Born Globals (BG). The presented paper is structured as follows. Firstly, the literature review is presented. Next, the research method is explained. Then the results of conducted analysis are discussed. The practical implications of the findings and the limitations of the study are also provided.

11.2 Research Method

The current research has been based on survey studies with respondents from three representative samples of Polish BGs (GUS data base N = 19,500 firms). Interviews with the first group of companies were conducted in February–March 2013 (CATI method). The second group was interviewed in September–October 2014 (same method), and the third one in February 2018 (mixed mode: CATI + CAWI). The analysis included only the firms that started international activities within three years of their inception and achieved the level at least 25% of revenues coming from the exports.

In all cases, the interviews targeted the managerial staff of manufacturing enterprises employing 10–249 people. The size of the first sample was 256 firms, the second sample consisted of 233 companies, and the third sample of 297 companies. The interviewed person was owner or top manager or a manager responsible for international activities.

11.3 Research Hypotheses

Since the existing research on the relationship between the internationalization level and the firm performance is inconclusive (i.e., Glaum and Oesterle 2007; Sleuwaegen and Onkelinx 2010), our main hypothesis is formulated without specifying the direction of relationship between the investigated variables:

H1: There exists a significant relationship between the degree of internationalization and the success of the firm perceived by its managers.

In the case of specific forms of activity on the foreign markets (direct exporting, indirect exporting, etc.), an additional hypothesis has been posed (again without specifying the direction of dependence):

H2: There exists a significant relationship between the form of international market activities (including the export type) and the firm success perceived by its managers.

The questionnaires (for the first two samples) contained questions that enabled calculation of the following internationalization measures of the firm:

(1) Three indicators capturing the attitude and the competences of the managerial staff expressed by the statements on the 5-point Likert scale:

   a. The management perceives the foreign markets as the firm’s targets [1]—The management perceives Polish market as the firm’s target [5];
   b. The management is highly experienced in doing business abroad [1]—The management has no experience in doing business abroad [5];

c. Our firm looks for new market opportunities more often abroad than domestically [1]—Our firm looks for new market opportunities more often domestically than abroad.

For the third sample, the items from International Vision Subscale (Weerawardena et al. 2015) have been applied together with the item 1b from the previous questionnaires.

(2) Different market entry modes, such as forms of exporting and other operations on the foreign markets (included as binary variables): direct export, indirect export through a domestic (Polish) intermediary, indirect export through a foreign intermediary, other forms of international operations (joint-venture, own subsidiary etc.).
(3) The total number of different types of international operations.
(4) The export share of the total revenues.
(5) The number of the main export markets.

For the first two samples the managerial perception of the firm success has been expressed by two statements on 5-point scales:

(1) Considering the financial indices (e.g. profitability) for our firm, it can be concluded that our company has been successful.
(2) Considering the situation on the (domestic and foreign) markets, where our firm operates, it can be concluded that our company has been successful in comparison to its competitors.

For the third sample the success compared to competitors has been retained and the evaluation of financial results in 2017 has been added (on a 5-point scale: from "heavy loss" [1] through "the result close to 0" [3] to substantial profit [5]).

11.4 Interpretation of the Results

The analysis of the relationship between the degree of internationalization and the managerial perception of success has been conducted based on the multiple regression model (stepwise selection method). In order to take into account possible differences between small- and medium-sized firms in the success evaluations, two binary variables have been created (for each of two considered categories) and included in the regression models with variables measuring the internationalization.

Table 11.1 presents the model of linear regression for the first measure of success in the first sample of Polish BGs.

Considering the first measure of success in the first research sample only one indicator (concerning managerial staff competences) has shown positive significant correlation with the firms' success in its financial dimension. This observation leads to the conclusion that the higher competences of managerial staff, the bigger the firms' success (regression coefficient is negative, because high experience is on the

Table 11.1 Model of linear regression of relations between internationalization measures and first measure of success (first sample)

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.194[a]	0.038	0.030	0.899	2.029

Coefficients[a]					
Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	4.235	0.124		34.162	0.000
The management is experienced in running business in international markets [1]—The management has no experience in running business in international markets [5]	−0.149	0.061	−0.151	−2.434	0.016
Medium-sized enterprises	0.216	0.113	0.118	1.905	0.058

[a]Dependent variable: considering the financial indices (e.g. profitability) for our firm, it can be concluded that our company has been successful [1:5]
Source own analyses, N = 256

lower end of the scale). Selection of medium-sized enterprises in regression model means that respondents from this group of firms evaluated success better than respondents from the small ones.

Another interesting observation is that none of other internationalization indicators was significantly (but incoherently) correlated with BG's success measured by the first indicator.

Table 11.2 presents the model of linear regression for the second measure of success in the first sample of BGs.

In case of the second measure of firms' success only one internationalization indicator (and the same as in the first measure of success) has shown weak but positive correlation with the BG's success (there was no significant difference between small- and medium-sized enterprises with respect to the favourability of the success evaluation in the dimension: "comparison to competitors").

Table 11.3 illustrates the linear regression model for the first measure of success in the second sample of Polish BGs.

In this case, as with the previous ones, only one internationalization measure has shown significant positive (but weak) correlation with the firms' success, e.g., the larger number of foreign target markets, the higher the success perception.

Table 11.4 shows the linear regression model for the second measure of success in the second sample of BGs.

In this model several internationalization indicators have shown significant correlations with the firms' success measured in relation to competitors (and small

Table 11.2 Model of linear regression for the relationship between internationalization measures and the second indicator of firm's success (first sample)

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.189[a]	0.036	0.032	0.881	2.103

Coefficients[a]

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.262	0.109		39.114	0.000
The management is experienced in running business in international markets [1]—The management has no experience in running business in international markets [5]	−0.182	0.060	−0.189	−3.017	0.003

[a]Dependent variable: considering the situation on the (domestic and foreign) markets, where our firm operates, it can be concluded that our company has been successful in comparison to its competitors [1:5]
Source own analyses, N = 256

Table 11.3 Model of linear regression showing relation between internationalization measures and the first indicator of success (second sample)

Model summary					
Model	R	R Square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.140[a]	0.020	0.015	0.876	2.061

Coefficients[a]

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	3.782	0.134		28.326	0.000
Number of export markets	0.093	0.043	0.140	2.137	0.034

[a]Dependent variable: considering the financial indices (e.g. profitability) for our firm, it can be concluded that our company has been successful [1:5]
Source own analyses, N = 233 (1 outlier removed)

enterprises evaluated their success lower than medium ones). Likewise, the first analysed sample, managerial staff competences to run business in foreign markets indicated positive correlation with BG's success. Exportation of goods through the domestic intermediaries has shown positive correlation with firms' success as well

Table 11.4 Model of linear regression for the relationship between the internationalization measures and the second indicator of firms' success (second sample)

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.335[a]	0.112	0.092	0.806	1.963

Coefficients[a]

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	3.517	0.252		13.935	0.000
The management is experienced in running business in international markets [1]—The management has no experience in running business in international markets [5]	−0.152	0.056	−0.175	−2.733	0.007
Exports through Polish intermediaries	0.278	0.133	0.135	2.098	0.037
Share of exports in total sales	0.008	0.003	0.235	3.360	0.001
In our company, we look for new market opportunities more often abroad rather than domestically [1]—(…) more often domestically rather than abroad [5]	0.162	0.053	0.211	3.048	0.003
Small enterprises	−0.274	0.110	−0.161	−2.492	0.013

[a]Dependent variable: considering the situation on the (domestic and foreign) markets, where our firm operates, it can be concluded that our company has been successful in comparison to its competitors [1:5]
Source own analyses, N = 233 (2 outliers removed)

as the share of revenues from exports in total income. However, in the case of second attitudinal measure of internationalization, i.e., international vs. domestic orientation, the correlation was negative, i.e., in the opposite direction than managerial competences. Thus, the relationship of attitudinal indices of internationalization with the success is not coherent.

Table 11.5 presents the linear regression model for the first measure of success in the third sample of BGs.

Two attitudinal internationalization measures are significantly (but incoherently) correlated with the evaluation of profits by managers (the first one comes from the "International vision" subscale of Weerawardena et al. 2015). The strength of the "far reaching vision" is positively correlated with profits, but the experience of management is correlated negatively. Other attitudinal indicators show no significant correlations with the success. Direct exports strategy was also positively, albeit weakly correlated with success judged in the financial terms.

Table 11.5 Model of linear regression for the relationship between internationalization measures and the first indicator of firm's success (third sample)

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.241[a]	0.058	0.048	0.464	2.192

Coefficients[a]					
Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	3.048	0.251		12.147	0.000
Far-reaching vision and drive of top managers were important in our decision to enter foreign markets [1:5]	0.090	0.036	0.155	2.536	0.012
The management is experienced in running business in international markets [1]—The management has no experience in running business in international markets [5]	0.083	0.044	0.115	1.870	0.063
Direct exports	0.280	0.163	0.101	1.715	0.088

[a]Dependent variable: loss/profit in 2017 compared to 2016 [1:5]
Source own analyses, N = 297 (2 outliers removed)

Table 11.6 shows the linear regression model for the second measure of success in the third sample of Polish BGs.

Internationalization measures showing significant and positive correlation with the success evaluated in comparison to competitors are both from Weerawardena et al. (2015) subscale.

Analysing non-linear (quadratic) relationships between measures of success and non-attitudinal measures of internationalization (share of exports in total sales, number of different forms of operations abroad, number of exports markets), the following relationships have been found:

- no significant relationships in the first sample,
- inverted U-shaped relationship between the success in financial terms and the number of export markets (from 1 to 6) in the second sample (the lowest level of success was declared by managers in the firms exporting to a single country and the highest—to 4 countries, followed by exporters to 5 countries),
- inverted U-shaped relationship between the success compared to competitors and the number of export markets (from 1 to 6) in the third sample (similarly, the lowest level of success was declared by managers from firms exporting to 1

Table 11.6 Model of linear regression showing relation between internationalization measures and the second indicator of success (third sample)

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
	0.223[a]	0.050	0.043	0.754	1.992

Coefficients[a]					
Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	2.676	0.256		10.446	0.000
The top managers were willing to go to great lengths to make our products or services succeed in foreign markets [1:5]	0.141	0.049	0.166	2.857	0.005
Far-reaching vision and drive of top managers were important in our decision to enter foreign markets [1:5]	0.115	0.055	0.122	2.105	0.036

[a]Dependent variable: considering the situation on the (domestic and foreign) markets, where our firm operates, it can be concluded that our company has been successful in comparison to its competitors [1:5]
Source own analyses, N = 297 (1 outlier removed)

country only followed by exporters to 6 countries, while the highest one was reported by exporters to 2 and 5 countries.

In the second and third sample, the managers in the firms exporting exclusively to one country, consistently evaluated the success at the lowest levels also for the other two measures of success. To be dependent on a single export market appears as the least favourable solution.

11.5 Summary and Conclusion

The analysis of relationship between the degree of internationalization (measured by simple indicators) and perceived firms' success leads to the conclusion that in the case of Polish BGs, the key success factors are: high competence of managerial staff in doing business in foreign markets and export management strategies (however, this relationship was not confirmed in the third sample).

Other measures of internationalization based on Likert-type scales produced mixed results. The far-reaching vision and the efforts to make products succeed in foreign markets were positively correlated with measures of success in the third sample. However, it was domestic and not foreign-markets orientation which was positively correlated with the success in the second sample.

The remaining simple measures of internationalization (number of different forms of activities on foreign markets, share of exports in total sales, number of export markets) didn't show consistent patterns of relationship with the firms' success. It has been observed that in the second sample, there were both linear and inverted U-shaped relationships between the number of export markets and measures of success. Therefore, given the number of internationalization measures, we may conclude that the first hypothesis has not been confirmed for the most of simple internationalization measures.

The second hypothesis, when different forms of exporting and other activities (e.g., having a representative abroad) were considered separately has not been confirmed in most of the cases. Only direct exports and exports through a domestic intermediary showed weak positive correlations with the measures of success.

The analysis of non-linear relationships revealed that the least favourable evaluations of success were in the case of firms depending on a single export market.

Summing up, it should be stressed that the results concerning Polish BGs didn't prove that simple internationalization measures were positively correlated with the success on foreign markets.

According to previous research on the sources of success of Polish BGs (e.g., Baranowska-Prokop and Sikora 2014), for all analysed firms, effective differentiation strategy (offering of unique products that have no close substitutes) and the supply of high quality goods as well as innovations (for the case of medium-sized firms, see e.g., Baranowska-Prokop and Sikora 2017) were more strongly and more consistently positively correlated with the firms' success.

Acknowledgements The research related to the third sample (2018) was supported by the National Science Centre, Poland; grant: "The entrepreneurial marketing concept and accelerated internationalization of new ventures. Antecedents, elements and outcomes", no. 2015/19/B/HS4/01728.

References

Baranowska-Prokop, E., & Sikora, T. (2014). Relationship between competitive strategies and the success perception of polish born globals. *International Journal of Management and Economics, 43,* 94–113.

Baranowska-Prokop, E., & Sikora, T. (2017). Innovativeness and success perception of Polish small- and medium-sized international new ventures. *Journal of International Studies, 10,* 134–146.

Cavusgil, T. S. (1980). The internationalization process of the firm. *European Research, 8,* 273–281.

Cieślik, J. (2010). Internacjonalizacja polskich przedsiębiorstw. Aktualne tendencje—Implikacje dla polityki gospodarczej. Warszawa: NPPG.

Danik, L., & Kowalik, I. (2015). Success factors and development barriers perceived by the polish born global companies. Empirical study results. *Journal of East European Management Studies, 20,* 360–390.

Doryń, W. (2011). *Wpływ internacjonalizacji na wyniki ekonomiczne polskich przedsiębiorstw przemysłowych*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.

Dörrenbächer, C. (2000). Measuring corporate internationalization. A review of measurement concepts and their use. *Intereconomics, 35,* 119–126.

Ebers, M. (1997). Explaining inter-organizational network formation. In M. Ebers (Ed.), *The formation of inter-organizational networks* (pp. 3–40). Oxford, England: Oxford University Press.

Glaum, M., & Oesterle, M. J. (2007). 40 years of research on internationalization and firm performance: More questions than answers? *Management International Review, 47,* 307–317.

Gorynia, M. (2007). *Strategie zagranicznej ekspansji przedsiębiorstw*. Warszawa: PWE.

Ietto-Gillies, G. (1998). Different conceptual frameworks for the assessment of the degree of internationalization: An empirical analysis of various indices for the top 100 transnational corporations. *Transnational Corporations, 7,* 17–39.

Johanson, J., & Vahlne, J.-E. (2009). The Uppsala internationalization process model revisited—From liability of foreignness to liability of "Outsidership". *Journal of International Business Studies, 40,* 1411–1431.

Karasiewicz, G. (2013). Marketingowe strategie internacjonalizacji polskich przedsiębiorstw. Podejście holistyczne. Warszawa: Oficyna Wolters Kluwer Business.

Kowalik, I., & Baranowska-Prokop, E. (2013). Determinanty powstawania i motywy ekspansji polskich przedsiębiorstw wcześnie umiędzynarodowionych. *Gospodarka Narodowa, 4,* 41–64.

Nowakowski, M. (1999). *Wprowadzenie do zarządzania międzynarodowego*. Warszawa: Difin.

Pera, B. (2017). Miary internacjonalizacji przedsiębiorstw—Przegląd wybranych koncepcji i badań. Studia Ekonomiczne. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, 19,* 184–197.

Ramaswamy, K., Kroeck, K. G., & Renforth, W. (1996). Measuring the degree of internationalization, a comment. *Journal of International Business Studies, 27,* 167–177.

Sleuwaegen, L., & Onkelinx, J. (2010). *Internationalization strategy and performance of small and medium size enterprises*. Working paper research (p. 197). National Bank of Belgium.

Sullivan, D. (1994). Measuring the degree of internationalization of a firm. *Journal of International Business Studies, 25,* 325–342.

Sullivan, D. (1996). Measuring the degree of internationalization, a Reply. *Journal of International Business Studies, 27,* 179–192.

Weerawardena, J., Mort, G. S., Salunke, S., Knight, G., & Liesch, P. W. (2015). The role of market sub-system and the socio-technical sub-system in innovation and firm performance: A dynamic capabilities approach. *Journal of the Academy of Marketing Science, 43,* 221–239.

Chapter 12
Inflation, Unemployment and the NAIRU in Poland

Pavlos Stamatiou and Chaido Dritsaki

Abstract The purpose of this paper is to investigate the relationship between inflation and unemployment rate, in the case of Poland over the period 1992–2017, within the Phillips curve context. Several econometric techniques are applied, including the bounds testing (ARDL) approach developed by Pesaran et al. (J Appl Econometrics 16(3):289–326, 2001) as well as Toda and Yamamoto (J Econometrics 66:225–250, 1995) modification of the Granger causality test (no-causality approach) in a two-variable vector autoregression (VAR) model. The results of the study confirm a long run relationship among the examined variables for the aforementioned period. Finally, the findings of Toda and Yamamoto (J Econometrics 66:225–250, 1995) analysis indicate a unidirectional causality between unemployment rate and inflation with direction from unemployment rate to inflation. Policy implications are then explored in the conclusions.

Keywords Inflation · Unemployment · NAIRU · Poland · Autoregressive distributed lag cointegration test · Toda-Yamamoto causality test

JEL Classification C22 · C32 · E31 · E50

12.1 Introduction

The observed inverse relationship between unemployment and inflation, first discovered by William Phillips (1958) on his article "*The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom,*

P. Stamatiou (✉) · C. Dritsaki
Department of Accounting and Finance, Western Macedonia
University of Applied Sciences, 50100 Kozani, Greece
e-mail: stamatiou@uom.edu.gr

C. Dritsaki
e-mail: dritsaki@teiwm.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_12

1861 to 1957", has come to be known as the Phillips curve. Since then, unemployment and inflation as economic concepts have been a central topic in macroeconomics. These two concepts are considered as key factors in the process of economic development of every country. All government programs are conducted focusing on policies that keep on stable price levels and low unemployment rates.

However, the failure to explain economic phenomena of the crisis of 1970s had created serious doubts about the validity of Phillips curve. The Phillips curve idea was openly criticized by the Monetarist school, among them Milton Friedman. Friedman (1968) argued that there is only short run trade-off between the inflation rate and the unemployment rate, but for the long run he introduced the concept of the NAIRU (Non-Accelerating Inflation Rate of Unemployment). NAIRU is defined as the rate of unemployment when the rate of inflation is stable. Therefore, the long run Phillips curve is vertical and there is no trade-off between unemployment and inflation (see Phelps 2006).

If the actual unemployment rate is below NAIRU for a few years, then the inflation rate tends to accelerate. On the other hand, if the actual unemployment rate exceeds NAIRU for a few years, then the inflation rate tends to fall (disinflation). In the case that the actual unemployment is equal to NAIRU, the inflation rate tends to be stationary (see also Zaman et al. 2011; Dritsaki and Dritsaki 2012) (Fig. 12.1).

In 2017, unemployment rate in Poland reached the lowest level in the country's post-communist history, as youth employment picks up. Even during the recent financial crisis of 2007–2008, increasing growth rates helped Polish economy to respond in the difficult conditions of the global economy. The purpose of this paper is to examine the existence of Phillips curve in Poland using annual time series data for the period 1992–2017.

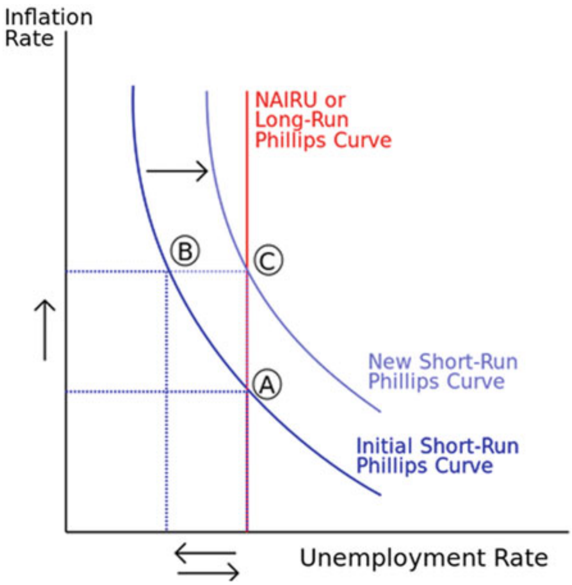


Fig. 12.1 Short run Phillips curve with long run Phillips curve (NAIRU)

Most of the previous relevant studies examine the trade-off relationship between inflation and unemployment rate on the developed countries. The focus on the developing countries, regarding the Phillips curve is relatively recent. The structure of the paper is as follows: Sect. 12.2 presents the literature. Section 12.3 analyzes the theoretical framework. Section 12.4 describes data and methodology. Empirical results are discussed in Sect. 12.5. Concluding remarks are given in the final section.

12.2 Literature Review

An extensive and expanding volume of both theoretical and empirical studies exists on the relationship between inflation and unemployment across developed and developing countries, over varying sample periods and different econometric approaches. However, the issue still remains controversial for the policy makers. The results seem to vary from country to country due to the different structure of their domestic economies and the continuous changes in economic conditions.

Changes in monetary conditions are often believed to have a significant impact on real economic variables, such as output and employment, through the classical Phillips curve relationship (Vermeulen 2017). Among prominent economists who support the existence of the Phillips curve are Samuelson and Solow (1960). Samuelson and Solow (1960) examined the relationship between the rate of inflation and unemployment rate for a twenty-five year period (1934–1958) for the case of the United States (US). The results of their study revealed an inverse relationship between inflation and unemployment. It is worth mentioning that these researchers were the first who championed the Phillips curve as a policy tool.

In addition, Solow (1970) and Gordon (1971) confirmed Phillips relation in the US using macroeconomic data for the pre-1970s and the post-1970s periods. The studies by Solow (1970) and Gordon (1971) have been known as the "Solow-Gordon affirmation" of the Phillips Curve.

The fact that there exists an inverse relationship between unemployment and inflation was criticized by Phelps (1967) and Friedman (1968). Phelps (1967) and Friedman (1968) supported that as the Phillips curve shifts over time, the equilibrium rate of unemployment is independent from the rate of inflation. Therefore there is only short run trade-off between inflation and unemployment rate. Later, other researchers argued against the Phillips hypothesis (Lucas 1976; Okun 1975).

Lucas (1976) argued that could be a trade-off relationship between unemployment and inflation under the condition that the workers do not expect the policy-makers to create an artificial situation of high inflation combined with low unemployment. In a different case, employees would predict high inflation and an increase in wages would be possible. In such a case, high unemployment and high inflation could coexist, which is known as “Lucas Critique” (see also Zaman et al. 2011; Dritsaki and Dritsaki 2012).

In 1975, Okun commented that “Phillips curve has become an unidentified flying object” (p. 353)”. However, in the 1990s, Phillips curve came to the front giving mixed results. Alogoskoufis and Smith (1991) supported empirically the “Lucas Critique”. On the other hand, Fisher and Seater (1993), King and Watson (1994) and Fair (2000) find a long run inflation unemployment trade-off.

Recent advances in data analysis methods allow a more in depth examination of the Phillips curve hypothesis. Schreiber and Wolters (2007) investigated the relationship between unemployment and inflation, using a vector autoregressive model (VAR) and a vector error correction model (VECM), for the case of Germany over the period 1977–2002. Their study revealed a negative relationship between unemployment and inflation, both in the short and in the long run, for the examined period.

Del Boca et al. (2008) examined the existence of Phillips curve in Italy using data covering the period 1978–2000. The results of the study showed that a trade-off relationship exists only during low inflation and stable aggregate supply. Del Boca et al. (2008) captured the effects of structural changes and asymmetries on the estimated parameters of alternative Phillips equations using the Kalman filter.

A similar study, conducted by Russell and Banerjee (2008), examined the Phillips curve hypothesis assuming non-stationarity in the series. They found that there is a positive relation between inflation and unemployment rate in the short run for the case of US during the period 1952–2004.

Islam et al. (2011) used the ARDL bound approach to examine the existence and stability of Phillips curve for North Cyprus using data covering the period 1978–2007. The results of their analysis showed the existence of Phillips curve both in the short and in the long run. In addition, stable relation is confirmed.

Karahan et al. (2012) investigated the relationship between unemployment and inflation for Turkey over the period 2006–2011. The ARDL bounds tests indicated that, in the short run, unemployment has a negative impact on inflation. However, the results did not reveal any causal relation between the two variables in the long run supporting the views of Friedman (1968) and Phelps (1967), not advocating the “hysteresis effect”.

Dritsaki and Dritsaki (2012) investigated the Phillips curve hypothesis in Greece using data for the period 1980–2010. Their results revealed a long run relationship and a causal relationship between unemployment and inflation. In addition, their results showed that shocks in inflation cause a reduction on unemployment for the first years, following by a slight rise for the remaining years.

12.3 Theoretical Framework

The mainstream literature supports that there is a short run relation between the inflation and unemployment rate, usually described through the Phillips curve. However, in the long run the equilibrium rate of unemployment seems to be independent from the rate of inflation.

Nobelists Phelps (1967) and Friedman (1968) accepted that the short run Phillips curve existed, but for the long run they introduced the concept of NAIRU (Non-Accelerating Inflation Rate of Unemployment). NAIRU refers to a level of unemployment, below which inflation rises. The stability of original Phillips curve was disputed in the early 1970s, where the US economy faced high inflation and unemployment rate simultaneously (stagflation).

According to Freidman's (1968) theory, the inflation rate depends on the expected inflation rate and the deviation of unemployment from its natural rate:

$$P_t = P_t^* + a(U_t - U_t^*) + e_t \tag{12.3.1}$$

where P_t is inflation, P_t^* is the expected inflation, U_t is unemployment rate, U_t^* is natural rate of unemployment, e_t is the error term and $\alpha < 0$.

Friedman (1968) argued that past inflation is well-proxied for expected inflation, so that the change in inflation is determined by the gap variable. With this assumption, Eq. (12.3.1) can be written as follows:

$$P_t = P_{t-1} + a(U_t - U_t^*) + e_t \tag{12.3.2}$$

where P_{t-1} is the past inflation.

Equation (12.3.2) is often called as the accelerationist Phillips curve. Over the past decades many economists based their research on the accelerationist Phillips curve, including Gordon (1982, 1990, 2013), Stock and Watson (1999, 2009), Ball and Mazumder (2011), Fuhrer (1995), Murphy (1999, 2000) and Staiger et al. (1997).

Using the natural rate of unemployment, Eq. (12.3.2) can be expressed as follows:

$$P_t = c(L)P_{t-1} + a(L)(U_t - NAIRU_t) + e_t \tag{12.3.3}$$

where $c(L)$ and $a(L)$ are polynomials in the lag operation, U_t is the actual unemployment rate, $NAIRU_t$ is natural rate of unemployment in the year t.

Equation (12.3.3) can be modified as:

$$P_t = c(L)P_{t-1} + a(L)(UNGAP_t) + e_t \tag{12.3.4}$$

where $UNGAP_t$ is the unemployment gap (the actual unemployment rate minus natural rate of unemployment rate). To support the Phillips curve, we would require negative and significant coefficients for the unemployment gap.

12.4 Data and Methodology

12.4.1 Data

The variables that are used in this study are inflation (INF) expressed as percentage change of average consumer prices, and unemployment (UN) expressed as a percentage of civilian labor force. The sample data of this study is from 1992 to 2017. Data are gathered from economic databases International Monetary Fund (IMF) and Annual Macro-Economic Database (AMECO). Figure 12.2 plots the actual and forecast values of inflation and unemployment rates.

The descriptive statistics for all variables are shown in Table 12.1.

12.4.2 Unit Root Tests

We begin our analysis by checking the stationary properties of the variables included in the study. The econometric literature proposes several methods for

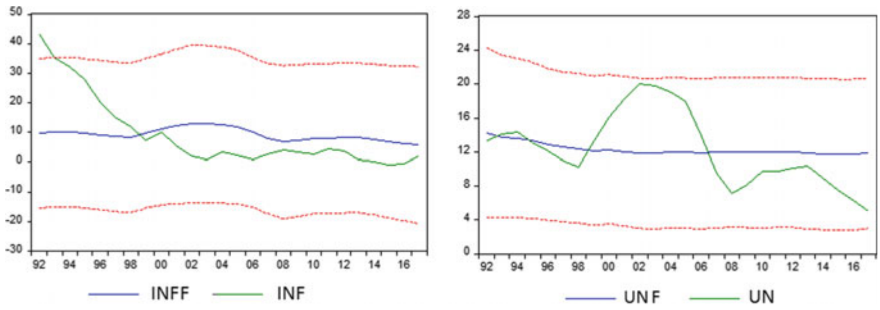


Fig. 12.2 Actual and forecast values of the inflation and unemployment (INFF and UNFF denotes forecast values of inflation and unemployment rate respectively)

Table 12.1 Descriptive statistics

	INF	UN
Mean	9.201962	12.27308
Median	3.596000	11.50000
Maximum	43.00000	20.00000
Minimum	−0.933000	5.000000
Std. Dev.	12.25142	4.299633
Skewness	1.540673	0.326658
Kurtosis	4.139750	2.134451
Jarque-Bera	11.69320	1.273996
Observations	26	26

testing unit root. Considering that these methods may give different results, we apply the tests suggested by Dickey-Fuller (ADF) (1979), Phillips-Perron (PP) (1988) and Kwiatkowski et al. (KPSS) (1992).

12.4.3 Autoregressive Distributed Lag (ARDL) Cointegration Analysis

The purpose of this paper is to investigate the relationship between unemployment and inflation in the case of Poland, within the Phillips Curve context. For this reason, this study employs the Auto-Regressive Distributed Lag (ARDL) analysis of cointegration, developed by Pesaran and Shin (1999) and extended by Pesaran et al. (2001).

The ARDL approach has a number of advantages over traditional cointegration methods, such as Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990), as noted below: (i) it provides consistent estimates regardless of whether the variables are integrated $I(0)$ or $I(1)$, (ii) all variables of the models assumed to be endogenous, (iii) it is more efficient for small sample data, (iv) it allows that the variables may have different lag lengths, (v) in addition, the bounds of ARDL approach can distinguish and eliminate autocorrelation and endogeneity problems between dependents and independents variables, (vi) finally, a dynamic error correction model can be derived from the ARDL method through a simple linear transformation (Harris and Sollis 2005; Jalil and Ma 2008).

The autoregressive distributed lag (ARDL) cointegration technique as a general vector autoregressive (VAR) model of order p is shown below:

$$L_t = (INF_t, UNGAP_t) \tag{12.4.1}$$

where L_t is a column vector composed of the three variables.

The ARDL models that are used in this study are the following:

$$\begin{aligned}\Delta UNGAP_t = \beta_{01} + \delta_{11} UNGAP_{t-1} + \delta_{21} INF_{t-1} \\ + \sum_{i=1}^{p} \alpha_{1i} \Delta UNGAP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta INF_{t-i} + \varepsilon_{1t}\end{aligned} \tag{12.4.2}$$

$$\begin{aligned}\Delta INF_t = \beta_{02} + \delta_{12} INF_{t-1} + \delta_{22} UNGAP_{t-1} \\ + \sum_{i=1}^{p} \alpha_{1i} \Delta INF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta LUNGAP_{t-i} + \varepsilon_{2t}\end{aligned} \tag{12.4.3}$$

where Δ denotes the first difference operator, β is constant and ε_{1t}, ε_{2t} are the "well behaved" random disturbance terms. The error terms assumed to be independently and identically distributed.

The optimal values for the maximum lags, p and q will be determined by the minimum values of criteria Akaike (AIC), Schwarz (SIC) and Hannan-Quinn (HQC) in accordance with the following models:

$$\Delta UNGAP_t = \beta_{01} + \sum_{i=1}^{p} \alpha_{1i} UNGAP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} INF_{t-i} + \mu_{1t} \tag{12.4.4}$$

$$\Delta INF_t = \beta_{02} + \sum_{i=1}^{p} \alpha_{1i} INF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} UNGAP_{t-i} + \mu_{2t} \tag{12.4.5}$$

where $\Delta UNGAP_t$ and ΔINF_t are the dependent variables, β is constant, α_{1i} and α_{2i} are the long terms and (p, q) are the optimal lag lengths of the ARDL model. Under the Eqs. (12.4.2) and (12.4.3), the null and alternative hypotheses are as follow:

$$H_0 : \delta_{11} = \delta_{21} = 0$$

i.e., there is no cointegration among the variables

$$H_1 : \delta_{11} \neq \delta_{21} \neq 0$$

i.e., there is cointegration among the variables
and

$$H_0 : \delta_{12} = \delta_{22} = 0$$

i.e., there is no cointegration among the variables

$$H_1 : \delta_{12} \neq \delta_{22} \neq 0$$

i.e., there is cointegration among the variables.

According to Pesaran et al. (2001) the null hypothesis is tested by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables.

Two sets of critical values, for a given level significance, have been calculated by Narayan (2005). Narayan (2005) critical bounds are more appropriate for small samples. The lower bound is based on the assumption that all variables including in the model are $I(0)$, and the upper bound is based on the assumption that all of the variables are $I(1)$.

The null hypothesis of no cointegration is rejected when the F-statistic exceeds the upper critical bound value. If the calculated F-statistic is lower than the critical value of lower limit, we accept the null hypothesis. The cointegration test is inconclusive when the F-value is between the lower and the upper limit of critical bounds (Pesaran et al. 2001).

Once cointegration is confirmed, the next step is to proceed with the estimation of the long run coefficient of the ARDL model using Eqs. (12.4.6) and (12.4.7):

$$UNGAP_t = \beta_{01} + \sum_{i=1}^{p} \delta_{11} UNGAP_{t-i} + \sum_{i=0}^{q} \delta_{21} INF_{t-i} + e_{1t} \tag{12.4.6}$$

$$INF_t = \beta_{02} + \sum_{i=1}^{p} \delta_{12} INF_{t-i} + \sum_{i=0}^{q} \delta_{22} UNGAP_{t-i} + e_{2t} \tag{12.4.7}$$

This study also estimates a dynamic error correction model (ECM) to investigate the short run dynamics of the respective variables towards the long run equilibrium. The ECM integrates the short run coefficient with the long run coefficient without losing long run information

The dynamic unrestricted ECM is depicted in Eqs. (12.4.8) and (12.4.9), as shown below:

$$\begin{aligned} \Delta UNGAP_t = \beta_{01} &+ \sum_{i=1}^{p} \alpha_{1i} \Delta UNGAP_{t-i} \\ &+ \sum_{i=0}^{q} \alpha_{2i} \Delta INF_{t-i} + \lambda_1 ECM_{t-1} + \varepsilon_t \end{aligned} \tag{12.4.8}$$

$$\begin{aligned} \Delta INF_t = \beta_{02} &+ \sum_{i=1}^{p} \alpha_{1i} \Delta INF_{t-i} \\ &+ \sum_{i=0}^{q} \alpha_{2i} \Delta UNGAP_{t-i} + \lambda_2 ECM_{t-1} + \varepsilon_t \end{aligned} \tag{12.4.9}$$

where ECM_{t-1} is the error correction term.

The coefficient of ECM_{t-1} should be negative and statistically significant. This coefficient indicates the speed of adjustment to the long run equilibrium after a short run shocks.

12.4.4 Diagnostics Tests of the Model

One of the most important and crucial assumptions in the bounds testing (ARDL) approach is that the error terms of Eqs. (12.4.2) and (12.4.3) have to be serially independent and normally distributed. So, in order to check the validity and reliability of the estimation results, several diagnostics are performed. The diagnostic tests include Jarque-Bera normality test, ARCH test for heteroscedasticity, Breusch-Godfrey Serial Correlation (LM) test and Ramsey RESET specification test.

12.4.5 Stability Tests of the Model

According to Bahmani-Oskooee and Bohl (2000), the existence of cointegration does not necessarily imply that the estimated coefficients of the model are stable. Therefore, in order to check that all parameters used in each of the models are sufficiently stable, the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) are applied. These tests are also suggested by Pesaran et al. (2001) for measuring the parameter stability.

12.4.6 Toda-Yamamoto Causality Analysis

The objective of our study is to identify the causality relations between inflation and unemployment rates for the case of Poland, using data covering the period 1992–2017. In this paper, we employ the Toda and Yamamoto (1995) and the Modified Wald (MWALD) causality techniques in order to find out the direction of causality between the two variables. Toda and Yamamoto (1995) test ignores the condition of stationary or cointegration of the series to test the causality.

Toda and Yamamoto (1995) develop a different approach based on a level VAR model. Two steps are involved with implementing this approach. The first step is to define the optimal time length of the initial VAR model. Afterwards, the next step is the selection of the maximum integration order on variables system. We define the appropriate lag order of the VAR model using the Likehood Ratio (LR), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE) and Hannan-Quinn (HQ) Information Criterion.

The equations that are used to test Granger causality can be described as follows:

$$\begin{aligned} INF_t = \mu_0 + \sum_{i=1}^{k} a_{1i} INF_{t-i} + \sum_{j=k+1}^{d\max} a_{2j} INF_{t-j} \\ + \sum_{i=1}^{k} \beta_{1i} UNGAP_{t-i} + \sum_{j=k+1}^{d\max} \beta_{2j} UNGAP_{t-j} + \varepsilon_{1t} \end{aligned} \tag{12.4.10}$$

$$\begin{aligned} UNGAP_t = \varphi_0 + \sum_{i=1}^{k} \gamma_{1i} UNGAP_{t-i} + \sum_{j=k+1}^{d\max} \gamma_{2j} UNGAP_{t-j} \\ + \sum_{i=1}^{k} \delta_{1i} INF_{t-i} + \sum_{j=k+1}^{d\max} \delta_{2j} INF_{t-j} + \varepsilon_{2t} \end{aligned} \tag{12.4.11}$$

where k is the optimal lag length on the initial VAR model and dmax is the maximum integration order in VAR model.

In Eq. (12.4.10), $UNGAP_t$ causes INF_t if $\beta_{1i} \neq 0$, for all i. Similarly, in Eq. (12.4.11), INF_t causes $UNGAP_t$ if $\delta_{1i} \neq 0$ for all i.

12.5 Empirical Results

12.5.1 Unit Roots Tests

The preliminary stage of the study is to define the integration order for each time series. To improve the robustness of the selected variables (inflation rate, unemployment gap), we apply ADF by Dickey and Fuller (1979), PP by Philips and Perron (1988) as well as KPSS by Kwiatkowski et al. (1992) test. The results of these tests are presented in Table 12.2.

The results revealed that INF is stationary in levels in all the test that were applied which means that INF is integrated $I(0)$, while UNGAP is stationary in first differences which means that UNGAP is integrated $I(1)$. So, we examine the long run relationship of the variables using the ARDL bounds test.

12.5.2 ARDL Cointegration Analysis

In order to estimtate the parameters of Eqs. (12.4.2) and (12.4.3), we select the optimal values of p and q lags by the minimum value of Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQC), and Likelihood Ratio (LR). The results of these criteria are presented in Table 12.3.

The ARDL bound test is sensitive to lag length, so we use the Akaike Information Criterion to determine the optimal lag length in Eqs. (12.4.4) and (12.4.5). AIC showed that optimal lag length in these equations [Eqs. (12.4.4) and

Table 12.2 Univariate unit root tests

Variable	ADF		PP		KPSS	
	C	C,T	C	C,T	C	C,T
INF	−5.49(0) ***	−2.76(0)	−8.38[9] ***	−4.71[10] ***	0.57[3] ***	0.18[3] ***
UNGAP	−3.23(1) **	−3.15(1)	−2.06[2]	−2.03[2]	0.75[3]	0.81[3]
ΔINF	−3.38(0) **	−4.55(0) ***	−3.33[2] **	−4.54[2] ***	0.69[2] ***	0.15[1] ***
ΔUNGAP	−4.29(1) **	−4.18(1) **	−3.15[3] **	−3.27[3] **	0.06[2] ***	0.05[2] ***

Notes ***, ** show significant at 1 and 5% levels respectively, the numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals, the lag lengths for ADF equation were selected using Schwarz Information Criterion (SIC), Mackinnon (1996) critical value for rejection of hypothesis of unit root applied, the numbers within brackets followed by PP and KPSS statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel, *C* constant, *T* trend, Δ first differences

Table 12.3 Var lag order selection criteria (max = 4)

Lag	LogL	LR	FPE	AIC	SIC	HQC
0	−120.994	NA	246.091	11.181	11.280	11.204
1	−84.501	63.034	12.871	8.227	8.524	8.297
2	−70.298	21.948*	5.156	7.299	7.795*	7.416
3	−67.024	4.465	5.673	7.365	8.060	7.529
4	−60.019	8.279	4.565*	7.092*	7.985	7.302*

Notes * indicates lag order selected by the criterion

(12.4.5)] is (2, 4) and (1, 0) respectively. Table 12.4 shows the cointegration results using ARDL bounds test (Fig. 12.3).

The results of Table 12.4 indicate that, in Eq. (12.4.3), the calculated F statistic (15.41) exceeds the upper bound critical value (5.58) at 1% level of significance.

Table 12.4 The results of ARDL cointegration test

Bounds testing to cointegration			Diagnostic tests			
Estimated models	Optimal lag	F-stat.	X^2_{NOR}	X^2_{ARCH}	X^2_{RESET}	X^2_{SERIAL}
F_{UNGAP}(UNGAP/INF)	(2, 4)	2.93	0.41	1.16[1]	10.3[1]	0.33[2]
F_{INF}(INF/UNGAP)	(1, 0)	15.41 ***	1.20	0.02[1]	4.57[2]	2.77[2]
Significant level			Lower bounds		Upper bounds	
			$I(0)$		$I(1)$	
10%			3.02		3.51	
5%			3.62		4.16	
2.5%			4.18		4.79	
1%			4.94		5.58	

Notes The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. Critical values are collected from Narayan (2005). *** show significant at 1% level

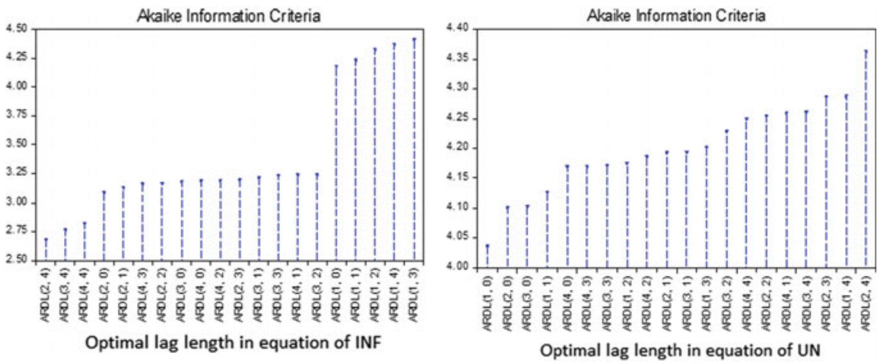


Fig. 12.3 Optimal lag length in Eqs. (12.4.4) and (12.4.5) respectively

Findings confirm that there is a long run relationship between inflation rate and unemployment in Poland.

Within the cointegration test results, a number of standard diagnostic tests were applied in order to check the robustness of the model. The ARDL model fulfills the assumptions of normality, autoregressive conditional heteroskedasticity (ARCH), functional forms and serial correlation.

12.5.3 Long Run and Short Run Estimates

Table 12.5 presents the results of long and short run relationship between the variables in our model.

From the above table we see that, in the long run equation of INF, a decrease 1% of unemployment will cause an increase 0.30% of inflation. The ECM_{t-1} is negative and statistically significant which implies a long run relationship between the examined variables. This means that in the short term the deviations from the long run equilibrium are adjusted by 86% every year.

The DW statistic is 2.04 which confirms that the model is not spurious. The R squared is 0.96 implying that 96% variations in the dependent variable are explained by the model and the rest by the error term. In addition, the computed F-statistic (296.3) clearly rejects the null hypothesis that the regressors have zero coefficients.

Table 12.5 Long run and short run results

Variables	Coefficient	T-statistic
Long run analysis		
Dependent variable = INF_t		
Constant	0.13	0.25
INF_{t-1}	0.81	23.76***
$UNGAP_t$	−0.30	−1.78*
R^2	0.96	
F-Statistic	296.3***	
D-W	2.04	
Short run analysis		
Dependent variable = ΔINF_t		
Constant	−0.01	−0.03
ΔINF_{t-1}	0.92	4,18***
$\Delta UNGAP_t$	−0.49	−2.02*
ECM_{t-1}	−0.86	−3.57***
R^2	0.59	
F-Statistic	6.45***	
D-W	1.86	

Notes ***, * show significant at 1 and 10% levels respectively. Δ denotes the first difference operator

12.5.4 Diagnostics Tests

As illustrated in the tables below, the model passes the tests regarding normality (Jarque-Bera), serial correlation (LM) heteroscedasticity (ARCH) and specification (Ramsey RESET). The results of all the diagnostics tests for the long run and short run equations are displayed in Tables 12.6 and 12.7 respectively.

The diagnostics tests further strengthen and confirm the reliability and validity of our estimation results.

12.5.5 Instability Tests

It is obligatory to ensure the dynamic stability of any model having autoregressive structure. A graphical representation of CUSUM and CUSUMSQ statistics is provided in Fig. 12.4. If the plots of the CUSUM lie inside the critical bounds at 5% level of significance it would signify the parameter constancy and the model stability.

Table 12.6 Diagnostics tests (long run)

Diagnostics tests	X^2 Normal	X^2 Serial	X^2 ARCH	X^2 Reset
	1.19	3.08 [2]	0.00 [1]	3.86 [2]

Notes Numbers in brackets are lags for ARCH and Serial tests and fitted terms for Reset test

Table 12.7 Diagnostics tests (short run)

Diagnostics tests	X^2 Normal	X^2 Serial	X^2 ARCH	X^2 Reset
	1.45	3.24 [2]	0.03 [1]	0.08 [1]

Notes Numbers in brackets are lags for ARCH and Serial tests and fitted terms for Reset test

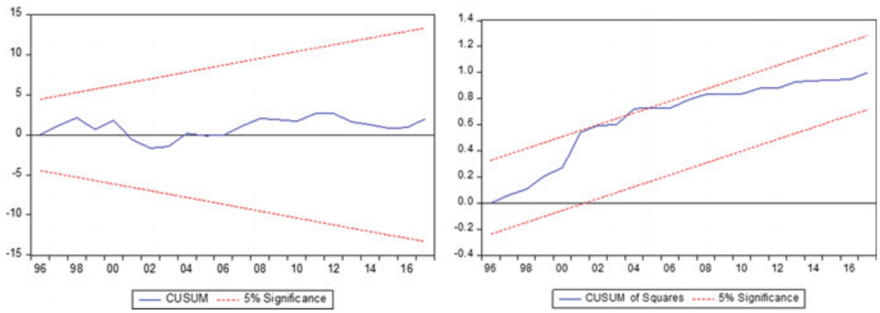


Fig. 12.4 Plots of CUSUM and CUSUMSQ

Table 12.8 Results of Toda and Yamamoto causality test

Dependent variables	MWALD test		Causality inference
	INF_t	$UNGAP_t$	
INF_t		8.63* (0.07)	$UNGAP_t \rightarrow INF_t$
$UNGAP_t$	2.44 (0.65)		

Notes * denotes statistical significant at 10% level, numbers in parenthesis are *p*-values, → denotes a uni-directional causality

Both plots indicate that almost none of the straight lines are crossed by CUSUM and CUSUMSQ (the plot of CUSUM has hovered around the zero line, the plot of CUSUMSQ slightly crossed the upper bound for the tow data of 2004). According to the test results for the given regression, we conclude that that all the coefficients are stable over the sample period.

12.5.6 Toda-Yamamoto Causality Test

The objective of our study aims to identify the causal relationships between unemployment rate and inflation. Table 12.8 presents the results on Toda and Yamamoto (1995) causality testing according to Eqs. (12.4.10) and (12.4.11). In Table 12.2 the ADF, PP and KPSS unit root tests confirm that the maximum integration order (dmax) for the selected variables is 1. In addition, Table 12.3 suggests that the optimal lag length (k) is 4.

As reported in Table 12.8, the results provide evidence of a unidirectional causal relationship between inflation (INF) and unemployment rate (UNGAP) at 10% level of significance, with direction from unemployment rate to inflation. The knowledge about the direction of causality will help policy makers to trace out policies for sustainable economic growth in Poland.

12.6 Conclusions

This study represents an attempt to investigate the hypothesis referred by Phillips curve in the case of Poland, using data covering the period 1992–2017. In 2017 unemployment rate in Poland hit a 25 year low, as youth employment picks up. The labor market of the country remains resilient in relation to the impact of the global financial crisis of 2007–2008. It is important to be mentioned that low unemployment rates are due to the intense business activity of international companies (such as “Gillette International”, “Dell Computers”, “Fujitsu” “Procter & Gamble” etc.) through the investment incentives provided by the Polish Government [Special Economic Zones (SEZs)].

On the other hand, low unemployment rates can have important implications for monetary policy (Altig et al. 1997). Although the numbers may be impressive, behind them is the labor supply which is under pressure from immigration, the low workforce participation rate and government policies such as raising the retirement age. Poland's central bank estimates that the unemployment rate is already lower that the rate which puts upward pressure on wages.

The results of this paper, based on the bounds testing for cointegration, confirm that the inflation-unemployment hypothesis exists in Poland. More specifically, the long run estimates show that a decrease 1% of unemployment will cause an increase 0.30% of inflation. In addition, the causality results based on Toda-Yammamoto analysis (1995) reveal that there is a unidirectional causality relationship between unemployment rate and inflation, with direction from unemployment rate to inflation.

The finding, that a stable Phillips curve exists for Poland, opens opportunities for the central bank to adopt monetary policies that would keep inflation and unemployment at political and social acceptable rates. Policy makers could make use of this paper for their future policy-making decisions which would stabilize the price level by controlling inflation and at the same time, living within an unemployment rate consistent with inflation (Islam et al. 2011).

References

Alogoskoufis, G., & Smith, R. (1991). The Phillips curve: The persistence of inflation and the Lucas critique: Evidence from exchange-rate regime. *American Economic Review, 81,* 1254–1275.

Altig, D., Fitzgerald, T., & Rupert, P. (1997). *Okun's law revisited: Should we worry about low unemployment?* Economic Commentary-Federal Reserved Bank of Cleveland, May.

Annual Macroeconomic Database (AMECO). http://ec.europa.eu/economy_finance (Accessed 4 May 2018).

Bahmani-Oskooee, M., & Bohl, M. T. (2000). German monetary unification and the stability of the German M3 money demand function. *Economics Letters, 66*(2), 203–208.

Ball, L., & Mazumder, S. (2011). Inflation dynamics and the great recession. *Brookings Papers on Economic Activity*, 337–405.

Del Boca, A., Fratianni, M., Spinelli, F., & Trecroci, C. (2008). *The Phillips curve and the Italian Lira 1861–1998*. University of Brescia Department of Economics Working Paper.

Dickey, D. A., & Fuller, W. A. (1979). Distributions of the estimators for autoregressive time series with a unit root. *Journal of American Statistical Association, 74,* 427–431.

Dritsaki, C., & Dritsaki, M. (2012). Inflation, unemployment and the NAIRU in Greece. *Procedia Economics and Finance, 1,* 118–127.

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 55,* 251–276.

Fair, R. C. (2000). Testing the NAIRU model for the United States. *The Review of Economics and Statistics, 82*(1), 64–71.

Fisher, M. E., & Seater, J. J. (1993). Long run neutrality and supeneutrality in an ARIMA framework. *The American Economic Review, 83,* 402–415.

Friedman, M. (1968). The role of monetary policy. *American Economic Review, 58,* 1–17.

Fuhrer, J. (1995). The Phillips curve is alive and well. *New England Economic Review*, 41–56 (March/April).

Gordon, R. J. (1971). Price in 1970: The horizontal Phillips curve. *Brookings Papers on Economic Activities, 3,* 449–458.

Gordon, R. (1982). Inflation, flexible exchange rates and the natural rate of unemployment. In M. Baily (Ed.), *Workers, jobs and inflation* (pp. 89–158). The Brookings Institution.

Gordon, R. (1990). U.S. inflation, labor's share, and the natural rate of Unemployment. In H. Koenig (Ed.), *Economics of wage determination.* Berlin: Springer.

Gordon, R. (2013). The Phillips curve is alive and well: Inflation and the NAIRU during the slow recovery. *National Bureau of Economic Research*, 19390.

Harris, R., & Sollis, R. (2005). *Applied time series. Modeling and forecasting*. Chichester: Wiley (2003, reprinted 2005).

International Monetary Fund (IMF). http://www.imf.org/en/Data (Accessed 4 May 2018).

Islam, F., Shahbaz, M., & Shabbir, M. S. (2011). *Phillips curve in a small open economy: A time series exploration of North Cyprus*. Munich Personal RePec Archive 28397.

Jalil, A., & Ma, Y. (2008). Financial development and economic growth: Time series evidence from Pakistan and China. *Journal of Economic Cooperation, 29*(2), 29–68.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control, 12,* 231–254.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics, 52,* 169–210.

Karahan, O., Colak, O., & Bolukbaşı, O. F. (2012). Tradeoff between inflation and unemployment in Turkey. *The Empirical Economics Letters, 11*(9), 973–980.

King, R. G., & Watson, M. W. (1994). The post-war U.S. Phillips curve: A revisionist econometric history. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 41, pp. 157–219).

Kwiatkowski, D., Phillips, P., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics, 54,* 159–178.

Lucas, R. E. (1976). Econometric policy evaluation: A critique. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 1, pp. 19–46).

MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics, 11*(6), 601–618.

Murphy, R. (1999). Accounting for the recent decline in the NAIRU. *Business Economics*, 34.

Murphy, R. (2000). What's behind the decline in the NAIRU? In S. Hymans (Ed.), *The economic outlook*. University of Michigan.

Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics, 37*(17), 1979–1990.

Newey, W. K., & West, K. D. (1994). Automatic lag selection in covariance matrix estimation. *Review of Economic Studies, 61,* 631–653.

Okun, A. M. (1975). Inflation: Its mechanics and welfare costs. *Brookings Papers on Economic Activity, 2,* 351–390.

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed lag modeling approach to cointegration analysis. In S. E. Strom (Ed.). Cambridge: Cambridge University Press.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289–326.

Phelps, E. (1967). Phillips curve, expectation of inflation and optimal inflation over time. *Economica, 34,* 254–281.

Phelps, E. (2006). Analysis of intertemporal trade offs in macroeconomic policy. *The Royal Swedish Academy of Sciences*.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75,* 335–346.

Russell, B., & Banerjee, A. (2008). The long run Phillips curve and non-stationary of inflation. *Journal of Macroeconomics, 30,* 1792–1815.

Samuelson, P. A., & Solow, R. M. (1960). Analytical aspect of anti-inflation policy. *American Economic Review, 50*(2), 177–194.

Schreiber, S., & Wolters, J. (2007). The long run Phillips curve revisited: Is the NAIRU framework data-consistent? *Journal of Macroeconomics, 29*(2), 355–367.

Solow, R. M. (1970). Discussion of RJ Gordon's recent acceleration of inflation and its lessons for the future. *Brookings Papers on Economic Activities, 1,* 42–46.

Staiger, D., Stock, J., & Watson, M. (1997). How precise are estimates of the natural rate of unemployment? In *Reducing inflation: Motivation and strategy* (pp. 195–246). National Bureau of Economic Research.

Stock, J., & Watson, M. (1999). Forecasting inflation. *Journal of Monetary Economics, 44,* 293–335.

Stock, J., & Watson, M. (2009). Phillips curve inflation forecasts. In J. Fuhrer, Y. Kodrzycki, J. Little, & G. Olivei (Eds.), *Understanding inflation and the implications for monetary policy* (pp. 99–202). Cambridge: MIT Press.

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector auto regressions with possibly integrated processes. *Journal of Econometrics, 66,* 225–250.

Vermeulen, J. C. (2017) Inflation and unemployment in South Africa: Is the Phillips curve still dead? *Southern African Business Review*, *21*.

Zaman, K., Khan, M. M., Ahmad, M., & Ikram, W. (2011). Inflation, unemployment and the NAIRU in Pakistan 1975–2009. *International Journal of Economics and Finance, 3*(1).

Chapter 13
On Some Characteristics of Liquidity Proxy Time Series. Evidence from the Polish Stock Market

Joanna Olbrys and Michal Mursztyn

Abstract The aim of this paper is to investigate major statistical properties of selected liquidity proxy time series based on high frequency (intraday) and low frequency (daily) data from the Warsaw Stock Exchange (WSE). We analyse daily time series of six liquidity estimates for the group of eighty-six WSE-traded companies, in the period from January 2005 to December 2016. These liquidity measures are: (1) percentage relative spread, (2) percentage realized spread, (3) percentage price impact, (4) percentage order ratio, (5) the modified daily turnover, and (6) the modified version of daily Amihud measure. We test distributional properties, linear and non-linear dependences, as well as stationarity of the analysed daily time series. Assessing statistical properties of time series of liquidity proxies is crucial for further research on econometric modelling of commonality in liquidity on the WSE.

Keywords Stock market · Liquidity measure · Time series · Intraday data
Daily data

13.1 Introduction

The role of liquidity in empirical finance and the microstructure of markets has grown over the last years and has influenced conclusions regarding asset pricing, corporate finance, and market efficiency. Among others, Lesmond (2005) emphasizes that liquidity, by its very nature, is difficult to define and even more difficult to estimate.

J. Olbrys (✉) · M. Mursztyn
Bialystok University of Technology, Wiejska 45A, 15-351 Bialystok, Poland
e-mail: j.olbrys@pb.edu.pl

M. Mursztyn
e-mail: m.mursztyn@student.pb.edu.pl

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_13

Measuring liquidity/illiquidity on the WSE is an important subject. For example, Nowak and Olbryś (2016) document cross-time and cross-security patterns in non-trading among the WSE-listed stocks. The empirical results reveal that a large number of companies exhibit the phenomenon of substantial non-trading, which means a lack of transactions over a particular period when the WSE is open for trading.

The goal of this paper is to investigate major statistical properties of time series of selected liquidity proxies based on intraday and daily data from the Warsaw Stock Exchange (WSE). We analyse 516 daily series of six liquidity estimates for eighty-six WSE-traded companies in the period from January 2005 to December 2016. These liquidity measures are: (1) percentage relative spread, (2) percentage realized spread, (3) percentage price impact, (4) percentage order ratio, (5) the modified daily turnover, and (6) the modified version of daily Amihud (2002) illiquidity measure. We assess distributional properties, linear and non-linear dependences, as well as stationarity of the analysed daily time series.

Four liquidity proxies (i.e. percentage relative spread, percentage realized spread, percentage price impact, and percentage order ratio) are approximated using high frequency intraday data rounded to the nearest second. The WSE raw data set does not contain any information about a trade direction, thus the Lee and Ready (1991) algorithm for classifying the initiator of a trade is employed to distinguish between so-called buyer- and seller-initiated trades. This information is essential for calculating the following liquidity proxies: percentage realized spread, percentage price impact, and percentage order ratio (Olbryś and Mursztyn 2017). Furthermore, we analyse statistical properties of time series of two liquidity measures which are approximated from low frequency (daily) data. These measures are: the modified daily turnover and the modified version of daily Amihud (2002) measure. It is important to note that assessing statistical properties of liquidity proxy time series is essential for further investigation concerning commonality in liquidity on the WSE, e.g. Chordia et al. (2000), Kamara et al. (2008), Karolyi et al. (2012) and Foran et al. (2015).

To the best of the authors' knowledge, the empirical results on the WSE presented here are novel and have not been reported in the literature thus far.

The remainder of the study is organized as follows. Section 13.2 describes the methodological background concerning the measurement of liquidity using high frequency (intraday) data. Section 13.3 presents selected liquidity proxies based on low frequency (daily) data. Section 13.4 discusses the empirical results for the WSE. The last section summarizes the main findings with the conclusion.

Nomenclature	
WSE	Warsaw Stock Exchange
LR	The Lee and Ready (1991) trade side classification algorithm
%RS	Percentage relative spread
%RealS	Percentage realized spread

(continued)

(continued)

Nomenclature	
%PI	Percentage price impact
%OR	Percentage order ratio
MT	Modified turnover
MAmih	Modified Amihud measure

13.2 Measuring Liquidity from High Frequency Intraday Data

There has been quite extensive research on direct measurement of liquidity from high frequency intraday data. Specifically, the related literature indicates that different versions of a bid/ask spread are proper measures for stock illiquidity because they estimate the cost of immediate execution of a trade. For example, the percentage relative spread (sometimes referred to as inside bid/ask spread or as proportional quoted spread) is commonly used as a measure for stock illiquidity (see e.g. Olbrys and Mursztyn (2018) and the references therein).

According to the literature, the bid/ask spread can be decomposed into permanent (informational) and transitory (immediacy-related) components, e.g. Glosten (1987). Realized spread is a temporary component of the effective spread, which is defined as the amount earned by a dealer or other supplier of immediacy, e.g. Huang and Stoll (1996). It is sometimes referred to as a price reversal component since a dealer takes profit only if price reverses. A proxy for price impact measures the sensitivity of a stock's price to trades (Stoll 2000), and most of researchers derive price impact from intraday transaction data (see e.g. Fong et al. (2017) and the references therein). Kyle (1985) provides a theoretical model for such a measure based on the adverse information conveyed by a trade. Price impact could be defined as an increase (decrease) in the quote midpoint over a time interval that begins at the time of the buyer- (seller-) initiated trade. This is a permanent price change of a given transaction, or equivalently, a permanent component of the effective spread.

Furthermore, order imbalance has important influence on stock liquidity, considerably more important even than volume. Therefore, order imbalance indicators could be employed among other liquidity and trading activity measures to estimate liquidity. The literature proposes various alternative proxies for order imbalance, e.g. Chan and Fong (2000), Chordia et al. (2002), Olbrys and Mursztyn (2017, 2018).

In this research, four alternative estimates of liquidity/illiquidity derived from intraday data are utilized: (1) percentage relative spread, (2) percentage realized spread, (3) percentage proxy for price impact, and (4) the percentage order ratio as an indicator of order imbalance. To justify the measures selection for the WSE, we would like to point out that Olbrys and Mursztyn (2018) propose five liquidity proxies including percentage effective spread, but their empirical results reveal that daily values of percentage effective spread and percentage relative spread are almost equal for data from the WSE. Moreover, percentage effective spread is factored into our research by its two components that complement each other: percentage realized spread and percentage price impact. Furthermore, Olbryś (2018) tests stability of correlations between four liquidity proxies (excluding percentage effective spread) and her results indicate, that four liquidity estimates seem to capture various sources of market liquidity on the WSE.

As mentioned in Introduction, we utilize a database containing high frequency data rounded to the nearest second. The dataset contains opening, high, low and closing prices, as well as volume for a security over one unit of time.

The midpoint price P_t^{mid} at time t is calculated as an arithmetic mean of the best ask price $P_t(a)$ and the best bid price $P_t(b)$ at time t. Considering that the bid and ask prices are not made public on the WSE, the midpoint price at time t is rounded by an arithmetic mean of the lowest price P_t^L and the highest price P_t^H at time t, which approximate the best ask price and the best bid price, respectively (Olbryś and Mursztyn 2015):

$$P_t^{mid} = \frac{P_t^H + P_t^L}{2}. \tag{13.1}$$

The transaction price P_t at time t is approximated by the closing price.

The **percentage relative spread** value is given by Eq. (13.2):

$$\%RS_t = \frac{100 \cdot \left(P_t^H - P_t^L\right)}{P_t^{mid}}, \tag{13.2}$$

where P_t^H, P_t^L are the highest and lowest prices at time t, respectively, while the midpoint price P_t^{mid} at time t is given by Eq. (13.1). Percentage relative spread is in fact a measure of illiquidity. A high value of percentage relative spread denotes low liquidity. Conversely, a small value of percentage relative spread denotes high liquidity. %RS at moment t is equal to zero when $P_t^H = P_t^L$. The value of daily percentage relative spread is calculated as a volume-weighted average of percentage relative spreads computed over all the trades within a day.

13.2.1 Algorithms for Inferring the Initiator of a Trade

To calculate various liquidity measures using intraday data, it is essential to recognize the side that initiates a transaction and to distinguish between so-called buyer- and seller-initiated trades. The WSE is classified as an order-driven market with an electronic order book, but information regarding the best bid and ask price is not publicly available. In fact, even the non-proprietary financial databases that provide information on trades and quotes do not possess an information about an initiator of a trade. As a consequence, researchers rely on indirect classification rules to infer the initiator of a trade. Various classification procedures of this type are described in the literature, but the Lee and Ready (1991) algorithm (LR) remains the most frequently used. For a brief literature review concerning trade classification rules see e.g. (Olbryś and Mursztyn 2015).

The LR algorithm proceeds in three steps (Theissen 2001):

1. Transactions that occur at prices higher (lower) than the quote midpoint are classified as buyer-initiated (seller-initiated) trades
2. Transactions that occur at a price that equals the quote midpoint but is higher (lower) than the previous transaction price are classified as being buyer-initiated (seller-initiated)
3. Transactions that occur at a price that equals both the quote midpoint and the previous transaction price but is higher (lower) than the last different transaction price are classified as buyer-initiated (seller-initiated) trades.

Moreover, the opening trade is treated as being unclassified.

In this paper, the LR procedure is employed as Olbrys and Mursztyn (2015, 2017, 2018) indicate that this algorithm performs quite well for data from the WSE. The empirical results turn out to be robust to the choice of the sample and do not depend on firm size.

13.2.2 Liquidity Proxies Supported by an Algorithm Inferring the Initiator of a Trade

In this research, three alternative estimates of liquidity/illiquidity derived from intraday data and supported by a trade side classification algorithm, are utilized: (1) percentage realized spread, (2) percentage price impact, and (3) the percentage order ratio as an indicator of order imbalance. Both the realized spread and price impact proxies are treated as the components of the effective spread, and they are calculated over a time interval beginning at the moment of the buyer- or seller-initiated transaction. For example, Goyenko et al. (2009) and Fong et al. (2017) employ a five minute interval and the subscript $t + 5$ indicates trade five minutes after trade at time t. Chakrabarty et al. (2007) use the subscript $t + 10$ which indicates trade ten minutes after trade at time t. Theissen (2001) proposes a more general approach and the subscript $t + \tau$. In this study, the subscript $t + 5$ indicates the fifth trade after the t-th trade (Olbryś and Mursztyn 2017).

Percentage realized spread is a temporary component of the effective spread and is given by Eq. (13.3):

$$\%RealS_t = \begin{cases} 200 \cdot ln\frac{P_t}{P_{t+5}}, when\,the\,trade\,t\,is\,classified\,as\,buyer-initiated \\ 200 \cdot ln\frac{P_{t+5}}{P_t}, when\,the\,trade\,t\,is\,classified\,as\,seller-initiated \end{cases}, \tag{13.3}$$

where the transaction price P_t at moment t is approximated by the closing price. The price P_{t+5} is the closing price of the fifth trade after trade t. %RealS at moment t is equal to zero when $P_t = P_{t+5}$. The value of daily percentage realized spread is calculated as a volume-weighted average of percentage realized spreads computed over all the trades within a day. Moreover, value of daily percentage realized spread is defined to be equal to zero when all of the transactions within a day are unclassified.

Percentage price impact focuses on the change in the quote midpoint after a signed trade and is given by Eq. (13.4):

$$\%PI_t = \begin{cases} 200 \cdot ln\frac{P^{mid}_{t+5}}{P^{mid}_t}, when\,the\,trade\,t\,is\,classified\,as\,buyer-initiated \\ 200 \cdot ln\frac{P^{mid}_t}{P^{mid}_{t+5}}, when\,the\,trade\,t\,is\,classified\,as\,seller-initiated \end{cases}, \tag{13.4}$$

where the midpoint price P^{mid}_t at time t is given by Eq. (13.1), while P^{mid}_{t+5} is the quote midpoint of the fifth trade after trade t. Price impact could be defined as the increase (decrease) in the midpoint over a five trade interval beginning at the time of a buyer- (seller-) initiated transaction. %PI at moment t is equal to zero when $P^{mid}_t = P^{mid}_{t+5}$. The proxy for daily percentage price impact is calculated as a volume-weighted average of the estimates of percentage price impact computed over all the trades within a day. Moreover, value of daily percentage price impact is defined to be equal to zero when all of the transactions within a day are unclassified.

Percentage order ratio is employed as an indicator of imbalance in daily orders and is given by Eq. (13.5):

$$\%OR = 100 \cdot \frac{\left|\sum_{i=1}^{m} VBuy_i - \sum_{j=1}^{k} VSell_j\right|}{\sum_{n=1}^{N} V_n}, \tag{13.5}$$

where the sums: $\sum_{i=1}^{m} VBuy_i$, $\sum_{j=1}^{k} VSell_j$, $\sum_{n=1}^{N} V_n$ denote the daily cumulative volume of trading related to transactions classified as buyer- or seller-initiated trades, and daily cumulative volume of trading for all transactions, respectively. The %OR indicator captures imbalance in the market since it rises as the difference in the numerator grows. A high value of the order ratio denotes low liquidity. Conversely, a small value of the order ratio denotes high liquidity. The %OR indicator is equal to zero when the numerator is equal to zero. This happens when the daily cumulative volumes of trading related to transactions classified as buyer- and seller-initiated trades, respectively, are equal. Moreover, the value of daily order ratio is defined to be equal to zero in the following two cases: (1) when all of the transactions within a day are unclassified, or (2) when the total volume of daily trading, in the denominator, is equal to zero.

13.3 Measuring Liquidity Using Low Frequency Daily Data

Direct measurement of liquidity is difficult and even impossible as intraday trading data are not freely available in the case of most emerging stock markets. Lack of access to high frequency intraday data for emerging markets in general is a fact that is both widely known and amply commented in the literature, e.g. Lesmond (2005), Bekaert et al. (2007). Given the uncertainty surrounding liquidity estimation, some measures are especially often advocated in the literature to provide empirical research in liquidity/illiquidity effects in low frequency, especially daily data. The popular measures of daily trading activity, i.e. volume, dollar trading volume, and share or market turnover are among them. Raw trading volume is the number of shares traded. The stock turnover is defined as the ratio of the number of shares traded in a day to the number of shares outstanding at the end of the day. It is worthwhile to note that using turnover disentangles the effect of a firm's size from trading volume. The market turnover is the ratio of the shares traded to market capitalization.

In this research, we compute a **modified version of daily turnover**, $MT_{i,d}$, as a measure of liquidity for stock i on day d:

$$MT_{i,d} = log\left[1 + \frac{V_{i,d}}{NSO_{i,d}}\right] - \frac{1}{30} \cdot \sum_{k=1}^{30} log\left[1 + \frac{V_{i,d-k}}{NSO_{i,d-k}}\right], \tag{13.6}$$

where $V_{i,d}$ is the trading volume of stock i on day d, and $NSO_{i,d}$ is the number of shares outstanding of stock i on day d.

Our method is based on Karolyi et al. (2012), but we use the number of shares outstanding at the beginning of the quarter for stock i on day d in Eq. (13.6), while Karolyi et al. use the number of shares outstanding at the beginning of the year. We compute turnover in logs and detrend the resulting series with a 30-day moving average to account for non-stationarity. The moving average is calculated for the available data over the past 30 trading days. The empirical results presented by Nowak and Olbryś (2015) reveal several day-of-the-week patterns in liquidity on the WSE. Therefore, it is important to note that using the modified version of daily turnover (13.6) disentangles these day-of-the-week effects from daily turnover.

The second measure that is approximated from daily data is a **modified version of the Amihud (2002) liquidity proxy**, $MAmih_{i,d}$, given by Eq. (13.7):

$$MAmih_{i,d} = \begin{cases} log\left(1 + \frac{|r_{i,d}|}{V_{i,d}}\right), whenV_{i,d} \neq 0 \\ 0, whenV_{i,d} = 0 \end{cases}, \tag{13.7}$$

where $r_{i,d}$ is the simple rate of return of stock i on day d, and $V_{i,d}$ is the trading volume of stock i on day d. We follow Karolyi et al. (2012), but our method is slightly different, because they use return and volume in local currency, and finally multiply the result by negative one to obtain a variable that is increasing alongside with liquidity of individual stock. Moreover, the value of daily Amihud measure (13.7) is defined to be equal to zero when the total volume of daily trading, in the denominator, is equal to zero. Finally, to avoid numerical problems, the daily values of the estimator (13.7) are rescaled by multiplying by 10^2.

In the literature, the Amihud measure is usually calculated for stock i for each month, e.g. Goyenko et al. (2009), Lischewski and Voronkova (2012), Olbryś (2014), Foran et al. (2015), Będowska-Sójka (2017), Fong et al. (2017). In this paper, we estimate and investigate daily time series of the Amihud proxy (13.7).

13.4 Data Description and Empirical Results for the WSE

In this study, two data samples are used. The first sample contains daily data (available at www.bossa.pl) for the group of eighty-six WSE-listed companies, in the period from January 2, 2005 to December 30, 2016 (3005 trading days). The quarterly number of shares outstanding of each stock is available at www.bankier.pl
.

The second sample consists of high frequency data rounded to the nearest second from the WSE (available at www.bossa.pl) for the same group of the companies. The dataset contains the opening, high, low and closing prices, and volume for a security over one unit of time. The whole sample covers the same period from January 2, 2005 to December 30, 2016. When forming the database, we included only the securities that were listed on the WSE for the whole sample period since December 31, 2004, and were not suspended. The 138 WSE companies met these basic conditions, and they were initially selected. However, Nowak and Olbryś (2016) document that a large number of the WSE-traded companies reveal a substantial non-trading problem, Therefore, to mitigate this problem, we excluded the stocks that exhibited extraordinarily many non-traded days during the whole sample period, precisely, above 300 zeros in daily volume, which constituted about 10% of all 3005 trading days. In this way, 104 companies were entered into the database. In the next step, we excluded stocks that were suspended or removed from the WSE in 2017. Moreover, we perceived the problem of inconsistency between both intraday and daily data sets. We observed various gaps in data for some companies and therefore we decided to exclude them from our database. Finally, 86 firms were contained in the database. In the last step, we removed the period between January

16, 2014 and January 30, 2014 (11 trading days) from intraday data set as the common (technical) gap in data for all companies.

13.4.1 Some Statistical Properties of Daily Time Series of Liquidity Proxies

We begin to analyse time series of liquidity proxies with their distributional properties. Table 13.1 reports summarized cross-sectional results of basic statistics and tests for asymmetry, tail thickness, normality, as well as linear and non-linear dependences for 516 daily time series of six liquidity proxies, for the study group of

Table 13.1 Summarized cross-sectional results of basic statistics and tests for skewness, excess kurtosis, normality, and interdependence for daily time series of six liquidity proxies (for the study group of 86 WSE-traded companies)

Liquidity proxy	%RS	%RealS	%PI	%OR	MT	MAmih
Mean	0.129	0.238	-0.088	38.55	0.0004	0.0041
Median	0.036	0.023	0.000	32.81	0.0000	0.0000
Standard deviation	0.269	1.208	0.774	29.74	0.0028	0.0554
The null hypothesis that skewness = 0 can be rejected at 5% significance level. The series is positively and significantly skewed	All series	76/86 series	22/86 series	74/86 series	All series	All series
The null hypothesis that skewness = 0 can be rejected at 5% significance level. The series is negatively and significantly skewed	–	8/86 series	61/86 series	1/86 series	–	–
The null hypothesis that excess kurtosis = 0 can be rejected at 5% significance level. The series is leptokurtic	All series	All series	All series	8/86 series	All series	All series
The null hypothesis that excess kurtosis = 0 can be rejected at 5% significance level. The series is platykurtic	–	–	–	74/86 series	–	–
The null hypothesis of normality can be rejected at 5% significance level (the Doornik-Hansen test)	All series	All series	All series	All series	All series	All series
The null hypothesis that there is no linear dependence in the series can be rejected at 5% significance level (the LB(8) test)	80/86 series	56/86 series	51/86 series	84/86 series	82/86 series	52/86 series
The null hypothesis that there is no ARCH effect in the series can be rejected at 5% significance level (the $LB^2(8)$ test)	42/86 series	69/86 series	61/86 series	85/86 series	62/86 series	27/86 series

86 WSE-traded companies. The table is based on all observations in the sample from January 2, 2005 to December 30, 2016. The test statistic for skewness and excess kurtosis is the conventional t-statistic. The Doornik and Hansen (2008) test has a χ^2 distribution if the null hypothesis of normality is true. LB(q) and LB^2(q) are the Ljung and Box (1978) statistics for returns and squared returns, respectively, distributed as $\chi^2(q)$, $q \approx lnT$, where T is the number of data points (Tsay 2010, p. 33). In all cases, $q \approx 8$. To test the null hypothesis that there is no ARCH effect in the series, we utilize McLeod and Li (1983) method.

Several results in Table 13.1 are worth special notice. There is some right skewness in the cross-section of the daily time series, as the sample means exceed medians, except for the %PI proxy. The measure of skewness shows that most of the daily series (430 out of 516) are positively and significantly skewed. This evidence is similar to the observation concerning return series. Campbell et al. (1997) stress that the skewness estimates are generally positive for the individual stock return daily time series. Our results reveal that only the %PI series are negatively and significantly skewed. The probable explanation of this phenomenon is the fact, that empirical values of %PI are mostly negative, as the %PI is the component of the effective spread which complements the %RealS, e.g. Olbryś (2018), Olbrys and Mursztyn (2018).

The measurement for excess kurtosis shows that most of the series (438 out of 516), except for the %OR series, are leptokurtic with respect to the normal distribution. Only the %OR series (74 out of 86) are platykurtic. Campbell et al. (1997) stress that daily data series often have high sample excess kurtosis, which is a clear sign of fat tails (the series are leptokurtic). The Doornik and Hansen (2008) test rejects normality for each of the series at the 5% level of significance. This evidence is typical and consistent with the literature.

The Ljung and Box (1978) test indicates the presence of significant linear dependencies in the case of 405 out of 516 series, what is rather consistent with the literature. It is not surprising that the daily time series of an individual security data is significantly autocorrelated.

The McLeod and Li (1983) test confirms the presence of significant non-linear dependencies in the case of 346 out of 516 series. This evidence of significant ARCH effects in daily time series is rather a typical feature and is consistent with the literature, e.g. Tsay (2010) and Campbell et al. (1997).

13.4.2 Testing for Stationarity of Daily Liquidity Proxy Time Series

The foundation of time series analysis is stationarity (Tsay 2010, p. 30). Therefore, we detect with the ADF-GLS test (Elliott et al. 1996) whether the analysed daily liquidity proxy time series are stationary. Using daily data, we utilize a maximum lag equal to five and then remove lags until the last one is statistically significant

Table 13.2 Summarized cross-sectional results of testing for stationarity of daily time series of six liquidity proxies (for the study group of 86 WSE-traded companies)

	%RS	% RealS	%PI	%OR	MT	MAmih
Unit-root hypothesis can be rejected at 5% significance level (ADF-GLS test). The series is stationary	All series	All series	All series	All series	All series	All series

(Adkins 2014). The critical value of the ADF-GLS τ-statistics for the rejection of the null hypothesis of a unit root at the 5% significance level is equal to −1.94 (for T = 2500, the intercept model) or −2.86 (for T = 2500, the trend model) (Cook and Manning 2004, pp. 271–272). Table 13.2 presents summarized cross-sectional results of testing for stationarity of 516 daily time series of six liquidity proxies, for the study group of 86 WSE-traded companies. The table is based on all observations in the sample from January 2, 2005 to December 30, 2016. We proved that the unit-root hypothesis can be rejected for all series at 5% significance level.

13.5 Conclusion

The aim of this paper was to assess major characteristics of time series of selected liquidity proxies based on high frequency (intraday) and low frequency (daily) data from the WSE. We investigated distributional properties, linear and non-linear dependences, as well as stationarity of daily time series of six liquidity estimates for the group of eighty-six WSE-traded companies, in the period from January 2005 to December 2016. The following liquidity proxies have been tested: (1) percentage relative spread, (2) percentage realized spread, (3) percentage price impact, (4) percentage order ratio, (5) the modified daily turnover, and (6) the modified version of daily Amihud measure. The empirical results revealed some stylized facts and typical features of the analysed time series.

Moreover, we proved that all 516 analysed daily time series of liquidity measures are stationary, i.e. the unit-root hypothesis can be rejected in all cases. This evidence is crucial for further research concerning commonality in liquidity on the WSE, because we plan to employ econometric models that require stationarity of liquidity variables, e.g. Chordia et al. (2000), Kamara et al. (2008), Karolyi et al. (2012).

Acknowledgements This study was supported by the grant "Comparative research on commonality in liquidity on the Central and Eastern European stock markets" from the National Science Centre in Poland, No. 2016/21/B/HS4/02004.

References

Adkins, L. C. (2014). *Using gretl for principles of econometrics* (4th ed.), Version 1.041.

Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time-series effects. *Journal of financial markets, 5*(1), 31–56.

Będowska-Sójka, B. (2017). Comparison of monthly stock liquidity measures for WSE-listed companies based on low-frequency data (in Polish). *Problemy Zarzadzania-Managemnet Issues, 15*(1), 178–192.

Bekaert, G., Harvey, C. R., & Lundblad, C. (2007). Liquidity and expected returns: Lessons from emerging markets. *The Review of Financial Studies, 20*(6), 1783–1831.

Campbell, J. Y., Lo, A. W., & MacKinlay, A. C. (1997). *The econometrics of financial markets*. New Jersey: Princeton University Press.

Chakrabarty, B., Li, B., Nguyen, V., & Van Ness, R. A. (2007). Trade classification algorithms for electronic communications network trades. *Journal of Banking & Finance, 31,* 3806–3821.

Chan, K., & Fong, W.-M. (2000). Trade size, order imbalance, and the volatility-volume relation. *Journal of Financial Economics, 57,* 247–273.

Chordia, T., Roll, R., & Subrahmanyam, A. (2000). Commonality in liquidity. *Journal of Financial Economics, 56,* 3–28.

Chordia, T., Roll, R., & Subrahmanyam, A. (2002). Order imbalance, liquidity, and market returns. *Journal of Financial Economics, 65,* 111–130.

Cook, S., & Manning, N. (2004). Lag optimization and finite-sample size distortion of unit root tests. *Economic Letters, 84*(2), 267–274.

Doornik, J. A., & Hansen, H. (2008). An omnibus test for univariate and multivariate normality. *Oxford Bulletin of Economics and Statistics, 70*(Supp 1), 927–939.

Elliott, G., Rothenberg, T. J., & Stock, J. H. (1996). Efficient tests for an autoregressive unit root. *Econometrica, 64*(4), 813–836.

Fong, K. Y. L., Holden, C. W., & Trzcinka, C. (2017). What are the best liquidity proxies for global research? *Review of Finance, 21,* 1355–1401.

Foran, J., Hutchinson, M. C., & O'Sullivan, N. (2015). Liquidity commonality and pricing in UK. *Research in International Business and Finance, 34,* 281–293.

Glosten, L. R. (1987). Components of the bid-ask spread and the statistical properties of transaction prices. *The Journal of Finance, 42*(4), 1293–1307.

Goyenko, R. Y., Holden, C. W., & Trzcinka, C. A. (2009). Do liquidity measures measure liquidity? *Journal of Financial Economics, 92,* 153–181.

Huang, R. D., & Stoll, H. R. (1996). Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE. *Journal of Financial Economics, 41,* 313–357.

Kamara, A., Lou, X., & Sadka, R. (2008). The divergence of liquidity commonality in the cross-section of stocks. *Journal of Financial Economics, 89*(3), 444–466.

Karolyi, G. A., Lee, K.-H., & van Dijk, M. A. (2012). Understanding commonality in liquidity around the world. *Journal of Financial Economics, 105*(1), 82–112.

Kyle, A. S. (1985). Continuous auctions and insider trading. *Econometrica, 53*(6), 1315–1336.

Lee, C. M. C., & Ready, M. J. (1991). Inferring trade direction from intraday data. *The Journal of Finance, 46*(2), 733–746.

Lesmond, D. A. (2005). Liquidity of emerging markets. *Journal of Financial Economics, 77*(2), 411–452.

Lischewski, J., & Voronkova, S. (2012). Size, value and liquidity. Do they really matter on an emerging stock market? *Emerging Markets Review, 13,* 8–25.

Ljung, G., & Box, G. E. P. (1978). On a measure of lack of fit in time series models. *Biometrika, 66,* 67–72.

McLeod, A. I., & Li, W. K. (1983). Diagnostic checking ARMA time series model using squared residual autocorrelations. *Journal of Time Series Analysis, 4,* 269–273.

Nowak, S., & Olbryś, J. (2015). Day-of-the-week effects in liquidity on the Warsaw Stock Exchange. *Dynamic Econometric Models, 15,* 49–69.

Nowak, S., & Olbryś, J. (2016). Direct evidence of non-trading on the Warsaw Stock Exchange. Research Papers of Wroclaw University of Economics. Wroclaw Conference in Finance: Contemporary Trends and Challenges 428, 184–194.

Olbryś, J. (2014). Is illiquidity risk priced? The case of the Polish medium-size emerging stock market. *Bank & Credit, 45*(6), 513–536.

Olbryś, J. (2018). Testing stability of correlations between liquidity proxies derived from intraday data on the Warsaw Stock Exchange. In K. Jajuga, H. Locarek-Junge, & L. Orlowski (Eds.), *Contemporary trends and challenges in finance*. Springer Proceedings in Business and Economics (pp. 67–79). Cham: Springer.

Olbrys, J., & Mursztyn, M. (2018). Liquidity proxies based on intraday data: The case of the Polish order driven stock market. In N. Tsounis & A. Vlachvei (Eds.), *Advances in Panel Data Analysis in Applied Economic Research. Springer Proceedings in Business and Economics* (pp. 113–128). Cham: Springer.

Olbryś, J., & Mursztyn, M. (2015). Comparison of selected trade classification algorithms on the Warsaw Stock Exchange. *Advances Computer Science Research, 12,* 37–52.

Olbryś, J., & Mursztyn, M. (2017). Measurement of stock market liquidity supported by an algorithm inferring the initiator of a trade. *Operations Research and Decisions, 27*(4), 111–127.

Stoll, H. S. (2000). Friction. *The Journal of Finance, 55*(4), 1479–1514.

Theissen, E. (2001). A test of the accuracy of the Lee/Ready trade classification algorithm. *Journal of International Financial Markets, Institutions and Money, 11,* 147–165.

Tsay, R. S. (2010). *Analysis of financial time series*. New York: Wiley.

Chapter 14
Do Emerging and Frontier Stock Markets of Middle East and North Africa (MENA) Region Provide Diversification Opportunities?

Nisha Mary Thomas, Smita Kashiramka and Surendra Singh Yadav

Abstract The study investigates if emerging and frontier equity markets of Middle East and North Africa (MENA) region are well integrated with each other and with the developed markets of USA and UK. Gregory and Hansen cointegration test and Geweke Measures of Feedback are employed to analyze long-run relationship and short-run dependencies between equity markets respectively. The results show that emerging markets of Egypt and Saudi Arabia are fairly segmented with the developed markets and hence have the potential to enhance diversification benefits of a global portfolio. Further, frontier markets like Bahrain, Jordan and Morocco are not well integrated with both the developed markets and regional emerging markets. Hence, these frontier markets also offer gains of diversification to international investors. Results of this study will facilitate international investors in designing an optimal portfolio. It will also benefit policymakers in formulating suitable economic stabilization policies.

Keywords Stock market integration · MENA · Frontier markets
Emerging markets

Classification G10 · G15

14.1 Introduction

International investors are in constant lookout for markets that can enhance their portfolio's performance. In this context, the Middle East and North African (MENA) equity markets provide attractive investment avenues for investors as

---

N. M. Thomas (✉) · S. Kashiramka · S. S. Yadav
Department of Management Studies, Indian Institute of Technology Delhi, Delhi, India
e-mail: nishamthomas11@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_14

these markets are providing steady corporate earnings growth, attractive dividend yields and good stock valuations (Khatoun 2017). Institute of International Finance (2018) projects MENA markets to bounce back from their low economic growth rate of 1.8% in 2017 to 3.1% in 2019. MENA markets are enjoying increased business and consumer confidence owing to the series of reform measures undertaken by them over the last few years. For instance, Egypt has adopted floating exchange rate system to improve competitiveness and encourage industrial activity; Saudi Arabia has reduced its subsidies and increased taxes to tame its fiscal balance; Kuwait Stock Exchange has divided its bourse into three sections on the basis of market capitalization and turnover ratio to attract investors and to encourage initial public offerings; Morocco has revised its currency's band of fluctuation from 0.3 to 2.5% in order to strengthen itself against external crisis.

MSCI Market Classification Framework (2017) classifies equity markets of MENA region as emerging and frontier markets. Emerging markets have some characteristics of developed markets but have not yet reached its standards. They typically have a significant level of openness to foreign ownership, ease of capital flows and modest stability in the institutional framework. Emerging markets of MENA region includes Egypt, Turkey and Saudi Arabia. As compared to emerging markets, frontier markets have less liquidity, have lower levels of market capitalization and are more restrictive in terms of investment. However, investors view frontier markets as an attractive investment proposition as these markets promise better growth opportunities. Bahrain, Jordan, Morocco and Kuwait are examples of frontier markets in MENA region.

This study investigates if emerging and frontier equity markets of MENA region are integrated with each other and with developed markets of USA and UK. Strong stock market integration affects both international investors and policymakers. International investors will not enjoy benefits of diversification by investing in well-integrated equity markets. For policymakers, well-integrated equity markets imply increased susceptibility to external shocks.

This study makes the following three contributions to the literature on stock market integration. First, it adds on to the thin body of empirical work on frontier markets. Since frontier markets offer a good investment opportunity to investors, it is important to empirically examine the challenges of investing in these markets (Berger et al. 2013). Second, unlike previous studies (e.g. Batareddy et al. 2012; Demian 2011), this study takes into account instability in long run relationship by employing Gregory and Hansen cointegration test. Finally, this study contributes to the under-investigated region of MENA markets.

The remaining paper is ordered as follows. Section 14.2 presents the related literature, Sect. 14.3 explains data and empirical framework used in the study and Sect. 14.4 shows the outcomes of the study. Section 14.5 concludes and presents managerial implications of the study.

14.2 Related Literature

Stock market integration implies that the equity markets move together over a long period of time (Sharma and Seth 2012). There are plethora of studies that have investigated stock market integration in Europe (e.g. Kenourgios and Samitas 2011; Syllignakis and Kouretas 2010; Demian 2011; Thomas et al. 2016) and Asia Pacific regions (e.g. Dhanaraj et al. 2013; Thomas et al. 2017; Valadkhani and Chancharat 2008; Huyghebaert and Wang 2010). However, over the last decade, the focus has shifted to understand the level of integration between MENA equity markets and global capital markets. Arouri and Nguyen (2009) document low level of integration between select Gulf markets and major equity markets of the world during 2005-2008. However, Graham et al. (2013) find a modest degree of integration between MENA markets and USA during 2002–2010. Yu and Hassan (2008) observe significant impact of US market on volatility spillover of MENA region. Lagoarde-Segot and Lucey (2007) investigate diversification benefits in MENA region and find that MENA markets have the potential to attract more portfolio flows in the future. Recent studies have tried to analyze the impact of 2008 global financial crisis on MENA equity markets. Neaime (2012) finds that the 2008 crisis had an adverse impact on equity markets of Egypt, Jordan, Kuwait and Morocco. Maghyereh et al. (2015) observe increased integration between MENA markets and USA during 2008 global financial crisis.

Overall, one may surmise from the literature survey that research on MENA equity markets is still in nascent stage and hence it can be explored further. Studies till now have focused on examining how well MENA markets are integrated with global financial markets. There is limited work on understanding interlinkages between MENA markets themselves. Frontier markets of MENA region have also not received due attention from academia. This study attempts to address all these gaps and aims to achieve the following two objectives (i) to examine long-run equilibrium relationship among equity markets of USA and UK and emerging and frontier markets of MENA region and (ii) to analyze the pattern of short-run interdependencies between the aforementioned equity markets.

14.3 Data and Empirical Framework

This study uses indices of the equity markets enlisted in Table 14.1. Weekly data is used. Equity markets are classified as developed, emerging and frontier markets on the basis of MSCI Market Classification Framework (2015). The stock price indices are denoted in U.S. dollar terms. The data is obtained from Datastream and is collected from 2000 to 2017.[1]

[1]Weekly stock price information of Bahrain is available from 2003 onwards

Table 14.1 List of equity markets included in the study

Country	Index
Developed markets	
USA	S&P500
UK	FTSE100
Emerging markets	
Egypt	EGX30
Turkey	BIST30
Saudi Arabia	Tadawul All Share (TASI)
Frontier markets	
Bahrain	Bahrain Bourse All Share Index
Jordan	ASE General Index
Morrocco	CFG25
Kuwait	KSE

The study aims to examine long-run equilibrium relationship between the three pairs of markets (a) Developed and Emerging Markets (DM-EM) (b) Developed and Frontier Markets (DM-FM) and (c) Emerging and Frontier Markets (EM-FM). For this purpose, Gregory and Hansen (1996a, b) cointegration test is employed. Further, Geweke (1982) Measures of Feedback is used to assess time-varying interdependence between these three pairs of equity markets. The following sections explain the methodologies employed in the study.

14.3.1 Zivot and Andrews Unit Root Test

Prior to conducting cointegration test, it is imperative to assess if all the index series have unit root. For this purpose, Zivot and Andrews test is employed as it takes into account breaks in the series. Equation 14.1 presents Zivot and Andrew's (1992) mixed model which considers break in slope as well as intercept.

$$\Delta Y_t = \mu + \varphi t + \theta DM_t + \gamma DS_t + \alpha Y_{t-1} + \sum_{i=1}^{k} c_i \Delta Y_{t-i} + \mathcal{E}_t \tag{14.1}$$

where Y_t is the stock price, t is time, k is the length of the lag, T_b is time of the break, DU_t will be 1 if t is greater than T_b, DT_t will take the value of $t - T_b$ if t is greater than T_b and $\mathcal{E}_t$ is white noise disturbance. The dummy variables DM_t and DS_t represent break in intercept and slope respectively. Schwarz Bayesian Information Criterion (SBC) is used to ascertain the lag length k. T_b is determined on the basis of the minimum value of t-statistic for α.

14.3.2 Gregory and Hansen Cointegration Test

After establishing the existence of unit root in the index series, cointegration test can be performed. The benefit of using Gregory and Hansen cointegration test over conventional cointegration tests is that it takes into account the probability of a break in the long-run relationship. This test considers four types of breaks. The level shift model (Eq. 14.2) incorporates break in the intercept.

$$Z_{1t} = a_1 + a_2\phi_{t\tau} + bZ_{2t} + \mathcal{E}_t, \quad t = 1, 2, \ldots, n \tag{14.2}$$

Time trend is introduced in level shift with trend model (Eq. 14.3). This model deals with break in intercept as well.

$$Z_{1t} = a_1 + a_2\phi_{t\tau} + c_1 t + bZ_{2t} + \mathcal{E}_t, \quad t = 1, 2, \ldots, n \tag{14.3}$$

Break in the slope of the cointegration vector as well as the intercept is taken into account by regime shift model (Eq. 14.4)

$$Z_{1t} = a_1 + a_2\phi_{t\tau} + b_1 Z_{2t} + b_2 Z_{2t}\phi_{t\tau} + \mathcal{E}_t, \quad t = 1, 2, \ldots, n \tag{14.4}$$

Break in intercept, time trend and slope of the cointegration vector is considered by regime plus trend shift model (Eq. 14.5)

$$Z_{1t} = a_1 + a_2\phi_{t\tau} + c_1 t + c_2 t + b_1 Z_{2t} + b_2 Z_{2t}\phi_{t\tau} + \mathcal{E}_t, \quad t = 1, 2, \ldots, n \tag{14.5}$$

Z_{1t} and Z_{2t} are logarithms of stock price indices. The intercept, trend and slope coefficients before the breakpoint time are shown by a_1, c_1, b_1 respectively. The corresponding coefficients after the break are represented by a_2, c_2, d_2 respectively. The structural break is represented by $\phi_{t\tau}$ and is taken as 0 if $t \leq [n\tau]$, else it takes the value 1. The unknown parameter is $\tau \epsilon (0, 1)$ and it denotes the probable breakpoint time. ADF, Z_α and Z_t are the test statistics used in in this method and these are defined in Eqs. 14.6–14.8.

$$\mathrm{ADF} = \inf_{\tau \in T} \mathrm{ADF}(\tau) \tag{14.6}$$

$$Z_\alpha = \inf_{\tau \in T} Z_\alpha(\tau) \tag{14.7}$$

$$Z_t = \inf_{\tau \in T} Z_t(\tau) \tag{14.8}$$

All the models try to find the minimum values of $\mathrm{ADF}(\tau)$, $Z_\alpha(\tau)$ and $Z_t(\tau)$ across all values of τ, so that the null hypothesis of no cointgration can be rejected. If the computed values of the test statistics is less than the critical value, then the null hypothesis of no cointegration is rejected. Table 14.2 presents the critical values of the test statistics at 5% significance level.

Table 14.2 Gregory and Hansen (1996a, b) cointegration test: critical values of test statistics at 5% level

	ADF	Z_t	Z_α
Level	−4.61	−4.61	−40.48
Trend	−4.99	−4.99	−47.96
Regime	−4.95	−4.95	−47.04
Regime trend	−5.50	−5.50	−58.58

14.3.3 Geweke Measures of Feedback

To understand the time-varying interdependence between different equity markets, Geweke Measures of Feedback (1982) is used. Let daily log returns of markets x and y at time t be represented by r_{xt} and r_{yt} respectively. The return r_{xt} can be expressed as a function past returns of market y, its own past returns and noise. This is presented in the form of the following two seemingly unrelated regression equations:

$$r_{xt} = p_0 + \sum_{k=1}^{A} q_k r_{yt-k} + \sum_{k=1}^{B} s_k r_{xt-k} + \varepsilon_{xt} \tag{14.9}$$

$$r_{yt} = t_0 + \sum_{k=1}^{A} u_k r_{xt-k} + \sum_{k=1}^{M_1} v_k r_{yt-k} + \varepsilon_{yt} \tag{14.10}$$

$$\text{with} \quad \mathrm{M} = \mathrm{Cov}\begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \end{bmatrix} = \begin{bmatrix} \sigma_{\varepsilon x}^2 & \sigma_{xy} \\ \sigma_{xy} & \sigma_{\varepsilon y}^2 \end{bmatrix} \tag{14.11}$$

The terms ε_{xt} and ε_{yt} are assumed to be normally distributed and are not serially correlated. The lags A and B are fixed to 5 trading days. The coefficient q_k in Eq. 14.9 shows market y leading market x whereas coefficient u_k of Eq. 14.10 indicates market y following market x. The same day relationship between the two markets is shown by correlation across error terms in the matrix M. The following three null hypotheses are suggested:

H_1: No same day relationship between r_{xt} and r_{yt}
H_2: r_{yt} does not lead r_{xt}
H_3: r_{xt} does not lead r_{yt}

Under the joint hypothesis H4: H1, H2 and H3, Eqs. 14.9 and 14.10 become

$$r_{xt} = p'_0 + \sum_{k=1}^{B} s'_k r_{xt-k} + \mu_{xt} \tag{14.12}$$

$$r_{yt} = t'_0 + \sum_{k=1}^{B} v'_k r_{yt-k} + \mu_{yt} \quad \text{with Cov}\left(\mu_{xt}, \mu_{yt}\right) \tag{14.13}$$

Ordinary least square method is used to estimate Eqs. 14.12 and 14.13. Estimated residual variances and covariances in M, $\sigma^2_{\mu x}$ and $\sigma^2_{\mu y}$ are used to compute the three types of Geweke Measures of Feedback viz. Geweke Measures of Instantaneous Feedback (GMF_{x*y}), Geweke Measures of Unidirectional Feedback from market x to market y ($GMF_{x\rightarrow y}$) and Geweke Measures of Unidirectional Feedback from market y to market x $GMF_{y\rightarrow x}$. These three feedback measures are computed as below:

$$GMF_{x*y} = n \ln\left[\left(\sigma^2_{\mu x} * \sigma^2_{\mu y}\right)/|M|\right] \tag{14.14}$$

$$GMF_{y\rightarrow x} = n \ln\left(\sigma^2_{\mu x}/\sigma^2_{\varepsilon x}\right) \tag{14.15}$$

$$GMF_{x\rightarrow y} = n \ln\left(\sigma^2_{\mu y}/\sigma^2_{\varepsilon y}\right) \tag{14.16}$$

14.4 Results

14.4.1 Descriptive Statistics

Summary statistics of weekly stock returns of all the markets under study are reported in Table 14.3. Emerging markets of Egypt, Turkey and Saudi Arabia are yielding higher returns as compared to both developed markets and frontier markets. However, a closer look at the coefficient of variation will highlight that investors will earn better risk-adjusted returns by investing in frontier markets of Jordan, Morocco and Kuwait. Almost all the market returns are negatively skewed which indicates that the markets will witness frequent small gains and a few

Table 14.3 Descriptive statistics of weekly stock returns from 2000 to 2017

Markets	Mean	Standard deviation	Coefficient of variation	Skewness	Kurtosis
USA	0.10	2.41	25.33	−0.57	9.14
UK	0.04	2.82	74.50	−0.69	12.51
Egypt	0.20	4.46	22.63	−0.94	10.63
Turkey	0.22	6.57	29.44	0.24	13.98
Saudi Arabia	0.20	3.45	17.54	−1.05	9.52
Bahrain	0.04	1.39	33.94	−0.16	5.75
Jordan	0.11	2.51	22.13	2.22	67.03
Morocco	0.11	2.27	19.83	−0.09	5.93
Kuwait	0.33	8.80	26.97	24.43	720.84

extreme losses. All the return series are leptokurtic which implies that the markets are more likely to witness large fluctuations in returns.

14.4.2 Zivot and Andrews Unit Root Test

The result of the unit root test is presented in Table 14.4. Panel 1 displays the results for series at level. It can be inferred from Panel 1 that we fail to reject the null hypothesis of unit root for all the series at level. Panel 2 presents the results of series at first difference. Results of Panel 2 rejects the null hypothesis indicating that the first difference series are stationary. Hence, we can conclude that all series are I(1). The structural breaks mostly concentrate around 2007, 2008 and 2009. The possible explanation for the structural break may be the 2008 global financial crisis that had adversely affected financial systems across the world (Rizvi et al. 2018).

14.4.3 Gregory and Hansen Cointegration Test

Table 14.5 displays results of Gregory and Hansen cointegration test. The table shows only those models that indicate cointegration between stock market indices. Panel 1, Panel 2 and Panel 3 of Table 14.5 displays cointegration relationship between DM-EM, DM-FM and EM-FM respectively.

Table 14.4 Zivot and Andrews unit root test

Markets	Minimum t-statistics	Lag	T_b	Minimum t-statistics	Lag	T_b
	Panel 1: at level			Panel 2: at first difference		
USA	−4.38	0	2008	−33.09***	0	2009
UK	−4.10	0	2008	−33.27***	0	2007
Egypt	−4.09	0	2004	−31.90***	0	2006
Turkey	−4.05	0	2003	−33.71***	0	2004
Saudi Arabia	−3.87	0	2006	−30.43***	0	2006
Bahrain	−4.42	2	2008	−15.56***	1	2008
Jordan	−4.46	1	2003	−35.16***	0	2005
Morocco	−4.47	0	2006	−29.87***	0	2008
Kuwait	−5.16	3	2008	−24.87***	2	2008

Note At 1% significance level, the critical values is −5.57
*** denotes significance at 1% level

Table 14.5 Gregory and Hansen test of cointegration

Market pair	Model	Lag	ADF	T_b	Z_α	T_b	Z_t	T_b
Panel 1: Developed and Emerging Markets (DM-EM)								
Turkey–USA	Regime trend	1	−5.89**	2009	−63.79**	2008	−5.59**	2009
Turkey–UK	Regime	0	−5.11**	2008	−48.16**	2008	−4.65	2008
	Regime trend	0	−6.01**	2008	−64.76**	2008	−5.65**	2008
Saudi Arabia–UK	Regime trend	1	−6.35**	2006	−78.17**	2006	−6.85**	2006
Panel 2: Developed and Frontier Markets (DM-FM)								
Kuwait–USA	Regime trend	1	−7.76**	2008	−174.39**	2008	−8.79**	2008
Kuwait–UK	Regime trend	1	−7.73**	2008	−172.76**	2008	−8.74**	2008
Panel 3: Emerging and Frontier Markets (EM-FM)								
Bahrain–Egypt	Level	0	−4.71**	2006	−40.37	2006	−4.54	2006
	Regime	0	−5.05**	2006	−45.07	2006	−4.80	2006
Jordan–Saudi Arabia	Regime trend	0	−5.84**	2009	−57.33	2009	−5.41	2009
Kuwait–Egypt	Regime trend	1	−7.94**	2008	−184.99**	2008	−9.14**	2008
Kuwait–Turkey	Regime trend	1	−7.95**	2008	−185.90**	2008	−9.18**	2008
Kuwait–Saudi Arabia	Regime trend	1	−9.01**	2008	−264.78**	2008	−11.59**	2008

Results of Panel 1 show that Turkey shares long-run equilibrium relationship with both USA and UK. Cheng et al. (2010) have also observed that Turkey is very well integrated with global capital markets. Panel 1 also report cointegration relationship between Saudi Arabia and the UK. According to results of Panel 2 and Panel 3, Kuwait shares cointegration relationship with both the developed markets (USA and UK) and emerging markets (Egypt, Turkey and Saudi Arabia). Panel 3 reports the long-run relationship between two pairs markets viz. Bahrain and Egypt and Jordan and Saudi Arabia.

14.4.4 Geweke Measures of Feedback

Geweke Measures of Feedback (GMF) is employed to understand time-varying comovement between DM-EM, DM-FM and EM-FM. The study has 6 pairs of DM-EM, 8 pairs of DM-FM and 12 pairs of EM-FM combinations. The three types of GMF (viz. $GMF_{x \to y}$, $GMF_{y \to x}$ and GMF_{x*y}) are computed annually for each pair

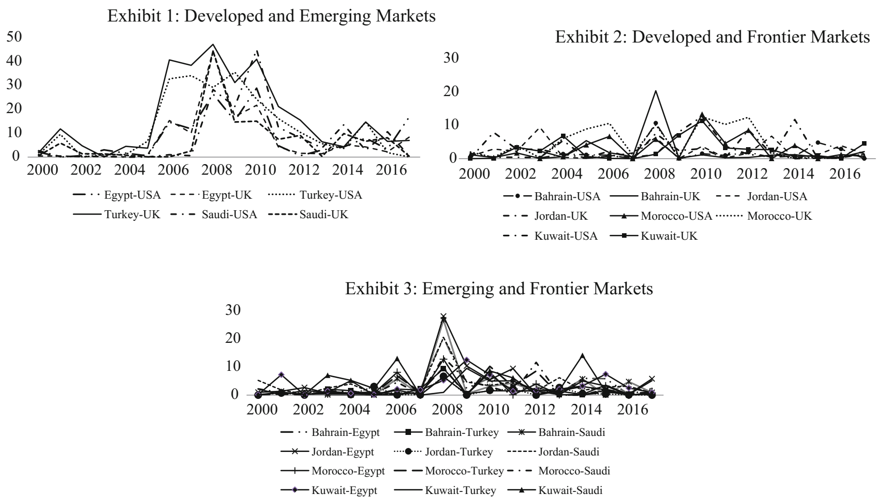


Fig. 14.1 Geweke measures of instantaneous feedback between developed and emerging markets, developed and frontier markets and emerging and frontier markets

of these markets for 17 years. Hence, overall we have 324 GMF for DM-EM, 414 GMF for DM-FM and 621 GMF for EM-FM.[2]

The results do not provide evidence of statistically significant lead-lag relationship (i.e. $GMF_{x \rightarrow y}$ and $GMF_{y \rightarrow x}$) between DM-EM, DM-FM and EM-FM. Figure 14.1 exhibits Geweke Measures of Instantaneous Feedback (GMF_{x*y}) between these three pairs of markets.[3] Exhibit 1 which presents instantaneous feedback between DM-EM clearly displays the three phases of crisis transmission (Chiang et al. 2007) viz. contagion, herding and post-crisis. During contagion, there is a sharp rise in comovement, which in this case is between 2007 and 2008. In herding phase, the comovement is maintained at high levels, which is observed between the years 2009–2010. In the post-crisis phase, the comovement level falls back to the pre-crisis level. This phase can be observed from 2011 onwards. A closer examination of instantaneous feedback measures between DM-EM will highlight that both Egypt and Saudi Arabia share a statistical significant relationship with the developed markets during 2006–2011 only. However, Turkey displays a statistically significant relationship with USA and UK throughout the time period under study. This confirms our findings from cointegration analysis that Turkey is very well integrated with the developed markets of USA and UK.

[2]The results of the three Geweke Measures of Feedback between DM-EM, DM-FM and EM-FM are available on request.

[3]Figure 14.1 presents only Geweke Measures of Instantaneous Feedback as only this feedback measures is found to be statistically significant for all the three pairs of markets.

As far as instantaneous feedback measures between DM-FM and EM-FM are concerned, only 25% of the feedback measures are found to be statistically significant. Further, these observations are not consistent over time. Hence, it can be surmised that the MENA frontier markets do not share strong linkages with the developed and emerging markets under study. Hence, these markets offer avenues for diversification to international investors.

14.5 Concluding Observations and Managerial Implications

This paper analyzes long-run equilibrium relationship and short-run dependencies between three pairs of markets (i) developed and emerging markets (ii) developed and frontier markets and (iii) emerging and frontier markets over the time period of 2000–2017. The scope of this study is limited to developed markets of USA and UK and emerging and frontier markets of MENA region. Gregory and Hansen cointegration test and Geweke Measures of Feedback are employed to assess long run and short run relationship respectively.

Overall, the cointegration results suggest that investors must be cautious of including Turkey in the portfolio, as this market is well integrated with the developed equity markets of USA and UK. However, Egypt and Saudi Arabia are fairly segmented with both the developed markets under study. Further, both these emerging markets provide better risk-adjusted returns as compared to Turkey. Hence, this study recommends investing in emerging markets of Egypt and Saudi Arabia. The study advises against investment in Kuwait as this market is well integrated with both the developed markets and regional emerging markets under study. Hence, this market will yield limited diversification opportunities to investors.

An examination of short-run dependencies highlights increases in comovement between all pairs of markets during 2008 global financial crisis. Further, the results support the conjecture that frontier markets of MENA region like Bahrain, Jordan and Morocco are not very well integrated with the developed markets and the regional emerging markets. Hence these frontier markets offer investors the strategic flexibility to re-engineer their investment strategies and improve their financial performance (Tripathi et al. 2017).

The results of this study are expected to provide valuable inputs to international investors and portfolio managers in designing an optimal global portfolio. The study is also expected to facilitate policymakers of MENA region to formulate suitable resource mobilization and economic stabilization policies.

References

Arouri, M. E., & Nguyen, D. K. (2009). Time-varying characteristics of cross-market linkages with empirical application to Gulf stock markets. *Managerial Finance, 36*(1), 57–70.

Batareddy, M., Gopalaswamy, A. K., & Huang, Chia-Hsing. (2012). The stability of long-run relationships: A study on Asian emerging and developed stock markets (Japan and US). *International Journal of Emergency Medicine, 7*(1), 31–48.

Berger, D., Pukthuanthong, K., & Yang, J. J. (2013). Is the diversification benefit of frontier markets realizable by mean-variance investors? The evidence of investable funds. *The Journal of Portfolio Management, 39*(4), 36–48.

Cheng, A.-R., Jahan-Parvar, M. R., & Rothman, P. (2010). An empirical investigation of stock market behavior in the Middle East and North Africa. *The Journal of Empirical Finance, 17,* 413–427.

Chiang, T. C., Jeon, B. N., & Li, H. (2007). Dynamic correlation analysis of financial contagion: Evidence from Asian markets. *Journal of International Money and Finance, 26*(7), 1206–1228.

Demian, C. V. (2011). Cointegration in Central and East European markets in light of EU accession. *Journal of International Financial Markets, Institutions & Money, 21*(1), 144–155.

Dhanaraj, S., Gopalaswamy, A. K., & Babu, M. (2013). Dynamic interdependence between US and Asian markets: an empirical study. *Journal of Financial Economic Policy, 5*(2), 220–237.

Geweke, J. (1982). Measurement of linear dependence and feedback between multiple time series. *Journal of American Statistical Association, 77*(378), 304–313.

Graham, M., Kiviaho, J., Nikkinen, J., & Omran, M. (2013). Global and regional co-movement of the MENA stock markets. *Journal of Economics and Business, 65,* 86–100.

Gregory, A. W., & Hansen, B. E. (1996a). Practitioners corner: tests for cointegration in models with regime and trend shifts. *Oxford Bulletin of Economics and Statistics, 58*(3), 555–560.

Gregory, A., & Hansen, B. E. (1996b). Residual-based tests for cointegration in models with regime shifts. *Journal of Economics, 70*(1), 99–126.

Huyghebaert, N., & Wang, L. (2010). The co-movement of stock markets in East Asia: Did the 1997–1998 Asian financial crisis really strengthen stock market integration? *China Economic Review, 21*(1), 98–112.

Institute of International Finance. (2018). *MENA economic outlook: Gradual recovery, reforms underway*. Dubai: Institute of International Finance.

Kenourgios, D., & Samitas, A. (2011). Equity market integration in emerging Balkan markets. *Research in International Business and Finance, 25*(3), 296–307.

Khatoun, B. (2017, January). *Why MENA stock markets are likely to shine in 2017?* Retrieved February 2018, from ArabianBusiness.com. http://www.arabianbusiness.com/why-mena-stock-markets-are-likely-shine-in-2017-660224.html.

Lagoarde-Segot, T., & Lucey, B. M. (2007). International portfolio diversification: Is there a role for the Middle East and North Africa? *Journal of Multinational Financial Management, 17*(5), 401–416.

Maghyereh, A. I., Awartanib, B., & Hilu, K. A. (2015). Dynamic transmissions between the U.S. and equity markets in the MENA countries: New evidence from pre- and post-global financial crisis. *The Quarterly Review of Economics and Finance, 56,* 123–138.

Neaime, S. (2012). The global financial crisis, financial linkages and correlations in returns and volatilities in emerging MENA stock markets. *Emerging Markets Review, 13*(2), 268–282.

Rizvi, N. U., Kashiramka, S., & Singh, S. (2018). Basel I to Basel III: Impact of credit risk and interest rate risk of banks in India. *Journal of Emerging Market Finance 17*(1_suppl), S83–S111.

Sharma, A., & Seth, N. (2012). Literature review of stock market integration: a global perspective. *Qual Res Financ Mark, 4*(1), 84–122.

Syllignakis, M. N., & Kouretas, G. P. (2010). German, US and Central and Eastern European Stock Market Integration. *Open Economies Review, 21,* 607–628.

Thomas, N. M., Kashiramka, S., & Yadav, S. S. (2016). Dynamic linkages among developed, emerging and frontier equity markets of Europe. *Journal of Financial Management and Analysis, 29*(2), 51–66.

Thomas, N. M., Kashiramka, S., & Yadav, S. S. (2017). Dynamic linkages among developed, emerging and frontier capital markets of Asia Pacific region. *Journal of Advances in Management Research, 14*(3), 332–351.

Tripathi, M., Kashiramka, S., & Jain, P. K. (2017). Flexibility in measuring corporate financial performance, EVA versus conventional earnings measures: Evidences from India and China. *Global Journal of Flexible Systems Management* 1–16.

Valadkhani, A., & Chancharat, S. (2008). Dynamic linkages between Thai and international stock markets. *Journal of Economic Studies, 35*(5), 425–441.

Yu, J.-S., & Hassan, M. K. (2008). Global and regional integration of the Middle East and North African (MENA) stock markets. *The Quarterly Review of Economics and Finance, 48,* 482–504.

Zivot, E., & Andrews, D. (1992). Further evidence on the crash great crash, the oil price shock and the unit root hypothesis. *Journal of Business & Economic Statistics, 10*(3), 251–270.

Chapter 15
Beta, Size and Value Factors in the Chinese Stock Returns

Doha Belimam and Ghizlane Lakhnati

Abstract This paper evaluates the performance of the three-factor model and investigates the explanatory power of firm size and book-to-market ratio in the Shanghai A-share exchange market over the January 2011–December 2016 period. Our results are in line with the findings of Fama and French (1993) and support the superiority of the three-factor model over the CAPM.

Keywords Fama-French model · Capital asset pricing model · Shanghai exchange market

JEL Classification G1 · C5

15.1 Introduction

Over the last decade, the capital asset pricing model of Sharpe (1964), Lintner (1965), and Mossin (1966) (hereafter CAPM) has been of great interest in the financial scene. However, several studies have documented a host of anomalies, which means that beta alone cannot fully explain the variations in expected stock returns. Among those anomalies were the size factor (Banz 1981), book-to-market equity (Rosenberg et al. 1985), earnings-to-price ratio (Basu 1983) and financial leverage (Bhandari 1988). Based on these findings, Fama and French constructed a three-factor model (hereafter FF3FM) adding two variables to the CAPM: firm size and book-to-market ratio.

Fama and French (1993) conducted a comprehensive testing of the FF3FM in the developed markets and showed that both size and value factors explain the average stock returns in a meaningful matter. Our study is motivated by the use of the FF3FM as a benchmark in the developed markets and investigates the

D. Belimam (✉) · G. Lakhnati
Laboratory of Industrial and Computer Engineering, National,
School of Applied Sciences, Ibn Zohr University, Agadir, Morocco
e-mail: doha.belimam@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_15

explanatory power of the beta, size and value factors in the Shanghai A-share exchange market. We follow Fama and French' approach to constructing factors related to size and book-to-market and provide a new evidence as to the international applicability of the size and value as robust factors in asset pricing models.

15.2 Empirical Approach

Our stock data consists of monthly-adjusted closing prices and monthly returns on Shanghai A-share index and our sample covers the period from January 2011 to December 2016. The main data source is Datastream. We also included measures of market capitalization and book-to-market equity ratio. Following Fama and French' approach, we exclude stocks with negative or missing book-to-market values.

Two factor models are tested in our study: the CAPM (for comparability) and the FF3FM using Fama and French (1993, 1996) time series method. The CAPM takes the form:

$$R_i(t) = \alpha_i + \beta_i(Rm(t) - Rf(t)) + e_i(t) \tag{1}$$

The FF3FM takes the form:

$$R_i(t) = \alpha_i + \beta_i(Rm(t) - R_f(t)) + s_i SMB(t) + h_i HML(t) + e_i(t) \tag{2}$$

where $R_i(t)$ is the monthly excess return on a certain portfolio i for month t and $R_m(t)$ is the monthly return on the Shanghai A-share index. $R_f(t)$ is the return on the one-month interest rate. In China, the one-month interest rate is unavailable and replaced with the three-month interest rate divided by three. SMB represents the difference between a portfolio of small market capitalization stocks and a portfolio of big market capitalization stocks. HML is the difference each month between the returns of the two-high book-to-market portfolios and the returns of the two-low book-to-market portfolios. The factor loadings on each one of the variables are represented by β_i, s_i, and h_i respectively. $e_i(t)$ represents the error term.

Factor construction consists of sorting stocks on two size groups (breakpoint 50%) and three groups for the value factor (breakpoints 30 and 70%). Then we construct six portfolios from the combination of size and book-to-market portfolios.

15.3 Findings

In Table 15.1, SMB factor shows a significant positive mean return. This suggests that small capitalization stocks generate higher returns than stocks with big capitalization. By contrast, there does not appear to be any significance to the market and value factors in the Shanghai A-share exchange market, with both $(R_m - R_f)$ and HML showing return premiums not significantly different to zero.

Table 15.1 Summary statistics for factor returns

	$R_m - R_f$	SMB	HML
Mean	−0.66	1.04	−0.10
Std dev	7.23	3.32	3.36
t-mean	−0.78	2.66	−0.25

Monthly mean, standard deviation and t-mean statistics for each factor. Returns are from January 2011 to December 2016

Table 15.2 CAPM and FF3FM performance (2 × 3 size/book-to-market portfolios)

		GRS	$\|\alpha\|$	R^2		SE(α)
Panel A: GRS statistics						
CAPM		4.44	1.04	0.76		0.54
FF3FM		0.79	0.23	0.93		0.30
Panel B: Model performance						
	α			t(α)		
	Low	Medium	High	Low	Medium	High
CAPM						
Small	1.75	1.61	1.33	2.34*	2.31*	2.20*
Big	0.41	0.52	0.63	0.68	1.20	2.47*
FF3FM						
Small	0.33	0.31	0.05	1.32	0.94	0.15
Big	0.12	0.16	0.41	0.36	0.51	1.60

Panel A reports the GRS statistics of Gibbons et al. (1989), the average absolute for the intercepts ($|\alpha|$), the average adjusted R^2, and the average standard error for the intercepts (SE(α)). Panel B reports the intercepts, α, and the t-statistics, t(α), for each of the 6 size/book-to-market portfolios and for each of the CAPM and FF3FM models. * represents significance at the 1% level

Moving now to the regression on the CAPM and the FF3FM reported in Table 15.2. The FF3FM performs better than the CAPM. The addition of the size and value factors to the CAPM results in the GRS reducing from 4.44 (for the CAPM) to 0.79 (for the FF3FM) and the average value for the intercept reducing to 0.23 (from 1.04 for the CAPM). The adjusted R^2 improves significantly to 0.93 (0.76 for the CAPM), indicating that the FF3FM is the best performing model examined.

15.4 Discussion

The CAPM ultimately fails to explain the variations of average stock returns, but when the size and value factors are added to the model, a significant improvement is noticed. This suggests that the FF3FM performs better in describing average stock returns in the Shanghai A-share exchange market. Future research might investigate alternative asset pricing models that incorporate the investment and profitability factors to provide greater insight as to the best asset pricing factors.

References

Banz, R. W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics, 9*(1), 3–18.

Basu, S. (1983). The relationship between earnings' yield, market value and return for NYSE common stocks: Further evidence. *Journal of Financial Economics, 12*(1), 129–156.

Bhandari, L. (1988). Debt/equity ratio and expected common stock returns: Empirical evidence. *Journal of Finance*, *43*, 507–528.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3–56.

Fama, E. F., & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *The journal of finance, 51*(1), 55–84.

Gibbons, M. R., Ross, S. A., & Shanken, J. (1989). A test of the efficiency of a given portfolio. *Econometrica: Journal of the Econometric Society*, 1121–1152.

Lintner, J. (1965). Security prices, risk, and maximal gains from diversification. *The journal of finance, 20*(4), 587–615.

Mossin, J. (1966). Equilibrium in a capital asset market. *Econometrica: Journal of the econometric society*, 768–783.

Rosenberg, B., Reid, K., & Lanstein, R. (1985). Persuasive evidence of market inefficiency. *Journal of Portfolio Management*, *11*(3), 9–16.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance, 19*(3), 425–442.

Chapter 16
Volatility Between Oil Prices and Stock Returns of Dow Jones Index: A Bivariate GARCH (BEKK) Approach

Dimitrios Kartsonakis Mademlis and Nikolaos Dritsakis

Abstract The relationship between the oil prices and the stock market has occupied several researchers in recent years. Most papers show that stock markets are affected by oil price fluctuations, with few papers supporting the reverse direction. The causal relationships between stock markets and oil prices depend on symmetric and asymmetric changes in oil prices or focus on the unexpected changes in oil prices. In this paper we employ a bivariate BEKK-GARCH(1,1) model in order to estimate the conditional volatility between the oil prices and the stock market index Dow Jones. We are using daily returns from 21 October 1997 to 31 May 2017. The results of our work showed that there is neither transmission of shocks nor volatility spillover between the two markets. Moreover, it was found that the conditional volatility of the returns for both indices is affected only by their own shocks and their own lagged conditional volatility.

Keywords BEKK-GARCH model · Oil prices · Stock market
Volatility

JEL Classification G10 · C32

16.1 Introduction

The oil price is the one that most affects the state of the world economy. In particular, when the oil price increases, the production cost of all goods and services, as well as the transporting cost of these goods increase too. This rise will lead to inflationary pressures leading to a reduction in consumption, which in turn will

D. Kartsonakis Mademlis (✉) · N. Dritsakis
University of Macedonia, Thessaloniki, Greece
e-mail: jimskg@yahoo.gr

N. Dritsakis
e-mail: drits@uom.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_16

have a negative impact on capital markets. Therefore, there are many reasons why oil prices have a significant effect on both financial and stock markets. Thus, fluctuations in oil prices can directly affect stock prices through cash flows as well as through the discount rate. In addition, a change in the interest rates will affect the company financing via higher borrowing costs and a reduced market value relative to book value, which in turn will harm the ability of the company to raise new funds (Gomes and Chaibi 2014).

The complex relationship between stock markets and oil prices has attracted the interest of researchers, investors and policymakers in recent years. Analyzes and models related to oil prices and financial markets are of great importance to portfolio and asset managers and other financial analysts. The examination of fluctuation in oil prices and volatility spillover in stock markets is a crucial part of this issue.

The relationship between stock markets and the world oil price presents interesting empirical projects. The main economic reasons for the researchers and finance professionals behind the examination of such links associations are the potential effects of fluctuations in world oil prices on stock market indices via the impact on corporate profits and cash flows. The extent to which stock prices are influenced by global oil price fluctuations can be explained by the equity market valuation that sets the stock market prices as the sum of discounted prices of expected future cash flows across different investment horizons (Jouini 2013).

The layout of the paper is as follows. Section 16.2 reviews the literature, Sect. 16.3 describes the theoretical model used for estimation, Sect. 16.4 outlines data and descriptive statistics, Sect. 16.5 presents the empirical finding of the research and Sect. 16.6 concludes the study.

16.2 Literature Review

Many studies have examined the relationship between economic variables and oil prices. The impact on oil price changes is important in the global economy, and above all, in the development of the countries. Understanding the relationship between changes in oil prices and stock markets is of paramount importance for energy policy planning and diversification of portfolios. This relationship has recently been examined by some researchers. Hamilton (1983) was one of the first to document that oil price fluctuations regularly have a significant impact on economic activity in the United States. Interestingly, despite the early evidence of the effect of oil prices on economic activity, research on the effects of oil prices on stock markets took about a decade to begin seriously (Degiannakis et al. 2017).

Jones and Kaul (1996) then, revealed the negative effect of oil price on stock markets because the oil price is a risk factor for stock markets. Using quarterly data, they studied the impact of oil shocks on four developed stock markets on the basis of standard cash flow dividend valuation model. They found evidence of significant impacts of oil price shocks on corporate cash flow only in the US and Canada.

Huang et al. (1996) used a vector autoregression (VAR) approach to investigate the relationship between the stock returns of some US oil companies and changes in oil prices. However, in their work, they found no evidence of a link between oil prices and stock market indices like the S&P 500. In contrast, Sadorsky (1999), using a VAR, showed that oil prices play an important role in the impact of economic activity. Sadorsky focused on the US market and mentioned that positive oil price changes are associated with declining stock market returns. In addition, Asteriou and Bashmakova (2013) focused on emerging stock markets and stated that stock market returns in Central and Eastern European countries (CEECs) are negatively affected by positive oil price innovations.

Finally, Choi and Hammoudeh (2010) employed a Markov-Switching GARCH model to measure the return volatility for five strategic commodity prices (copper, gold, silver, Brent oil, West Texas Intermediate oil) and the US stock market. Their findings showed that the duration of low volatility regime for the five commodities and the US stock market was longer than that of high volatility regime (excluding gold).

16.3 Empirical Methodology

The GARCH models have been used by many researchers for volatility modeling and forecasting the returns of time series. In the case that we are interesting to investigate the volatility interdependence and the transmission mechanisms between different time series, we can use the BEKK-GARCH model as originally formulated by Baba et al. (1990) and completed by Engle and Kroner (1995).

The first step for the bivariate methodology of the GARCH models is to determine the mean equations. Hence, these equations for the oil prices and for the stock market index are given as follows:

$$r_{it} = \mu_i + u_{it} \tag{16.1}$$

where,

r_{it} is the daily return at time t.
μ_i is a long term drift coefficient.
u_{it} is the error term for the return on index i at time t.

In this paper, we employ a multivariate GARCH model to estimate the conditional variance of oil prices and Dow Jones index. In addition, we use the BEKK parameterization of the bivariate GARCH model, which does not impose the restriction of constant correlation among variables over time. The BEKK model addresses the difficulty with VECH of ensuring that the H matrix is always positive definite by incorporating quadratic forms. The BEKK parameterization for the multivariate GARCH model is given by:

$$H_t = W'W + \sum_{k=1}^{K}\sum_{q=1}^{q} A'_{ik}\Xi_{t-i}\Xi'_{t-i}A_{ik} + \sum_{k=1}^{K}\sum_{p=1}^{p} B'_{ik}H_{t-i}B_{ik}$$

where,

W is a lower triangular matrix and A and B are $n \times n$ parameter matrices. For illustrative purposes, we will only consider the case $p = q = K = 1$, which is also the mostly applied model's order. Thus, the expression for conditional variance-covariance is:

$$H_t = W'W + A'\Xi_{t-1}\Xi'_{t-1}A + B'H_{t-1}B \tag{16.2}$$

The individual elements for H_t, Ξ_t, W, A and B matrices in the bivariate case are given as:

$$H_t = \begin{bmatrix} h_{11t} & h_{12t} \\ h_{21t} & h_{22t} \end{bmatrix},$$
$$\Xi_t = \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix},\ W = \begin{bmatrix} w_{11} & 0 \\ w_{21} & w_{22} \end{bmatrix},\ A = \begin{bmatrix} a_{11t} & a_{12t} \\ a_{21t} & a_{22t} \end{bmatrix},\ B = \begin{bmatrix} b_{11t} & b_{12t} \\ b_{21t} & b_{22t} \end{bmatrix} \tag{16.3}$$

The A matrix shows the extent to which conditional variances are correlated with past squared errors. So, the elements of A matrix capture the effects of shocks on conditional variances (volatility). The B matrix shows how current levels of conditional variances are affected by past conditional variances. In other words, the diagonal parameters of the matrices A and B (i.e., a_{ij} and b_{ij}, $i = j$) measure the impact of own past shocks and past volatility of market i on its conditional variance. While, the off-diagonal elements of the matrices A and B (i.e., a_{ij} and b_{ij}, $i \neq j$) depict how the past squared error and conditional variance of one market i affects the conditional variance of another market j, also known as volatility spillovers (Yonis 2011).

The conditional variance for each equation can be expanded for the bivariate BEKK-GARCH(1,1) as:

$$\begin{aligned} h_{11t} = {} & w_{11}^2 + a_{11}^2u_{1t-1}^2 + 2a_{11}a_{21}u_{1t-1}u_{2t-1} + a_{21}^2u_{2t-1}^2 + b_{11}^2h_{11t-1} + 2b_{11}b_{21}h_{12t-1} \\ & + b_{21}^2h_{22t-1} \end{aligned} \tag{16.4}$$

$$\begin{aligned} h_{12t} = {} & w_{11}w_{21} + a_{11}a_{12}u_{1t-1}^2 + (a_{21}a_{12} + a_{11}a_{22})u_{1t-1}u_{2t-1} + a_{21}a_{22}u_{2t-1}^2 \\ & + b_{11}b_{12}h_{11t-1} + (b_{21}b_{12} + b_{11}b_{22})h_{12t-1} + b_{21}b_{22}h_{22t-1} \end{aligned} \tag{16.5}$$

$$\begin{aligned} h_{22t} = {} & w_{21}^2 + w_{22}^2 + a_{12}^2u_{1t-1}^2 + 2a_{12}a_{22}u_{1t-1}u_{2t-1} + a_{22}^2u_{2t-1}^2 + b_{12}^2h_{11t-1} \\ & + 2b_{12}b_{22}h_{12t-1} + b_{22}^2h_{22t-1} \end{aligned} \tag{16.6}$$

where,

(16.4) and (16.6) are the variance equations of 1st and 2nd series, respectively. (16.5) is the covariance equation and $h_{12t} = h_{21t}$.

Equations (16.4), (16.5) and (16.6) reveal how shocks and volatility are transmitted across series and over time (Malik and Hammoudeh 2007). The coefficient[1] terms in Eqs. (16.4) and (16.6) are a non-linear function of the estimated elements of Eq. (16.2).

The following likelihood function is maximized assuming normally distributed errors:

$$L(\theta) = -T\log 2\pi - \frac{1}{2}\sum_{t=1}^{T}\left(\log|H_t| + \Xi_t' H_t^{-1}\Xi_t\right) \tag{16.7}$$

where,

T is the number of observations and θ represents the parameter vector to be estimated. We have to underline here that the H matrix, that is the estimation of our bivariate system, is calculated by Broyden (1970), Fletcher (1970), Goldfarb (1970) and Shanno (1970) numerical optimization algorithm (BFGS) to obtain the maximum likelihood estimates of the parameters.

16.4 Data

The data set comprises daily closing prices for the Dow Jones[2] Industrial Average index and for the crude oil Brent.[3] We choose the Brent crude oil as it accounts for the 60% of the world oil daily production (Maghyereh 2006). Both indices cover the period from 21/10/1997 to 31/05/2017 (5094 observations). The daily returns of the stock market and oil indices are calculated as follows:

$$r_t = \ln\left(\frac{Y_t}{Y_{t-1}}\right) \times 100 = [\ln(Y_t) - \ln(Y_{t-1})] \times 100 \tag{16.8}$$

where,

Y_t is the daily closing price of the stock market and oil indices at day t.
Y_{t-1} is the daily closing price of the stock market and oil indices at day $t-1$.
r_t is the daily return of stock market and oil indices at day t, respectively.

Table 16.1 presents the descriptive statistics of Dow Jones' and Brent's closing prices and returns. The histograms of the variables are presented in Fig. 16.1 in the

[1]A first-order Taylor expansion around the mean was used in order to calculate the standard errors for these coefficient terms (see Kearny and Patton 2000).

[2]Dow Jones Industrial Average data was collected by Yahoo Finance Database (^DJI).

[3]Crude oil Brent data was collected by U.S. Energy Information Administration (EIA) Database.

Table 16.1 Descriptive statistics of the indices

	Dow Jones closing prices	Dow Jones returns	Brent closing prices	Brent returns
N	5094	5093	5094	5093
Mean	12071.6	0.019	59.01	0.018
Median	10972.18	0.018	53.27	0.00
Minimum	6547.05	−8.20	9.1	−19.89
Maximum	21115.55	10.51	143.95	18.13
Stand. Dev.	3160.1	1.14	33.91	2.3
Skewness	0.93	−0.15	0.43	−0.018
Kurtosis	2.99	11.13	1.94	7.97
Jarque-Bera	737.49*	14051*	395.19*	5258*
ADF	−0.0914(1)	−54.4499*(1)	−1.5609(0)	−70.1954*(0)
$Q(24)$		75.388*		47.481*
$Q^2(24)$		6175.1*		936.11*

Notes N is the number of observations

ADF denotes the Augmented Dickey-Fuller tests (Dickey and Fuller 1979, 1981)

The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals

The lag lengths for ADF equations were selected using Schwarz Information Criterion (SIC)

MacKinnon (1996) critical values for rejection of the hypothesis of unit root applied

*indicates statistical significance at 1%

$Q(24)$ and $Q^2(24)$ are the Ljung-Box statistics for serial correlation and conditional heteroskedasticity of the series at 24th lags (Ljung and Box 1978)

Appendix. Both indices' closing prices are exhibit evidence of positive skewness. While the opposite pattern exists in the series' returns i.e., in all cases the series show negative skewness. Both series' returns are also leptokurtic (kurtosis >3) with fat tails, a fairly common occurrence in high-frequency financial data. The Jarque-Bera statistic rejects the null hypothesis of normality in all cases of closing prices and returns. Regarding the unit roots, the Augmented Dickey-Fuller (1979, 1981) tests with only a constant, determine that returns of the series are stationary in their levels (integrated of zero order, $I(0)$). Moreover, the Q-statistics of Ljung-Box indicates the presence of serial correlation in the returns of the series we considered. Finally, the Q^2-statistics provide strong evidence of conditional heteroskedasticity for all cases. Therefore, the choice of a GARCH class model is adequate for capturing any persistence in the volatility of stock and oil markets we consider (Arouri et al. 2011).

Figures 16.2a, b present plots of the Dow Jones' and Brent's closing prices and returns, respectively. First, upon close inspection, it appears that for each returns' series there is volatility clustering. This phenomenon according to Mandelbrot (1997) is defined as "*large changes tend to be followed by large changes—of either sign—and small changes tend to be followed by small changes*". Second, it seems that the two returns' series exhibit periods of low volatility and periods of high volatility around the same time. For example, each series experienced low volatility between 02/2004 and 03/2007 and between 04/2012 and 08/2014, while a period of high volatility occurs between 04/2008 and 03/2010 in both series. The latter observation is just a hint of volatility spillovers based on visual examination of the

Table 16.2 The estimated equations of the BEKK-GARCH(1,1)

Dow Jones conditional variance equation							
$h_{11t} =$	0.016 +	$0.085u^2_{1t-1} +$	$0.001u_{1t-1}u_{2t-1} +$	$0.000u^2_{2t-1} +$	$0.903h_{11t-1} +$	$0.000h_{12t-1} +$	$0.000h_{22t-1}$
	0.0024	0.007	0.0034	3.51×10^{-5}	0.0082	0.0026	5.67×10^{-8}
	[6.645]	[11.02]	[0.479]	[0.238]	[110.1]	[0.016]	[0.008]
	(0.000)	(0.000)	(0.631)	(0.811)	(0.000)	(0.986)	(0.993)
Brent conditional variance equation							
$h_{22t} =$	0.011 +	$0.000u^2_{1t-1} -$	$0.009u_{1t-1}u_{2t-1} +$	$0.039u^2_{2t-1} +$	$0.000h_{11t-1} +$	$0.002h_{12t-1} +$	$0.960h_{22t-1}$
	0.0040	0.0011	0.0107	0.0041	2.54×10^{-5}	0.0168	0.0041
	[2.750]	[0.407]	[-0.079]	[9.524]	[0.085]	[0.171]	[231.9]
	(0.005)	(0.683)	(0.424)	(0.000)	(0.931)	(0.864)	(0.000)

Notes h_{11} and h_{22} denote the conditional variance of the Dow Jones and Brent returns series, respectively. Directly below the estimated coefficients, the corresponding standard errors, t-values (in brackets) and p-values (in parentheses) are given. The mean equations include a constant term series. In order to deduce trustworthy results we have to proceed to a more formal time-series examination that permits for the variance of each series to change over time and that is capable of capturing volatility spillovers between the stock and oil markets, which is the BEKK model.

16.5 Empirical Results

Table 16.3 reports parameter estimates for the BEKK-GARCH(1,1)[4] model as well as the descriptive statistics of the obtained standardized residuals of the indices. Regarding the equations derived from the estimated coefficients, Table 16.2 shows that the squared off-diagonal elements of matrices A and B i.e. a_{12}, a_{21}, b_{12} and b_{21} are not statistically significant which imply that there are not cross-market effects of shocks and volatility spillover between oil and stock market in either direction.

More specifically, our findings support that the volatility (conditional variance) in stock market returns is directly affected (i.e. caused) by its own shocks (significant coefficient on u_1^2) and volatility (significant coefficient on h_{11}). The same applies to the volatility of crude oil returns (significant coefficients on both u_2^2 and h_{22}).

It's important to underline here that higher levels of conditional volatility in the past are associated with higher conditional volatility in the current period on both markets (positive and significant coefficients on h_{11} and h_{22} in Dow Jones' and Brent's variance equations, respectively). Our results do not indicate that volatility in Dow Jones returns is affected by shocks originating in the oil market (insignificant coefficient on u_2^2), as well as, volatility in Brent returns is not affected by shocks originating in the stock market (insignificant coefficient on u_1^2). Moreover, the insignificant coefficients on h_{22} (in Dow Jones' equation) and h_{11} (in Brent's equation) indicate that the current volatility of Dow Jones is not directly affected by the lagged volatility of Brent and vice versa. In addition, the estimated coefficients on the cross-error term $(u_1 u_2)$ and on the covariance term (h_{12}) are not significant, suggesting the absence of an indirect effect of shocks and volatility spillover between the two indices.

From our findings, we can also derive that Dow Jones' own shock effect (0.085) on current volatility is higher than Brent's own shock effect (0.039). Whereas, oil market is affected more by its own lagged volatility (0.960) when it is compared with the stock market (0.903).

The multivariate Q-statistics for the autocorrelations of standardized residuals are significant, while the multivariate ARCH tests show the existence of remaining ARCH effects (Table 16.3). As for the structures in the standardized residuals, the model performs well as the kurtosis has been reduced and there are no remaining autocorrelations in both cases (Table 16.3). While, only in the case of Brent's standardized residuals, the Q^2-statistic indicates that there are still remaining ARCH effects. Figure 16.3 (in the Appendix) presents the plots of estimated variances and

[4]«1» indicates the stock market (Dow Jones) and «2» indicates the oil market (Brent).

Table 16.3 BEKK-GARCH (1,1) estimates and descriptive statistics of obtained standardized residuals

Parameters				
μ_1		0.050 (0.000)	Standardized residuals of Dow Jones	
μ_2		0.033 (0.177)	Skewness	−0.4397
W(1,1)	w_{11}	0.126 (0.000)	Kurtosis	4.9376
W(2,1)	w_{21}	0.032 (0.182)	Jarque-Bera	960.891 (0.000)
W(2,2)	w_{22}	0.101 (0.000)	$Q(12)$	11.822 (0.460)
A(1,1)	a_{11}	0.291 (0.000)	$Q(24)$	23.803 (0.472)
A(1,2)	a_{12}	-0.022 (0.320)	$Q^2(12)$	14.298 (0.282)
A(2,1)	a_{21}	0.003 (0.636)	$Q^2(24)$	20.762 (0.653)
A(2,2)	a_{22}	0.198 (0.000)	Standardized residuals of Brent	
B(1,1)	b_{11}	0.950 (0.000)	Skewness	-0.1950
B(1,2)	b_{12}	0.001 (0.837)	Kurtosis	5.0413
B(2,1)	b_{21}	0.000 (0.988)	Jarque-Bera	916.610 (0.000)
B(2,2)	b_{22}	0.980 (0.000)	$Q(12)$	10.486 (0.573)
Log Likelihood		-17798.614	$Q(24)$	21.521 (0.607)
Multivariate $Q(5)$		32.2672 (0.040)	$Q^2(12)$	31.205 (0.002)
Multivariate ARCH(5)		300.48 (0.000)	$Q^2(24)$	45.404 (0.005)

Notes Multivariate Q is the variant of the multivariate Q statistic of Hosking (1981) and we computed it through the @MVQSTAT command of RATS software with 5 lags

Multivariate ARCH is a procedure for testing a set of series for multivariate ARCH effects and we implemented it through the @MVARCHTEST command of RATS software with 5 lags

$Q(i)$ and $Q^2(i)$ are the Ljung-Box statistics for serial correlation and conditional heteroskedasticity of the series at ith lags (Ljung and Box 1978)

covariances. We can comment here that, as we expected, the variances of both indices have a significant spike during the financial crisis (2007–2008).

16.6 Summary and Concluding Remarks

In this paper, we have employed a bivariate BEKK-GARCH(1,1) model to generate the conditional variances of daily Dow Jones and Brent indices. We then used these variances to examine the causal relationship between the two series. The results of our work showed that there is no any causal relationship between the volatilities of crude oil and Dow Jones. This result is in full agreement with the findings of Ewing and

Malik (2016) when they did not take into account structural breaks of their series. Furthermore, it was found that the conditional volatility of the returns for both indices is affected only by their own shocks and their own lagged conditional volatility.

Appendix

(Figures 16.1, 16.2 and 16.3).

Fig. 16.1 Histograms of the indices

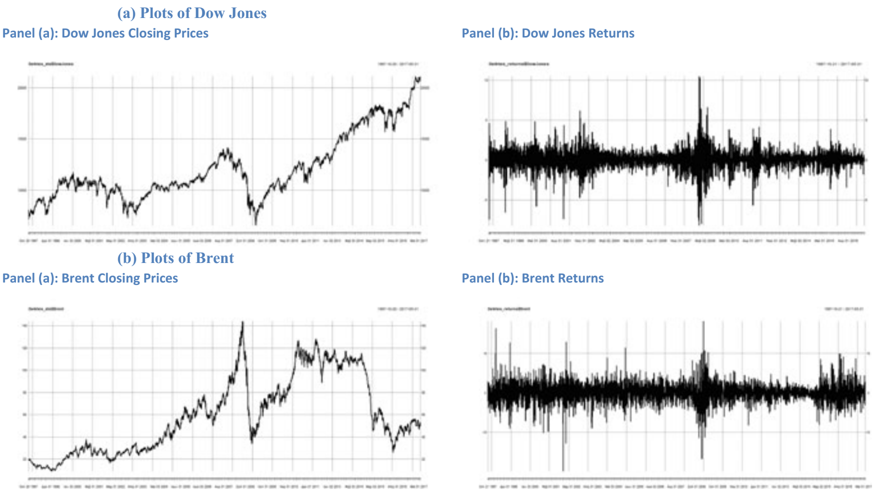


Fig. 16.2 **a** Plots of Dow Jones. **b** Plots of Brent

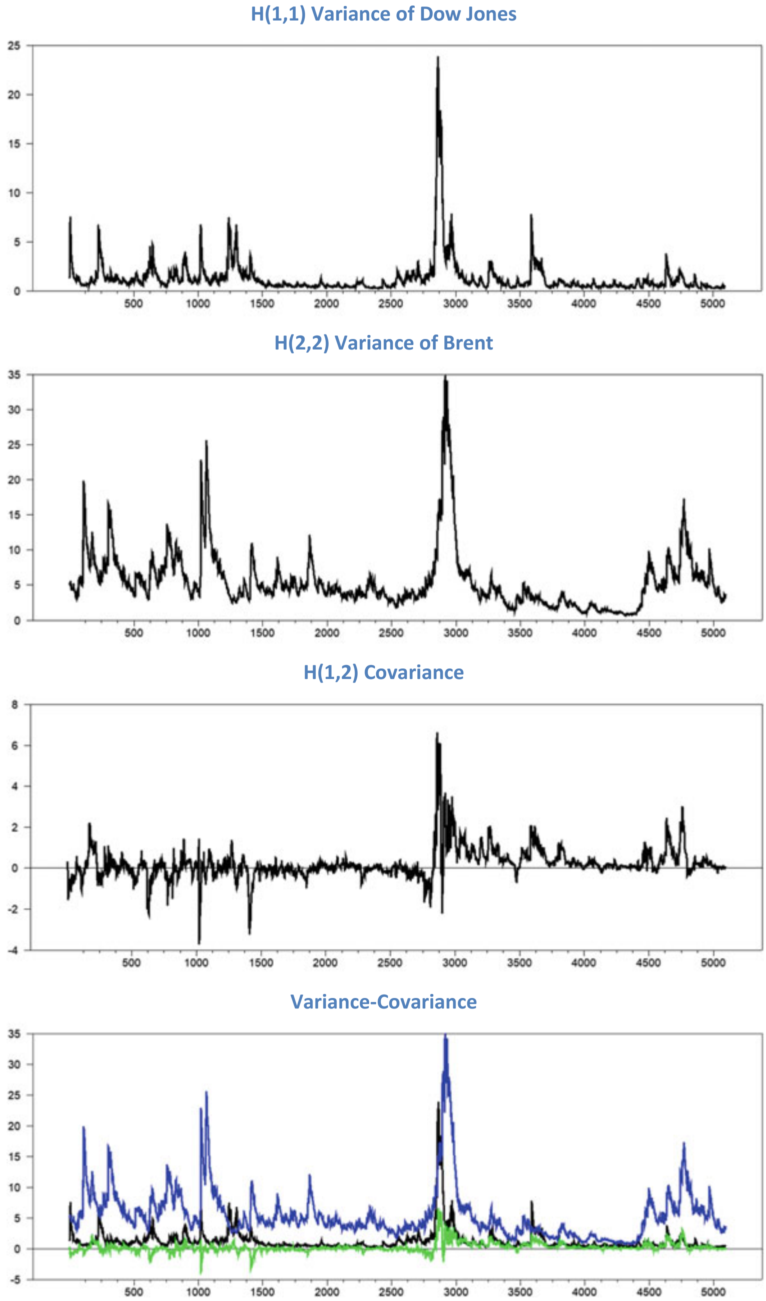


Fig. 16.3 Plots of variances-covariances between the stock and oil market for the full sample. *Notes* Black = Variance of Dow Jones. Blue = Variance of Brent. Green = Covariance of the indices

References

Arouri, M. E. H., Lahiani, A., & Nguyen, D. K. (2011). Return and volatility transmission between world oil prices and stock markets of the GCC countries. *Economic Modelling, 28*(4), 1815–1825.

Asteriou, D., & Bashmakova, Y. (2013). Assessing the impact of oil returns on emerging stock markets: A panel data approach for ten Central and Eastern European Countries. *Energy Economics, 38,* 204–211.

Baba, Y., Engle, R. F., Kraft, D., & Kroner, K. (1990). *Multivariate simultaneous generalized ARCH*. San Diego: Mimeo, Department of Economics, University of California.

Broyden, C. G. (1970). The convergence of a class of double-rank minimization algorithms 1. General considerations. *IMA Journal of Applied Mathematics, 6*(1), 76–90.

Choi, K., & Hammoudeh, H. (2010). Volatility behavior of oil, industrial, commodity and stock markets in a regime-switching environment. *Energy Policy, 38,* 4388–4399.

Degiannakis, S., Filis, G., & Arora, V. (2017). Oil prices and stock markets, Working Paper, Independent Statistics & Analysis U.S. Energy Information Administration, Washington.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366a), 427–431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057–1072.

Engle, R. F., & Kroner, K. F. (1995). Multivariate simultaneous generalized ARCH. *Econometric Theory, 11*(1), 122–150.

Ewing, B. T., & Malik, F. (2016). Volatility spillovers between oil prices and the stock market under structural breaks. *Global Finance Journal, 29,* 12–23.

Fletcher, R. (1970). A new approach to variable metric algorithms. *The Computer Journal, 13*(3), 317–322.

Goldfarb, D. (1970). A family of variable-metric methods derived by variational means. *Mathematics of Computation, 24*(109), 23–26.

Gomes, M., & Chaibi, A. (2014). Volatility spillovers between oil prices and stock returns: A focus on frontier markets. *The Journal of Applied Business Research, 30*(2), 509–526.

Hamilton, D. J. (1983). Oil and the macroeconomy since World War II. *The Journal of Political Economy, 9,* 228–248.

Hosking, J. R. (1981). Fractional differencing. *Biometrika, 68*(1), 165–176.

Huang, R. D., Masulis, R. W., & Stoll, H. R. (1996). Energy shocks and financial markets. *Journal of Futures Markets, 16,* 1–27.

Jones, C. M., & Kaul, G. (1996). Oil and the stock markets. *Journal of Finance, 51,* 463–491.

Jouini, J. (2013). Return and volatility interaction between oil prices and stock markets in Saudi Arabia. *Journal of Policy Modeling, 35*(6), 1124–1144.

Kearney, C., & Patton, A. J. (2000). Multivariate GARCH modeling of exchange rate volatility transmission in the European monetary system. *Financial Review, 35*(1), 29–48.

Ljung, G. M., & Box, G. E. (1978). On a measure of lack of fit in time series models. *Biometrika, 65*(2), 297–303.

MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of applied econometrics*, 601–618.

Maghyereh, A. (2006). Oil price shocks and emerging stock markets: A generalized VAR approach. In *Global stock markets and portfolio management* (pp. 55–68). Palgrave Macmillan, London.

Malik, F., & Hammoudeh, S. (2007). Shock and volatility transmission in the oil, US and Gulf equity markets. *International Review of Economics & Finance, 16*(3), 357–368.

Mandelbrot, B. B. (1997). The variation of certain speculative prices. In *Fractals and scaling in finance* (pp. 371–418). Springer, New York, NY.

Sadorsky, P. (1999). Oil price shocks and stock market activity. *Energy Economics, 21,* 449–469.

Shanno, D. F. (1970). Conditioning of quasi-Newton methods for function minimization. *Mathematics of Computation, 24*(111), 647–656.

Yonis, M. (2011). Stock market co-movement and volatility spillover between USA and South Africa. Master Thesis, UMEA University.

Chapter 17
The Dynamic Relationship of Defense Expenditure, Energy Consumption, and Economic Growth in Indonesia

Muhammad Fikruzzaman Rahawarin, Amarulla Octavian and Supandi Halim

Abstract It has been understood that energy consumption and defense expenditure have an impact on economic growth. However, it is still unclear which aspect has a bigger effect towards another, especially in each country. This study aims to analyze causal relationship amongst those aspects in Indonesia for a period of 1986–2016. Auto-regressive Distributed Lag (ARDL) bound testing approach was used to determine the co-integration in the short-run and the long-run. The result shows that co-integration exist within economic growth and energy consumption, while Granger Causality also exists between defense expenditure to economic growth and economic growth towards energy consumption.

Keywords ARDL · Bound test · Defense expenditure · Economic growth
Energy consumption · Granger causality

17.1 Introduction

Energy is one of the determinant sectors that drive the economic activities of a country. Most of the productive sectors require energy to support their respective activities, including the defense sector. Robustness of the defense sector inherently needs more than adequate budget, which categorized as one of the components of government expenditure. Furthermore, increase in the defense expenditure derivatively contributes to government expenditure, which corresponds to economic growth. The trilateral relationship amongst those three sectors is considered as complex to one another.

M. F. Rahawarin (✉) · A. Octavian · S. Halim
Faculty of Defense Management, Indonesia Defense University, Bogor, Indonesia
e-mail: muhammad.rahawarin@mp.idu.ac.id

A. Octavian
e-mail: amarulla.octavian@idu.ac.id

S. Halim
e-mail: supandi@idu.ac.id

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_17

The complexity was reflected by the variance of relationship in each case. Although there is a correlation between and amongst those three variables, it was not necessarily proved that causality relationship exists as well. Studies have been consistently proved that there is a strong relationship between energy consumption and economic growth. Stern (2010), argued that energy inputs have provided an important role in economic growth both in emerging and industrialized countries.

The complexity existed as well on the economic growth relationship with defense expenditure. Defense expenditure can stimulate the economy through the Keynesian multiplier mechanism, especially in the period of high unemployment, which increase aggregate demand. However, this theory was not certainly occurred practically. Although since 1987 world defense expenditure has exceeded for more than the US $ one trillion for the very first time (Frederiksen 1991), it still can affect economic growth on both outcome. An expansion of aggregate demand or through increase security could affect economic growth in a positive way (Hassan et al. 2003), contradictory if utilizing a crowding out investment (Deger and Sen 1983).

Further, there is only one outcome on the relationship between energy consumption and defense expenditure. Defense, as the proxy of defense expenditure, has a positive impact tendency towards energy consumption. Since World War II to Operation Desert Storm in 1991, energy consumption had multiplied four times from 1 to 4 gallons per day per soldier (LMI Report 2007). The evolution of war was also identified as the catalyst for the significant increase of energy demand (Saritas and Burmaoglu 2016).

Interrelationship among economic growth, energy consumption, and defense expenditure that are complex also consisted in Indonesia. Following the Asian crisis in 1998, which happened to transformed political and defense regime, Indonesia slowly but successfully stabilize the economic condition, not more than five years later. Since then, the economic growth relatively stagnant on the growth rate of five percent. This has caused high energy consumption in Indonesia due to the increasing standard of living, population growth, and high urbanization rate. Meanwhile, despite its volatile growth rate, defense expenditure has an average of growth around 30% for 30 years period. However, it was not necessarily fulfilled the essential allocation based on the rule of thumb on defense expenditure, that is 1% of Gross Domestic Product (GDP). Furthermore, it was still far from the Department of Defense of Indonesia of whom sets 2.2% of GDP as a target for 2015 and slowly increasing to 3.14% of GDP on 2024 (Indonesia Defense Posture Book, 2015) (Fig. 17.1).

This paper aims to examine the causal relationship amongst economic growth, energy consumption, and defense expenditure in Indonesia using annual data for period 1986 to 2016. It is worth to note that no one has ever done a study that measured causality between the variables in Indonesia. Auto-regressive Distributed Lag (ARDL) method was used to determine if those three variables are co-integrated for Indonesia in the certain period after unit test root was implemented. Granger Causality was used as a complementary test for measuring the causality. Lastly, forecast-error variance decomposition technique were applied to test the strength of causality test.

Next section highlights previous studies that discussing the relationship between and amongst the variables. The source and characteristics of data as well as the methodology used in this paper were discussed in the third section. After that,

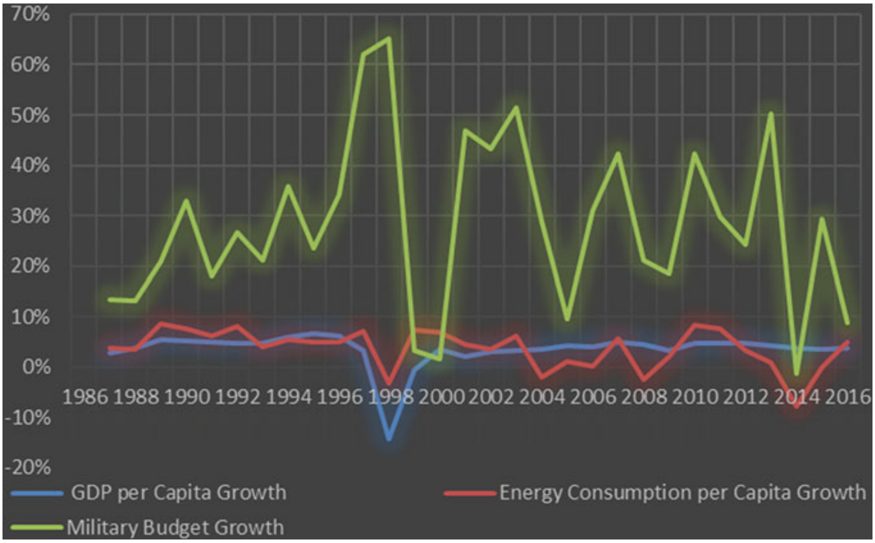


Fig. 17.1 The growth of GDP per capita, energy consumption per capita, and defense expenditure of Indonesia (1986–2016)

interpretation of the empirical result was explained before move on to conclusion and policy implications.

17.2 Previous Studies

It was hard to find empirical findings that coherently emphasize the causality relationship amongst the variables. It is not only because it was quite rare to combine them at once, but also most of the studies only show the connection between two of the three variables. Azam et al. (2015) confirmed that the causality from GDP to energy consumption is more predominant in the OECD/developed countries. Although Shahbaz et al. (2013), have identified that energy consumption and economic growth granger cause each other.

Further, the role of energy as a global commodity is highly imperative and a vital determinant of economic growth and development, including in developing countries, such as Indonesia. There is an uni-directional Granger Causality in the long-run from energy consumption and energy prices to income for Indonesia (Asafu-Adjaye 2000). It was different with what Yoo (2006) and Hwang and Yoo (2012), who consecutively argued that there is an uni-directional causality runs from economic growth to electricity (as part of energy) consumption in Indonesia without any feedback effects. Jafari et al. (2012) also empirically find it different with no causality effects on each other.

In the relationship of defense expenditure and economic growth, Benoit Hypothesis was one of the most prominent argument that proved the defense expenditure stimulates economic growth, along with Joerding (1986). Meanwhile, Aizenman and Glick (2006) emphasized that defense expenditure without threats would only reduce growth, while defense expenditure in the presence of sufficiently large threats increases growth. In Indonesia, Frederiksen (1991) found the results that indicate that defense expenditure granger causes economic growth, which strengthens by Hirnissa, et al. (2008) in the long-run.

In terms of energy consumption and defense sector relationship, LMI Report (2007) emphasizes that energy consumption on defense sector has quadrupled since between World War II and Desert Storm Operation. Meanwhile, Clark et al. (2010) revealed that high-tech militarization in the form of defense expenditures per soldier increases the scale of energy consumption. The expansion and development of high-tech equipment and vehicles have increased the energy demands of the military, as enormous quantities of fossil fuels are required to operate the planes, ships, tanks, helicopters, and vehicles of the armed force.

The only study that directly measured causality relationship amongst those three variables is Bildirici (2016), who argues that the increase of defense expenditure and energy consumption has a positive and a statistically significant impact on economic growth in China and proving that there are significant causal relations amongst variables.

17.3 Data and Methodology

17.3.1 Data

The data used in this study covered real GDP per capita (gdp), primary energy consumption per capita (enercons), and defense expenditure (defex) from 1986 to 2016 period for Indonesia as variables used. Data of GDP per capita was obtained from World Bank, while Defense Expenditure data was gathered from Stockholm International Peace Research Institute (SIPRI). Both were measured at Indonesian Rupiah (IDR) 2010 constant price. Primary energy consumption data was obtained from British Petroleum Statistical Review of World Energy 2017 with kilogram of oil equivalent (kgoe) as the measuring unit, subject to population data from World Bank. All of the data used in this study were transformed into natural logarithm to minimize the skewness in the data.

17.3.2 Methodology

17.3.2.1 Unit Root Test

Augmented Dickey-Fuller (ADF) is commonly used as stationarity examiner of the time series data because the use of non-stationary data in causality tests can lead to spurious results. ADF is commonly used because of its easy applicability (Nkoro and Uko 2016). The ADF test is measured using equation as follows:

$$\Delta Yt = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{k} d_j \Delta Y_{t-1} + \varepsilon_t \tag{17.1}$$

where Δ is the first difference, ΔY_t is a variable with time t, α_0 is the constant, k is the optimum numbers of lags of the dependent variables, and ε_t is pure white noise term.

17.3.2.2 Auto-Regressive Distributed Lag (ARDL) Model

Pesaran and Shin (1999) and Pesaran et al. (2001) in Shahbaz et al. (2013) developed co-integration technique to determine the long run relationship between series with a different order of integration. There are six advantages of using ARDL. First, all variables are assumed endogenous, which means it is free of residual correlation. Secondly, when there is a single long-run relationship, the ARDL procedure can distinguish between dependent and explanatory variables. Third, the identification of the co-integrating vectors.

Following that, the Error Correction Model (ECM), can be derived from ARDL model through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information. Fifth, the model seems flexible regarding the stationarity properties of the variables and is more suitable once variables are found to be stationary at I(1) or I(0) or I(1)/I(0). Lastly, the ARDL model provides robust results in small sample size (Hirnissa et al. 2008). The ARDL models for the standard log-linear used to measure the long-term co-integration are shown as follows:

$$\begin{aligned}\Delta \mathrm{In}\, GDP_t &= \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta \mathrm{In}\, GDP_{t-i} + \sum_{i=1}^{n} \beta_i \Delta\, enercons_{t-i} \\ &+ \sum_{i=1}^{p} \beta_i \Delta \mathrm{In}\, defex_{t-i} + \delta_1 \mathrm{In}\, GDP_{t-i} + \delta_2 \mathrm{In}\, enercons_{t-i} + \delta_2 \mathrm{In}\, defex_{t-i} + \varepsilon_{1t}\end{aligned} \tag{17.2}$$

$$\begin{aligned}\Delta \mathrm{In}\, enercons_t &= \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta \mathrm{In}\, enercons_{t-i} + \sum_{i=1}^{m} \beta_i \Delta GDP_{t-i} \\ &+ \sum_{i=1}^{p} \beta_i \Delta \mathrm{In}\, defex_{t-i} + \delta_1 \mathrm{In}\, enercons_{t-i} + \delta_2 \mathrm{In}\, GDP_{t-i} + \delta_3 \mathrm{In}\, defex_{t-i} + \varepsilon_{2t}\end{aligned} \tag{3}$$

$$\Delta \,\text{In}\, defex_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta \, In\, defex_{t-i} + \sum_{i=1}^{m} \beta_i \, \Delta \, GDP_{t-i} + \sum_{i=1}^{n} \beta_i \Delta \,\text{In}\, enercons_{t-i} + \delta_1 \, In\, defex_{t-i} + \delta_2 \, In\, GDP_{t-i} + \delta_3 \, In\, enercons_{t-i} + \varepsilon_{3t} \tag{17.4}$$

where Δ is the first different operator and ε represents the white noise term. The lag selection is based on Schwartz Criterion (SC), while the bounds testing will be based on the joint F-statistic to examine the long-run relationship.

17.3.2.3 Error Correction Model (ECM)

The ECM can be specified accordingly as follows:

$$\Delta \ln GDP_t = \alpha_0 + \sum_{i=1}^{m} \theta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=1}^{n} \theta_{2i} \Delta \, enercons_{t-i} + \sum_{i=1}^{p} \theta_{3i} \Delta \ln defex_{t-i} + \varsigma_{1i} ECM_{t-1} + e_t \tag{17.5}$$

$$\Delta \ln defex_t = \alpha_0 + \sum_{i=1}^{n} \lambda_{1i} \Delta \ln enercons_{t-i} + \sum_{i=1}^{m} \lambda_{2i} \Delta \, GDP_{t-i} + \sum_{i=1}^{p} \lambda_{3i} \Delta \ln defex_{t-i} + \varsigma_{2i} ECM_{t-1} + e_t \tag{17.6}$$

$$\Delta \ln defex_t = \alpha_0 + \sum_{i=1}^{p} \phi_{1i} \Delta \ln defex_{t-i} + \sum_{i=1}^{m} \phi_{2i} \Delta GDP_{t-i} + \sum_{i=1}^{n} \phi_{3i} \Delta \ln enercons_{t-i} + \varsigma_{3i} ECM_{t-1} + e_t \tag{17.7}$$

Error Correction Model (ECM) procedure specifically allows for a causal linkage between two or more variables stemming from an equilibrium relationship, thus characterizing the long-run equilibrium alignment that persists beyond the short-run adjustment (Hirnissa et al. 2008).

17.3.2.4 Granger Causality

This approach explains the relationship of two variables, x causes y, and vice versa, by looking at the past values of the variable and then to see whether adding lagged values of the other variable can improve the explanation.

17.3.3 Data Processing

After implemented unit root test to determine whether the variables are I(0) or/and I(1) or combination of both, the ARDL bound test was used to determine whether there was a co-integration relationship. The optimal lag order was chosen in order to reduce the residual serial correlation problems as well as avoid over-parameterization problems on the ECM (Bildirici 2016). After that, Granger Causality test was applied before testing the strength of the causality test using forecast error variance decomposition technique.

17.4 Empirical Results

17.4.1 Co-integration

Based on the ADF unit root tests, all variables are considered as stationary on the first difference (I (1)) and none of them are found in second difference (I (2)) and beyond as shown in Table 17.1. The results in Table 17.2 also conclude that co-integration exists in the long-run only when ln_gdp and ln_enercons variables were treated as a dependent variable. Furthermore, the ECM results shown in Table 17.3, summarized the magnitude of adjustment to any disequilibrium that will correct within one period with statistically significant measurement. Defense expenditure was determined as the variable with the fastest adjustment of all variables (Table 17.4).

Table 17.1 Unit root test

Variable	ADF	
	Level	First difference
ln_GDP	−4.026**	−4.588***
ln_enercons	−3.375*	−5.593***
ln_defex	−5.201***	−5.883***

Notes *, **, *** are significant in 10, 5, and 1% respectively

Table 17.2 Bound test for cointegration

Dependent variable	ADF	
	F-stat	t-stat
ln_GDP	6.863***	−3.9146**
ln_enercons	10.959***	−5.496***
ln_defex	4.204*	−2.222

Notes *, **, *** are significant in 10, 5, and 1% respectively

Table 17.3 Error correction model

Dependent variable	ECM
ln_GDP	−0.658***
ln_enercons	−1.445***
ln_defex	−0.489**

Notes *, **, *** are significant in 10, 5, and 1% respectively

Table 17.4 Granger causality Wald tests

Dependent variable	Independent variable		
	ln_GDP	ln_enercons	ln_defex
ln_GDP	–	2.472	6.916*
ln_enercons	8.443*	–	3.650
ln_defex	0.203	2.136	–

Notes * is significant in 5%

17.4.2 Causality

The causality test that applied using Granger Causality Wald test proved that evidently bi-directional Granger Causality did not exist between economic growth, energy consumption, and defense expenditure on the traditional level of significance. However, the result stated that uni-directional Granger Causality do exist, where defense expenditure granger causes economic growth, which granger causes primary energy consumption. Further, forecast-error variance decomposition (FEVD) was implemented to examine the fraction of the forecast error variance of an endogenous variable that can be attributed to orthogonalized shocks to itself or to another endogenous variable. Based on Table 17.5, around 5.82% of the forecast-error variance of economic growth is explained by energy consumption, while defense expenditure indicates 15.12%. The forecast-error variance of energy consumption is explicated by 32.57% economic growth and 8.41% defense expenditure. Lastly, the forecast-error variance of defense expenditure is defined by 62.94% of economic growth and 18.55% of energy consumption.

17.5 Conclusion

The dynamic relationship between economic growth, defense expenditure, and energy consumption in Indonesia was examined using ARDL approach. This approach helps to conclude that between the certain period of time, co-integration exists in each economic growth and energy consumption variables. Granger Causality also exists between defense expenditure to economic growth and economic growth towards energy consumption. Further, the results obtained from the FEVD conclude that economic growth has important impact to defense expenditure.

The results have certain implications on the policy of each sectors. The Government of Indonesia under President Jokowi administration should expedite

Table 17.5 Variance decomposition

Period	ln_GDP			ln_enercons			ln_defex		
	ln_GDP	ln-_enercons	ln_defex	ln_GDP	ln-_enercons	ln_defex	ln_GDP	ln-_enercons	ln_defex
1	100	0	0	5.79	94.21	0	58.48	4.12	37.40
5	81.29	6.03	12.67	26.03	66.95	7.02	58.23	23.01	18.74
10	79.00	5.87	15.12	32.57	59.00	8.41	62.94	18.55	18.50

the increase of Defense Budget agenda as promised on the early 2016. The increase of defense budget could possibly maintain economic growth through multiplier effect. As relatively stable economic growth achieved, diversification of energy should be pushed even further through Energy Mix Policy 2025 with special attention to new and renewable energy, following the increasing energy consumption, and subject to Paris Agreement and Climate Change Issues. The Government of Indonesia also should avoid sudden excessive expenses on defense sector, in order to maintain stable economic growth and inherently, the sustainability of defense expenditure itself, including war and direct confrontation.

References

Azam, M., Khan, A. Q., Zaman, K., & Ahmad, M. (2015). Factors determining energy consumption: Evidence from Indonesia, Malaysia, and Thailand. *Renewable and Sustainable Energy Reviews, 42,* 1123–1131.

Aizenman, J., & Glick, R. (2006). Military expenditure, threats, and growth. *Journal International Trade & Economic Development, 15*(2), 129–155.

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices, and economic growth: Time series evidence from Asian developing countries. *Energy Economics, 22,* 615–625.

Bildirici, M. (2016). Defense, economic growth, and energy consumption in China. *Procedia – Economics and Finance, 38*, 257–263.

Clark, B., Jorgenson, A. K., & Kentor, J. (2010). Militarization and energy consumption: A test of treadmill of destruction theory in comparative perspective. *International Journal of Sociology, 402,* 23–43.

Deger, S., & Sen, S. (1983). Defense expenditure, spin-off and economic development. *Journal of Development Economics, 13,* 67–83.

Frederiksen, P. C. (1991). Economic growth and defense spending: Evidence on causality for selected Asian countries. *Journal of Phillippine Devt, 32*.

Hassan, M. K., Waheeduzzaman, M., & Rahman, A. (2003). Defense expenditure and economic growth in the SAARC countries. *The Journal of Political, Social and Economic Studies, 28*(3), 275–293.

Hirnissa, M., Habibullah, M., & Baharom, A. H. (2008). Military and economic growth in ASEAN-5 countries. Universiti Putra Malaysia.

Hwang, J. H., & Yoo, S. H. (2012). Energy consumption, CO_2 emissions, and economic growth: Evidence from Indonesia. Springer Sc. B. Media.

Jafari, Y., Othman, J. & Nor, A. H. S. M. (2012). Energy consumption, economic growth, and environmental pollutants in Indonesia. *Journal of Policy Modeling, 34*, 879–889.

Joerding, Wayne. (1986). Economic growth and defense spending granger causality. *Journal of Development Economics, 21,* 35–40.

LMI Report. (2007). Transforming the way DOD looks at energy an approach to establishing an energy strategy. Report FT602T1.

Ministry of Defense of Republic Indonesia. (2015). Indonesia Defense Posture Book. Jakartas.

Nkoro, Emeka, & Uko, A. K. (2016). Autoregressive distributed lag (ARDL) cointegration technique: Application and interpretation. *Journal of Statistical and Econometric Methods, 5* (4), 63–91.

Saritas, O., & Burmaoglu, S. (2016). Future of Sustainable Military Operations under Emerging Energy and Security Considerations. *Technological Forecasting and Social Change*, *102*, 331–343.

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitao, N. C. (2013). Economic growth, energy consumption, financial development, international trade, and CO_2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews, 25*, 109–121.

Stern, D. I. (2010). The role of energy in economic growth. Centre for Climate Economics & Policy, Australian National University.

Yoo, S. H. (2006). The causal relationship between electr cons and econ growth in the ASEAN countries. *Journal of Energy Policy, 34*.

Chapter 18
Integration Measures Based on Principal Component Analysis: Example of Eurozone Stock Markets

Elzbieta Majewska and Pawel Jamroz

Abstract This article discusses selected ways of measuring financial market integration that can be found in existing scientific literature. The main aim of this research is to characterize those integration measures which are based on principal components analysis, such as: (1) Coefficient of determination of the regression model with principal components as the regressors, (2) integration index equal to the share of variance explained by the first principal component with respect to the overall variance of the original variables, and (3) segmentation index that captures the variation in loadings of the first principal component. The above mentioned measures have been utilized to carry out a dynamic analysis of the level of integration of eurozone stock markets in the time periods: 2007–2009 and 2009–2012.

Keywords Financial integration · Principal component analysis
Euro area stock markets

18.1 Introduction

A natural consequence of globalization processes is the ever increasing interdependence of the economies of individual countries. Currently the integration of global economic and financial systems rises in conjunction with dynamic increase in the international trade of goods, services, and financial assets. Integration is one of the most important aspects of the development and growth of financial markets. Because the notion of integration is very wide, there is no single universal definition of this phenomenon. It is most commonly perceived as a process, in which the allocation of financial assets is not subjected to any significant restrictions.

E. Majewska (✉) · P. Jamroz
University of Bialystok, Swierkowa 20B, 15-328 Bialystok, Poland
e-mail: e.majewska@uwb.edu.pl

P. Jamroz
e-mail: p.jamroz@uwb.edu.pl

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_18

Therefore, integrated markets exhibit uninhibited flow of capital which in turn leads to equalization of prices and profits from assets with the same levels of risk across different markets. Manifestations of globalization prompt many economists and capital market researchers to reflect on the direction in which world stock markets will continue to develop in future.

The amount of literature on the topic of financial markets integration is substantial, hence there are many ways in which this phenomenon is explained. One of the most commonly cited definitions has been put forward by Baele et al. (2004), according to which market of particular financial instruments or services is fully integrated if all of its participants: (1) are subject to same rules and regulations, (2) have equal access to these instruments (services), (3) are treated equally while active in the market. This definition is very broad but its authors point out three important aspects. Firstly, financial integration is independent of regional market structures that encompass: intermediaries, institutions, and markets. Moreover, experience shows that integration does not result in unification of said structures. Secondly, one can infer from this definition that integration does not always lead to removal of frictions that inhibit effective capital allocation. Integration can however be associated with symmetrical or asymmetrical consequences of frictions existing in different areas. If those frictions affect different markets symmetrically, then their financial integration remains possible. And finally, one can infer from the above mentioned definite that integrated markets must exhibit an equilibrium between demand and supply for investment opportunities. On one hand this means that investors must have identical access to trading and clearing platforms and cannot be discriminated against based on their country of residence, on the other hand there should be no restrictions on the availability of investment opportunities from other countries.

The above definition of financial integration is closely related to the law of one price, according to which the valuation of assets with identical levels of risk and return should be the same regardless of the market in which the transaction happens (Bekaert and Harvey 1995). When the law of one price does not hold then an arbitrage opportunity arises. However if all investors have equal access to investment opportunities, then by utilizing them they will eventually remove the arbitrage opportunity and the law of one price will be reestablished.

Some authors e.g. Bekaert et al. (2005), Hardouvelis et al. (2006) and Boamah (2017), point to one more aspect of integration related to factors that shape the rates of return from instruments. Highly integrated markets will primarily price global risk factors, whereas markets that are only partially integrated will price both global and local risk factors.

Financial integration brings many benefits for markets and investors. First of all, it stimulates financial development (easier flow of capital allows to generate higher profits) contributing to the economic growth. Undoubtedly, it also lessens and removes barriers to international investments. One should remember, however, that integration and rampant glottalization carries, not just benefits, but also threats. According to many authors e.g. Büttner and Hayo (2011), Lehkonen (2015) and Oprea (2017), strong financial markets integration allows for dissipation of disturbances and other adverse changes between the markets, including contagion of financial crises. It is a popular opinion that strong international integration of financial markets significantly contributed to the spreading of American 2007–2009 sub-prime crisis to many markets around the world. Additionally a strong integration can significantly hamper the benefits of risk diversification—which is especially important during periods of crisis when investors seek strategies that can defend their portfolios from unfavorable changes in the markets (Bekaert et al. 2002; Beine et al. 2010; Labuschagne et al. 2016).

This paper has the following structure: Chap. 2 contains a brief review of methods for measuring financial integration; principal components analysis along with integration measures that are based on it are described in Chap. 3; Chap. 4 describes the methodology and results of empirical analysis that illustrates the application of methods presented in Chap. 3; Chap. 5 contains a summary of the chapter.

18.2 Measuring Financial Integration: A Brief Literature Review

Because the notion of financial integration can be characterized in different ways, various ways of measuring it exist. Many authors, e.g.: Fung et al. (2008), point to two main groups of integration measurement methods: (1) price-based measures, and (2) quantity-based measures. Price-based measures analyze discrepancies between prices and returns on assets listed on markets in multiple countries. Those measures directly test whether the law of one price holds true. Significant discrepancies between prices or returns are considered as signs of lack of integration. In reality confirmation of the law of one price poses difficulties because it is rarely the case that two identical assets are available on two different markets. Therefore, a common approach is to consider assets with fundamentally similar characteristics, by analyzing the differences in their sensitivity to global risk factors and assessing whether the difference (spread) in their prices can be rationally explained. Whereas, quantity based measures allow to quantitatively establish the consequences of interference (frictions) between the markets. Those measures are most commonly based on economic indicators that measure such categories as: assets, liabilities, stocks, bank loans, and financial flows on an international scale.

Baele et al. (2004) also distinguish news-based measures. Those are based on an assumption that new local-scope information should not significantly influence asset prices in integrated markets. Whereas, new global-scope information should have a much stronger influence.

Some authors, e.g. Poonpatpibul et al. (2006), point out a regulatory (legal) aspect of market integration. This concerns facilities and barriers to international trade and cross-border capital flows. In this case the determinant of integration is the openness of legal regulations towards international capital flows.

The range of integration measures is therefore very wide. Some authors utilize correlation-based measures. Longin and Solnik (2001), Ang and Bekaert (2002) and Campbell et al. (2002) prove that an increase in integration can result in an increase in cross correlations. A correlation based method of evaluating the connections between markets is a simple and convenient tool to analyze the interdependence of two financial markets. An analysis of interdependence for a bigger group of markets can be carried out with the use of mean correlation coefficients for each pair (e.g. Mauro et al. 2002; Goetzmann et al. 2005; Quinn and Voth 2008). An increase in the value of mean correlation can be interpreted as an indication of increasing integration between corresponding markets (e.g. Longin and Solnik 1995; Chesnay and Jondeau 2001). In order to confirm (or disprove) an increase in the integration between markets for different time periods (e.g. financial crises) one can also utilize correlation matrix equality tests. Most commonly used test statistics are those proposed by: Jennrich (1970), Larntz and Perlman (1985) and Goetzmann et al. (2005). Results obtained with those methods for various market pairs can be found among others in Chesnay and Jondeau (2001), Goetzmann et al. (2005), Briere et al. (2012) and Olbryś and Majewska (2014, 2015, 2017).

However measures based only on correlation are subject to significant concern due to many limitations of the correlation coefficient (both statistical and interpretative) (e.g. Carrieri et al. 2007; Volosovych 2011, 2013). Moreover, even strongly integrated markets can be weakly correlated and vice versa—high correlation can occur among less integrated markets (Pukthuanthong and Roll 2009).

Among other methods of measuring integration the most popular include: cointegration tests (e.g. Voronkova 2004; Kizys and Pierdzioch 2011; Guidi and Ugur 2014; Bentes 2015; Oanea 2015; Al Nasser and Hajilee 2016), and GARCH-type models (e.g. Fratzscher 2002; Carrieri et al. 2007; Büttner and Hayo 2011; Kenourgios and Samitas 2011). Multivariate regression models are also widely used. Those include regression models of rates of returns on stock market indices against: (1) macroeconomic variables (e.g. Peša et al. 2017), (2) rates of return on other indices (e.g. Schotman and Zalewska 2006; Al Nasser and Hajilee 2016), (3) synthetic variables in the form of principal components (e.g. Pukthuanthong and Roll 2009; Lehkonen 2015). This group also includes regression models of portfolios of highly developed markets, for which the analysis of integration is carried out based on the proportion of variation in rates of return that can be explained by the influence of global factors (e.g. Bekaert et al. 2005; Boamah 2017). Other methods include: wavelet analysis, causal models and Monte Carlo simulation-based methods.[1]

[1]An extensive review of methods and tools for measuring integration can be found in Chen et al. (2014).

18.3 Measures of Integration Based on Principal Component Analysis

Principal component analysis is one of the primary methods of dataset reduction for datasets containing large numbers of interdependent variables. It is carried out in a way that preserves the biggest possible amount of information from the initial dataset. Observable input variables are transformed into new unobservable variables called principal components, which are linear combinations of original variables. Consecutive principal components are uncorrelated with each other and are calculated in a way that maximizes variance that has not been explained by preceding principal components (Jolliffe 2002). Consequently few first components will contain the vast majority of information that are present in the dataset (Donadelli and Paradiso 2014).

18.3.1 Classical Principal Component Analysis (PCA)

Let X be the vector of N variables with known variances and known covariance matrix or correlation matrix. In the first step of the principal component analysis algorithm we look for a linear combination $a_1^T x$ of the elements of the X vector (Jolliffe 2002):

$$z_1 = a_1^T X = \alpha_{11}x_1 + \alpha_{12}x_2 + \cdots + \alpha_{1N}x_N = \sum_{j=1}^{N} \alpha_{1j}x_j,$$

where:

$X = [x_1, x_2, \ldots, x_N]^T$—vector of N input variables,
$a_1 = [\alpha_{11}, \alpha_{12}, \ldots, \alpha_{1N}]^T$—vector of N factors called principal loadings.
α_{1j} coefficients are calculated in a way that maximizes the variance of new variable z_1 (first principal component) subject to the following constraint[2]: $a_1^T a_1 = \sum_{j=1}^{N} a_{1j}^2 = 1$.

In the next step we look for a linear combination $z_2 = a_2^T x$ (second principal component) uncorrelated with $a_1^T x$ with the highest possible variance. This procedure is then repeated until N new variables are obtained. Each following variable (component) is orthogonal with respect to the previous one, that is: $a_i^T a_{i+1} = 0$. Therefore the k-th principal component can be described by the equation:

[2]This constraint ensures normalization of the components vector.

$$z_k = a_k^T x, \quad k = 1, 2, \ldots, N.$$

This procedure boils down to solving the following matrix equation:

$$(C - \lambda_k I) a_k = 0,$$

where: C is the covariance matrix of input variables and I is an identity matrix. Therefore a_k is an eigenvector of the covariance matrix of the elements of vector X that corresponds to the eigenvalue λ_k. It can be shown that $var(z_k) = \lambda_k$, i.e. k-th principal component corresponds to the k-th highest eigenvalue. Additionally because of the lack of correlation between consecutive principal components, the overall variance of the new set of variables is equal to: $\sum_{i=1}^{N} \lambda_i$.

Principal components can be calculated from the covariance matrix when the input variables are expressed in the same units and do not differ significantly in terms of variability. Otherwise one should standardize the variables. In this case, the covariance matrix becomes a correlation matrix. This approach is generally preferable for most practical applications.

18.3.2 Integration Analysis with the Use of Principal Component Method

Principal component analysis for the purposes of measuring financial markets integration is commonly used in conjunction with other methods—supplementing them. In recent years however, some researchers have been using principal components as the main tool for measuring integration e.g.: Pukthuanthong and Roll (2009), Volosovych (2013) and Majewska and Olbryś (2018).

Some authors e.g. Volosovych (2011), point to many advantages of principal components-based methods for measuring integration. First of all PCA is a well-known and transparent method often utilized for microeconomics analyses. Moreover it is robust to outliers and fat tails of distributions and its results are easy to interpret. Additionally it allows to diagnose global interference, which can be misinterpreted as integration by other methods.

Pukthuanthong and Roll (2009) propose, as a measure of integration, the use of mean adjusted coefficient of determination $\bar{R}^2$ calculated for the regression models of global factors represented by K principal components, calculated for each of the analyzed variables:

$$x_{i,t} = \beta_{i,0} + \beta_{i,1} z_{1,t} + \beta_{i,2} z_{2,t} + \cdots + \beta_{i,K} z_{K,t} + \varepsilon_{i,t}, \quad (K < N)$$

where:

$x_{i,t}$—value of i-th variable (representing the i-th market) at time t ($i = 1, 2, \ldots, N$; $t = 1, 2, \ldots, T$),
$\beta_{i,k}$—sensitivity coefficient of the i-th variable to changes of k-th principal component ($k = 1, 2, \ldots, K$),
$z_{k,t}$—value of k-th principal component at time t.

The number of principal components K in the above model is set in such a way that the sum of their variances is an adequately large proportion of the overall variance of initial input variables.[3]

Volosowych (2011, 2013) observed that if the input variables for the principal components analysis are comparable, e.g. returns or prices of assets listed on analyzed markets, then the first principal component has a natural interpretation—as a multidimensional equivalent of the correlation coefficient. He suggests therefore, that the share of variance explained by the first principal component in the overall variance of the input variables could serve as the index of integration:

$$v_{PC1} = \frac{\lambda_1}{\sum_{i=1}^{N} \lambda_i},$$

where λ_i is the i-th eigenvalue of the correlation (or covariance) matrix of the analyzed input variables. Additionally if the share of variance explained by the first principal component is substantial, it points to a significant level of interconnectedness between the markets. Conversely if each of the principal components explains a similar small share of variance, then the analyzed markets are poorly interconnected (Gilmore et al. 2008).

Principal component analysis also allows to analyze the strength with which each market affects the integration index. Principal component loadings determine the share of each input variable in the particular principal component. Markets with higher values of α_{1j} coordinate have a higher influence on unobservable returns of the entire analyzed group of markets. By calculating the correlation coefficient of a particular market with the first principal component one can determine the strength with which global factors influence this particular market. Low or negative value of the coefficient indicates that the market in question is only weakly connected with the analyzed group. Correlation between the initial input variable x_i and the unobservable first principal component z_1 can be estimated through decomposition of the input variables covariance matrix. Correlation is a factor of α_{1j} coefficients and the square root of the corresponding eigenvalue (Jolliffe 2002). Therefore, the α_{1j} coefficients are proportional to the correlation coefficients. Hence, Volosovych (2013) proposed to use the segmentation index—expressed as standard deviation of α_{1j} coefficients—as a measure of integration. High values of that index indicate a high variation in the loadings of first principal component and thus varied levels of

[3]Pukthuanthong and Roll (2009) assume 90% as an adequate value.

interconnectedness between the markets and the analyzed group—a sign of low integration. Conversely low values of the segmentation index point to a higher level of integration.

18.3.3 Dynamic Measures of Integration

Research papers on the measurement of financial markets integration with the use of principal component analysis can be roughly divided into two groups. First group contains statistical studies which aim to calculate the first principal component (or a few first ones) for a given time period. This type of research usually supplements other methods and measurements of integration with principal component approach. Many such studies provide results for various groups of markets (both developed and developing), e.g.: Nellis (1982), Gagnon and Unferth (1995), Mauro et al. (2002), Bordo and Murshid (2006) and Pukthuanthong and Roll (2009). A second category of papers, which has been initiated with a study by Volosovych (2011), aims to measure changes in the level of integration. In this case principal components are calculated over a moving window, this allows for a graphical presentation of results and a dynamic analysis of the level of integration. Volosovych analyzed treasury bond markets of 15 developed economies in the time period 1875–2009. He calculated the percentage of variance explained by the first principal component for a 13-year moving window.[4] Thanks to this approach he was able to determine periods of higher and lower integration of markets.

Analogous approach can be found in a paper by Donadelli and Paradiso (2014), who analyze data from 18 emerging and developing markets from around the world (broken down by continents) for the time period 1980–2012. These authors use a 60 months moving window in order to observe differences in integration for particular groups of markets and periods of booms and busts. Additionally they have analyzed the shape of the integration curve.

Similar research for the eurozone markets has been carried out by Majewska and Olbryś (2018). This study indicates significant changes (increase) in integration during the period of the 2007–2009 financial crisis.

18.4 Data Description and Empirical Results

Measures of integration described in the previous chapter have been used for a dynamic analysis of the level of integration of the eurozone capital markets. Research has been carried out for monthly closing prices of the main indices of 19 eurozone stock-markets (Table 18.1) for the time period ranging from January 2000

[4] A window with such length allowed to avoid the influence of short-term disturbances.

Table 18.1 Stock market indices included in the study

Country	Index	Market Cap. EUR billion Dec 2016	Year of accession to the eurozone
France	CAC 40	2049.21	1999
Germany	DAX	1630.41	1999
Netherlands	AEX	811.72	1999
Spain	IBEX 35	669.40	1999
Italy	FTSE MIB	525.05	1999
Belgium	BEL 20	358.91	1999
Finland	OMXH	209.00	1999
Ireland	ISEQ	113.85	1999
Austria	ATX	95.20	1999
Luxembourg	LuxX	57.87	1999
Portugal	PSI 20	48.91	1999
Greece	ATHEX	35.31	2001
Slovakia	SAX	5.28	2009
Slovenia	SBITOP	5.00	2007
Malta	MSE	4.21	2008
Lithuania	OMXV	3.50	2015
Cyprus	GENERAL	2.39	2008
Estonia	OMXT	2.29	2011
Latvia	OMXR	0.80	2014

Source http://sdw.ecb.europa.eu

until December 2017 (216 observations). Monthly logarithmic rates of return were the basis for further calculations.

First step was to calculate the eigenvalues for the correlation matrix of monthly logarithmic returns on the indices. This allows to avoid any possible influence that high variation in one or more indices could have on the outcomes. The share of variance explained by consecutive principal components is shown on Fig. 18.1. 90% level has been surpassed by 8 first principal components that jointly explain 90.23% of the overall variance of the input variables.

In order to carry out a dynamic analysis of the integration level, it was necessary to calculate each measure over a moving window with a set constant length. The length of the window is usually arbitrarily chosen by the researcher. This research utilizes a 60-month (5-year) window.

18.4.1 Dynamics of the Coefficient of Determination

Analysis of changes in the level of integration of the eurozone markets has been carried out first with the use of mean adjusted coefficient of determination $\bar{R}^2$ for the

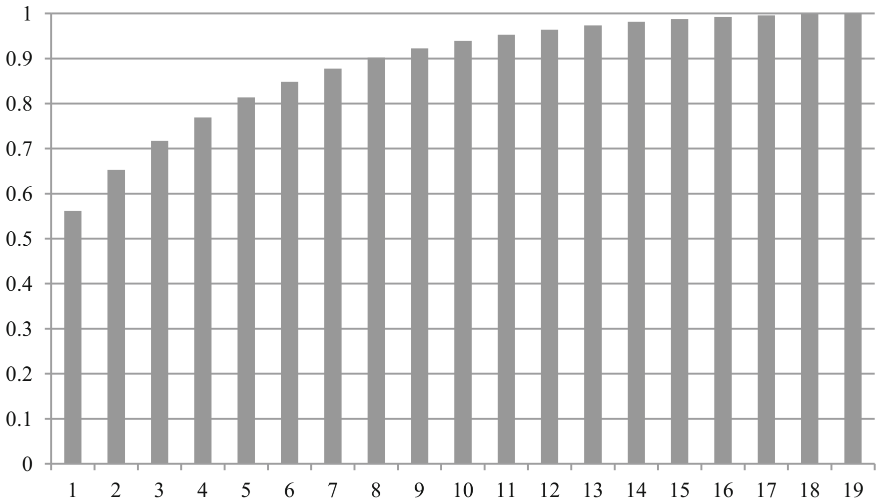


Fig. 18.1 Share of total variance of analyzed indices explained by a given number of first principal components (cumulative)

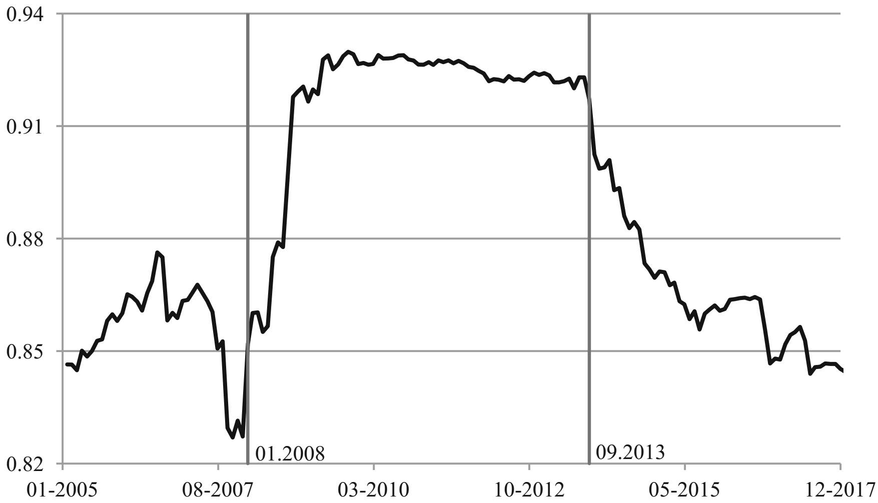


Fig. 18.2 Mean coefficient of determination of the regression model estimated for 8 principal components over a moving window

regression model of each market index against 8 principal components. For the entire studied sample its value varied from 0.8269 in October 2007 to 0.9298 in September 2009. Results are illustrated in Fig. 18.2.

Integration curve has an inverted U shape. Vertical lines indicate points in time when the indicator starts to increase significantly in January 2008 and when it starts to decrease in September 2013, thus encompassing a period of significantly higher values of $\bar{R}^2$. Previous research shows (Majewska and Olbryś 2018) that eurozone stock markets experienced two phases of significant decline in that time period. First one associated with the global financial crisis that started on the American market and was felt on European markets by the end of year 2007. Those declines were still present till the first months of 2009. Unfortunately a new phase of decline started at the end of 2009—this time caused by the problems of Greek economy—often referred to as the European debt crisis. Declines persisted in some eurozone markets until the final months of 2012.

It is worth noticing that the stock-market slump that started at the end of 2007 was reflected in a sudden increase in value of the coefficient of determination—indicating an increase in market integration. High level of the indicator persisted for the whole period of both crises. Decline in the value of the coefficient after the period of market bust was less sudden and more extended in time. Thus, the effect of slowly extinguishing signs of the crisis in the form of weakening market integration took place.

18.4.2 Variability of the Integration Indicator

Next calculated measure was the integration index equal to the share of variance explained by the first principal component in the overall variance of the analyzed indices. For the studied group of markets first principal components explains on average 56% of the overall variance of the indices, while the second component explains only about 9.1%. This indicates a strong interconnectedness between the markets.

Figure 18.3 shows the integration curve obtained with the integration index calculated over a moving window. It is quite apparent that its shape and path are very close to the integration curve calculated with the mean average coefficient of determination. Moreover, both curves reach their extrema at nearly the same points in time. The minimum of the index, equal to 0.4442, happens in September 2007, whereas the maximum at 0.6758 occurs in May 2009. Once again the index points to an increased level of eurozone markets integration during the period of global financial crisis and European debt crisis and an extended period of decreasing integration after the crisis.

18.4.3 Segmentation Index

The last measure calculated in this study is the segmentation index. This measure allows to analyze the influence that each initial variable (market index) has on the value of the integration index described in Chap. 4.2. High values of the index

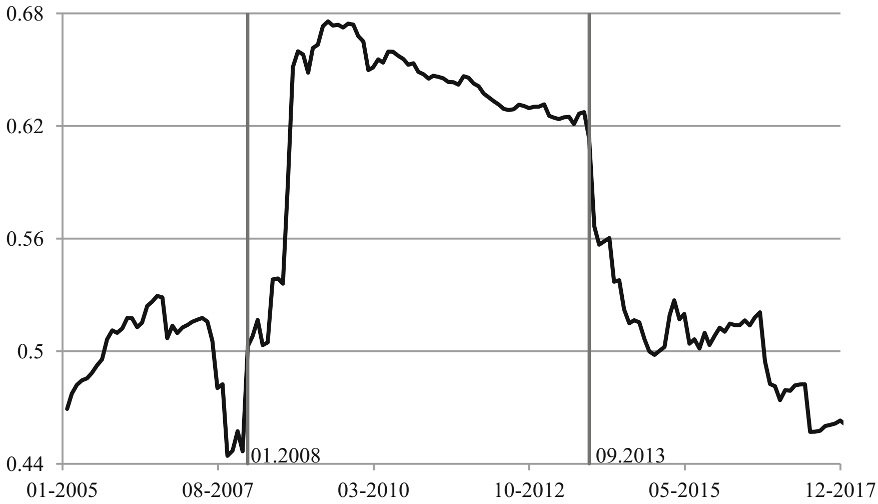


Fig. 18.3 Integration indicator of the analyzed markets over a moving window

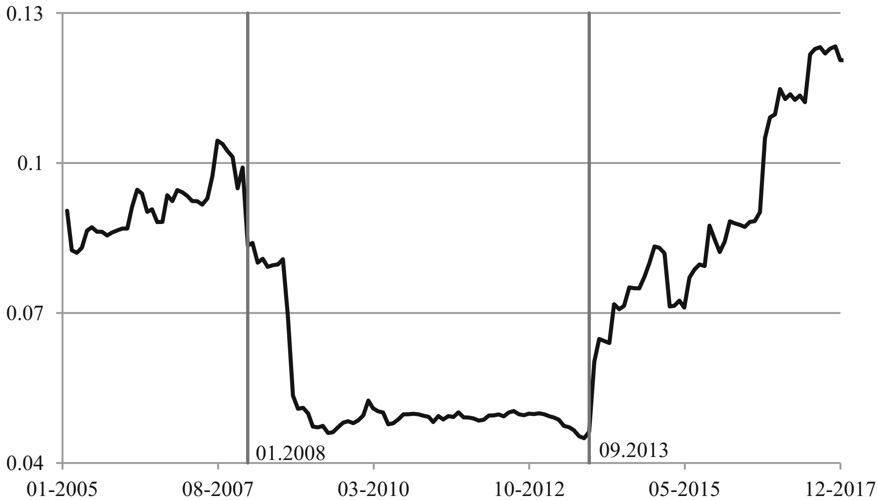


Fig. 18.4 Segmentation index for the analyzed markets calculated over a moving window

indicate that input variables have a very varied impact on the value of the first principal component—meaning that some variables are weakly and other strongly interconnected with the rest of the group. Values of the segmentation index calculated over the moving window are shown in Fig. 18.4.

The path of the segmentation curve confirms characteristic variations in the level of integration of eurozone stock-markets in the studied time period. The curve is

U-shaped and indicates higher interconnectedness of markets during the period of last two financial crises in Europe and a short period afterwards. This could have been an effect of the common anti-crisis policy carried out in the studied eurozone countries.

18.5 Conclusion

The aim of this paper was to present the dynamic methods of measuring financial integration based on principal components analysis. Three selected measures were discussed: (1) mean adjusted coefficient of determination of the regression model with principal components as regressors, (2) integration index equal to the share of variance of the studied markets explained by the first principal component, and (3) segmentation index measured as the variation in the correlation of each market index with the first principal component.

Presented measures have been utilized to analyze changes in the integration level of 19 stock-markets of the eurozone countries. Obtained results confirm an increased level of integration of those markets during the period of global financial crisis and the European debt crisis and for a brief period thereafter. A similar phenomena has been observed for other markets and described in many research papers e.g.: Donadelli and Paradiso (2014) and Volosovych (2011, 2013). Obtained results show that the level of interconnectedness between the markets was higher in the years of th last two crises in Europe and for a brief period after, this could have been a result of common anti-crisis policy.

The question of whether or not presented measures are sensitive to the frequency of analyzed data remains open, and could be subject of future research.

Acknowledgements This publication has received financial support from the Polish Ministry of Science and Higher Education under subsidy for maintaining the research potential of the Faculty of Mathematics and Informatics and Faculty of Economics and Management, University of Bialystok.

References

Al Nasser, O. M., & Hajilee, M. (2016). Integration of emerging stock markets with global stock markets. *Research in International Business and Finance, 36,* 1–12.

Ang, A., & Bekaert, G. (2002). International asset allocation under regime switching. *The Review of Financial Studies, 15,* 1137–1187.

Baele, L., Ferrado, A., Hördahl, P., Krylova, E., & Monnet, C. (2004). Measuring financial integration in the euro area. In *ECB occasional paper series* (Vol. 14).

Beine, M., Cosma, A., & Vermeulen, R. (2010). The dark side of global integration: increasing tail dependence. *Journal of Banking & Finance, 34,* 184–192.

Bekaert, G., & Harvey, C. R. (1995). Time-varying market integration. *The Journal of Finance, 1* (2), 403–444.

Bekaert, G., Harvey, C. R., & Lumsdaine, R. L. (2002). Dating the integration of world equity markets. *Journal of Financial Economics, 65,* 203–247.

Bekaert, G., Harvey, C. R., & Ng, A. (2005). Market integration and contagion. *Journal of Business, 78*(1), 39–69.

Bentes, S. R. (2015). On the integration of financial markets: How strong is the evidence from five international stock markets? *Physica A, 429,* 205–214.

Boamah, N. A. (2017). The dynamics of the relative global sector effects and contagion in emerging markets equity returns. *Research in International Business and Finance, 39,* 433–453.

Bordo, M. D., & Murshid, A. P. (2006). Globalization and changing patterns in the international transmission in financial markets. *Journal of International Money and Finance, 25,* 655–674.

Briere, M., Chapelle, A., & Szafarz, A. (2012). No contagion, only globalization and flight to quality. *Journal of International Money and Finance, 31*(6), 1729–1744.

Büttner, D., & Hayo, B. (2011). Determinants of European stock market integration. *Economic Systems, 35,* 574–585.

Campbell, J. Y., Koedijk, K., & Kofman, P. (2002). Increased correlation in bear markets. *Financial Analysts Journal, 58*(1), 87–94.

Carrieri, F., Errunza, V., & Hogan, K. (2007). Characterizing world market integration through time. *Journal of Financial and Quantitative Analysis, 42*(4), 915–940.

Chen, M.-P., Chen, P.-F., & Lee, C.-C. (2014). Frontier stock market integration and the global financial crisis. *The North American Journal of Economics and Finance, 29,* 84–103.

Chesnay, F., & Jondeau, E. (2001). Does correlation between stock returns really increase during turbulent periods? *Economic Notes, 30*(1), 53–80.

Donadelli, M., & Paradiso, A. (2014). Is there heterogeneity in financial integration dynamics? Evidence from country and industry emerging market equity indexes. *Journal of International Financial Markets, Institutions & Money, 32,* 184–218.

Fratzscher, M. (2002). Financial market integration in Europe: On the effects of EMU on stock markets. *International Journal of Finance & Economics, 7*(3), 165–194.

Fung, L. K., Tam, C., & Yu, I. (2008). *Assessing the integration of Asia's equity and bond markets*. BIS papers no. 42.

Gagnon, J. E., & Unferth, M. D. (1995). Is there a world interest rate? *Journal of International Money and Finance, 14,* 846–855.

Gilmore, C. G., Lucey, B. M., & McManus, G. M. (2008). The dynamics of Central European equity market comovements. *The Quarterly Review of Economics and Finance, 48,* 605–622.

Goetzmann, W. N., Li, L., & Rouwenhorst, K. G. (2005). Long–term global market correlations. *Journal of Business, 78*(1), 1–38.

Guidi, F., & Ugur, M. (2014). An analysis of South-Eastern European stock markets: Evidence on cointegration and portfolio diversification benefits. *Journal of International Financial Markets, 30,* 119–136.

Hardouvelis, G. A., Malliaropulos, D., & Priestley, R. (2006). EMU and European stock market integration. *Journal of Business, 79*(1), 365–392.

Jennrich, R. I. (1970). An asymptotic chi-square test for the equality of two correlation matrices. *Journal of the American Statistical Association, 65*(330), 904–912.

Jolliffe, I. T. (2002). *Principal component analysis*. Springer series in statistics (2nd edn.). New York: Springer.

Kenourgios, D., & Samitas, A. (2011). Equity market integration in emerging Balkan markets. *Research in International Business and Finance, 25,* 296–307.

Kizys, R., & Pierdzioch, C. (2011). The financial crisis and the stock markets of the CEE countries. *Finance a Uver, 61*(2), 153–172.

Labuschagne, C., Majewska, E., & Olbryś, J. (2016). Crisis periods, contagion and integration effects in the major African equity markets during the 2007–2009 global financial crisis. *Optimum Economic Studies, 83*(5), 31–52.

Larntz, K., & Perlman, M. D. (1985). *A simple test for the equality of correlation matrices*. Technical report no. 63. Department of Statistics, University of Washington.

Lehkonen, H. (2015). Stock market integration and the global financial crisis. *Review of Finance, 19*(5), 2039–2094.

Longin, F., & Solnik, B. (1995). Is the correlation in international equity returns constant: 1960–1990? *Journal of International Money and Finance, 14*(1), 3–26.

Longin, F., & Solnik, B. (2001). Extreme correlation of international equity markets. *The Journal of Finance, 56*(2), 649–676.

Majewska, E., & Olbryś, J. (2018). Measuring dynamics of financial integration on the euro area stock markets, 2000–2010. In N. Tsounis & A. Vlachvei (Eds.), *Advances in panel data analysis in applied economic research—Proceedings of the 2017 International Conference on Applied Economics* (*ICOAE*). Springer Proceedings in Business and Economics (in press).

Mauro, P., Sussman, N., & Yafeh, Y. (2002). Emerging market spreads: Then versus now. *Quarterly Journal of Economics, 117,* 695–733.

Nellis, J. G. (1982). A principal components analysis of international financial integration under fixed and floating exchange rate regimes. *Applied Economics, 14,* 339–354.

Oanea, D.-C. (2015). Financial markets integration: A vector error-correction approach. *The Journal of Economic Asymmetries, 12,* 153–161.

Olbryś, J., & Majewska, E. (2014). The 2007–2009 financial crisis on emerging markets: Quantitative identification of crisis in continent-based regions. *Chinese Business Review, 13*(7), 411–426.

Olbryś, J., & Majewska, E. (2015). Testing integration effects between the CEE and U.S. stock markets during the 2007–2009 global financial crisis. *Folia Oeconomica Stetinensia, 14*(1), 101–113.

Olbryś, J., & Majewska, E. (2017). Increasing cross-market correlations during the 2007–2009 financial crisis: contagion or integration effects? *Argumenta Oeconomica, 39*(2), 263–278.

Oprea, O. R. (2017). Financial integration and financial contagion, a problem for financial stability? *Journal of Public Administration, Finance and Law, 11,* 121–136.

Peša, A. R., Wrońska-Bukalska, E., & Bosna, J. (2017). ARDL panel estimation of stock market indices and macroeconomic environment of CEE and SEE countries in the last decade of transition. *Portuguese Economic Journal, 16,* 205–221.

Poonpatpibul, C., Tanboon, S., & Leelapornchai, P. (2006). The role of financial integration in East Asia in promoting regional growth and stability. In *BOT symposium.*

Pukthuanthong, K., & Roll, R. (2009). Global market integration: An alternative measure and its application. *Journal of Financial Economics, 94,* 214–232.

Quinn, D. P., & Voth, H.-J. (2008). A century of global equity market correlations. *American Economic Review: Papers & Proceedings, 98*(2), 535–540.

Schotman, P. C., & Zalewska, A. (2006). Non-synchronous trading and testing for market integration in Central European emerging markets. *Journal of Empirical Finance, 13,* 462–494.

Volosovych, V. (2011). Measuring financial market integration over the long run: Is there a U-shape? *Journal of International Money and Finance, 30,* 1535–1561.

Volosovych, V. (2013). Learning about financial market integration from principal components analysis. *CESifo Economic Studies, 59*(2), 360–391.

Voronkova, S. (2004). Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes. *International Review of Financial Analysis, 13,* 633–647.

Chapter 19
Factors Affecting the Soil Analysis Technique Adopted by the Farmers

Moammar Dayoub

Abstract This study aimed to show the reality of farmers and determine the extent of their adoption of the recommendations of the fertilizer and the difficulties and problems they face. The study was conducted on a random sample, consisting of 95 farmers who had analyzed their field soil in scientific research centers in the southern agricultural region through the form specially prepared for this purpose. The results showed that the rate of adoption of the fertilizer recommendations reached an average of 36.9% in the southern region. The degree of adoption was 34.7% in the region. The results showed that 41% of farmers did not implement the recommendations because of the non-convenient analysis, and 34% due to neglect, and 15% due to the weather and environment, while 10% of them for lack of manure at the suitable time. The study also revealed that the independent factors affecting the continuing adoption of soil analysis are: a farm's experience, the sampling method in farmers schools, the irrigated area, and personal knowledge of farmers in analyzing the soil. Also, it shows that the application of fertilizer recommendations led to an increased production of 15–20%, this analysis emphasizes the importance of soil analysis and adherence to the recommendations of the research centers.

Keywords Soil analysis · Adoption · Recommendations of the fertilizer

19.1 Studies of Reference

The southern region covers about 15.7% of the total area of the country. It includes Dara, Sweida, and Al-Qunaytirah. It is famous for its fruit production, especially apricots, apples, and grapes, but it also produces crops such as chickpeas and tomatoes, in addition to raising cattle. Between 2011 and 2012, the region's contribution to the national production was 36% for chickpeas, 51% for apples, 31% for grapes, and 62% for apricots (FAO 2015).

M. Dayoub (✉)
University of Turku, Turku, Finland
e-mail: modayo@utu.fi

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_19

Agricultural soils are formed from the fragmentation of volcanic rock, limestone, sand, or gypsum over millions of years by rain and variations in temperature which consist of small granules mixed with organic material decomposed by micro-organisms in the soil to form a combination surface layer (easy tillage and with different thickness) and a thin surface layer (soil) is a valid and suitable environment for the growth of the roots of plants. (Abdul Latif 1996).

The soil is considered one of the main factors for the growth of plants and its production. The types of soil vary according to their physical, chemical and biological properties. Good fertile soil is able to supply the necessary plant nutrients necessary and suitable environment for root growth and proliferation. The soil could be fertile not productive when climatic conditions are not suitable for the growth and production (NAPC 2014).

It is needed to continuously conduct analyzes of soils in order to know the decreases or increases in the elements of major and minor components and physical and chemical properties, as well as the vitality and its ability to provide a plant with mineral elements essential in order to add fertilizer to optimize and maintain the fertility of the soil by different growth stages and thus get high productivity.

The non-representative sample of the field has been wrongly taken, the result of its analytical data becomes useless, or in the best case, become difficult to interpret (Ryan 2013).

Deep indicates (1999), that the accuracy of the results of soil analysis depends on how representative samples of the soil are studied, it is natural that the greater the number of samples taken and which ones are formed samples composite increased representation of samples of the field. The depth of tillage (from 0 to 30 cm) for land cultivated and the depth (5–6 cm) of pasture land for taking samples for the purpose of conducting chemical analyses indicate the degree of fertility, after being drawn sampling and calibration of nutrients and compounds estimate of the soil constituents (GCSAR 2015).

But still farmers are facing many problems in complying with the recommendations of scientific research (MOAR 2015) so it is necessary to have a follow-up study and evaluation of the impact of these recommendations in farmers' fields, in terms of productivity per unit area and to sustain soil fertility.

19.2 Goals

The research aims to study the economic and social characteristics of farmers who analyzed the soil, and measuring indicators of adoption of the recommendations of fertilizer and evaluate the impact of adoption of soil analysis in the fields of farmers in the area studied, as well as identify the most important factors influencing the adoption of the recommended fertilizer, and finally shed light on the most important problems and obstacles faced by farmers in the field of soil analysis.

19.3 Materials and Methods

We depended on two data:

– The preliminary data—through a designed questionnaire for this purpose after rapid rural surveys a list of questions was prepared for farmers including social and economic characteristics of farms and data on farm crops and other information relevant to the topic.
– The questionnaire was tested on a sample of farmers and adopted as the final form. After the total number of analyses of farmers for soil from previous years, it was 950 farmers, the study was conducted on a random sample of 95 farmers which consists of 10% of the total farmers, who analyzed there soil at the soil analysis laboratories in the southern region in Syria.
– Depended on the secondary data collection from the annual statistical groups issued by the Ministry of Agriculture and Agrarian Reform, and laboratory analysis of soil data deployed in the southern region.

Data has been entered into the statistical programs—Excel and SPSS and conduct the necessary analysis and quantitative descriptive. Using the regression model logical duo in the study hypotheses research for the continued adoption and expresses the dependent variable (Y) about the possibility of a particular occurrence, and accordingly take (Y) values only, namely:

(1) When they occur (positive), and (0) in the absence of occurrence (negative).

The model uses the following equation:

$$Y = b0 + b1x1 + b2x2 + \cdots bnXn$$

X1, X2 … Xn: Independent factors used in forecasting. (b0, b1, b2 … bn) are constants independent factors.

To estimate the efficiency of the model an accuracy test was used (Hosmer-Lemeshow) which is based on the use of the test statistics (Chi-Square) to examine the Zero hypothesis, which says that there is no significant difference between the values seen and values forecasted with the variable's, where increasing the accuracy of the model whenever such differences are small.

b: non-standard logarithmic for independent factor.

SE: standard error of the independent factor.

It is then tested (Y) by Chi-Square within the confidence interval (5 and 1%).

Laboratory samples of farmers were taken in two ways:

1. The direct method where the farm sampling and brought to the laboratory closest to him personally and when the results are issued they are discussed directly with the farm in order to get the best recommendations.
2. An indirect way where the workers in the extension units to collect samples from farmers' fields (especially for strategic crops) and sent to the laboratory closest to them supplied with all the necessary data about the farms and are to send the results and recommendations to the interests of agricultural extension

after analysis of the samples. This method does not achieve the direct contact between the farmer and the laboratory.

The laboratory analyzes all elements necessary to assess the fertility of the soil in addition to some of the elements that have a negative impact in the soil, such as heavy metals, sodium, chlorine and other, which are as follows:

Determination of the pH and electrical conductivity—Determination of organic material—Determination of total carbonate—Cationic exchange capacity—Determination of major elements (nitrogen, phosphorus, potassium, calcium, magnesium)—Determination of trace elements (iron, copper, manganese, zinc, boron)—soil—and other analyzes as a heavy metals (lead, cadmium, chromium, nickel, cobalt) for samples from the areas of pollution and gypsum plaster in soils (Eastern Region), cations and anions of salt-affected soils.

The laboratories also carry out the following other tasks:

- Participation through various tests in identifying programs contamination of soil, water, and vegetation heavy elements and nitrogen compounds and other pollutants.
- Analysis of the heavy elements and elements of impact on soil, plants, fertilizer and water pollution in order to detect pollution in these elements.
- Fertility analysis of dust samples to give a true perception of the nutrient content of the plant.
- Complete physical and chemical analysis of complete soil in order to monitor the changes that accompany the various experiments and research.
- Analysis of mineral chemical fertilizers and imported organic fertilizers imported and domestically produced in order to ensure quality and compliance with the accompanying prospectus.
- Analysis of plant specimens to investigate the different elements shortages, minor and major, in addition to the analysis of plant samples in order to monitor the changes that accompany the various experiments and research.
- Analysis of water samples associated with the design of irrigation systems and irrigation research and experiences.

19.4 Results and Discussion

1. **Descriptive analysis of the study sample:**

The average age of the farmers was 50 years and the average experience in agriculture was 22 years. The average family size was 7 members. In education, the sample consists of 37.9% who had primary qualifications and 17.2% who had preparatory and in the same proportion had secondary schools and 10.3% of those who have literacy and 10% of those who have post-secondary education.

A large number of farmers working on livestock, the percentage of farmers who use compost 75.9% and more commonly used types of compost is the remnants of cows and sheep primarily in addition to poultry waste.

The majority of the analyzed soil is from olive, grape and apple trees by 63.8 and 18.3% vegetables and the rest were other crops.

The average agricultural holding was 48 Donum, (1 Donum = 1000 m^2), reaching the highest area of 180 Donum and analyst least of which 2 Donum with a standard deviation of 49.1 Donum.

2. **Analysis of the adoption of farmers to fertilizer recommendations:**

The definition of rate of adoption is the number of adopters of soil analysis divided on the number all farmers adoptions overall recommendation fertilizer (i.e. nitrogen and potash, and phosphorus) based on the results of soil analysis 36.9%, which is considered very low, which calls for follow-up and a stand on the reasons for the low percentage and to find out who the farmers analysts of the soil are and the reason for their analysis and non-application of the recommendations given. There are about 46.9% who add the nitrogen only, but those who add superphosphate fertilizer as recommended are approximately 57.4 and 61.8% sulfate of potash.

We note here that the farmers applied one or two recommendations, which indicates a lack of conviction of the soil analysis and they apply only what is believed in, therefore awareness and guidance does not depend on their opinion to analyze the soil, but the extent of its compliance with the fertilizer recommendations.

Due to ignore this index for the farmer's areas applied to them recommending fertilizer and take it only for the preparation of farmers regardless of the area of their holdings of agricultural. We used the indicator degree of adoption, which measures the percentage of an area of applied by the recommendation of the total area analyzed. The ratio was 34.7% of the total area of the farmers and this shows that the area applied to them very little and reached the highest 59.5% for the use of superphosphate and potassium sulfate 58.6%.

There are another indicators, the adoptions density is multiplied by the degree of the adoption rate of adoption and this indicator collects indicators together and in our sample amounted to 22.5%.

3. **The results of the standard analysis for adoption:**

The independent variables which could affect the adoption of the fertilizer recommendations were (10) variable, which is supposed to have an impact on the variable factor, in the regression model logical duo continuing adoption (Y), using the method (Stepwise-Backward WALD), which is based on the introduction of all the variables together in the first step, and then excludes one variable at each step in a particular order based on the basis of estimates of the maximum likelihood at every stage, so that the exclusion of a variable according to the value of statistical resulting from test (WALD).

The program has been to rely on SPSS to do the job using (6) steps, and it was the last step that is best excluded from all the independent variables is moral, and

Table 19.1 Variables that are not included in the regression equation rationale continuing (Y) according to test scores

Score test variables that did not enter the regression equation	Test score
Total area	0.011
Use compost	0.008
Depend on researchers in the sample taking	1.864
Depend on neighbors or acquaintances in the analysis of soil sampling	0.046
The number of sites taken from the soil sample	1.099

Source: the Sample survey

according to the test (Score), as shown in the Table 19.1. Accordingly, the number of independent variables excluded (5) independent variable, which does not affect the adoption.

To estimate the efficiency of the model test (Hosmer and Lemeshow) was used, which showed no significant differences between the values predicted for the dependent variable (Y) and the values seen, where the fallen value of chi-square to (7.717) level of significance (Sig = 0.05) which to some extent unacceptable, and therefore the resulting model is proportional to the data seen and able to predict the status of adoptions in the sample.

This model was able to predict the rate (76.8%) of the values seen for the dependent variable, depending on the predictive variables, as shown in Table 19.2.

- **Factors affecting the function of adoption (Y):**

The results showed the presence of (5) independent variables significantly affect effectively on the function adoption as shown in the Table 19.3, while the other independent variables were ineffective.

The Wald test indicated that all the constants for predictive variables in the model within the areas of significant on the confidence (5 and 1%), have a significant effect on the likelihood of adoption.

The Constant refers to the expected value of the likelihood of adoption when all predictor variables are equal to zero, and so it is not useful in practice, while constants (B) measure the estimate predictive of independent variables to predict the logarithmic likelihood of adoption (Y = 1), where increasing or decreasing in

Table 19.2 Measuring the predictive ability of the model used and approved for variable (Y)

Cases (frequencies)		Predictive frequencies		Total	Proportion of correct (%)
		Adopter	Non adopter		
frequencies observation	Non adopter	13	39	52	75
	Adopter	34	9	43	79.1
Total		47	48	95	76.8

Source: Sample survey

Table 19.3 Independent factors affecting the function adoption of soil analysis (Y)

Variables affecting	Kind of impact	Constant (B)	Test Wald	Exp (B)	The possibility of adoptions per unit (%)	Probability of adoption (%)
X1: farmers experience	Positive	0.065*	5.846	1.067	1.626	51.6
X2: personal knowledge of farms in analyzed soil	Negative	−0.062*	4.814	0.940	−1.547	48.5
X3: irrigated area	Negative	−0.091**	9.382	0.913	−2.269	47.7
X4: source sampling extension	Positive	1.115*	3.956	3.050	25.309	75.3
X5: source sampling farmers schools	Positive	2.039	2.731	7.683	38.483	88.5
Fixed (constant)		−2.096	3.306			

*5% level of confidence
**1% confidence level

the logarithm refer to the likelihood of adoption with the increase or decrease independent factor, after keeping all other factors independent are constant, at the same time a reference constant refers to the nature and direction of the relationship between the variable predictive and variable adoption, where all the predictive variables affect the likelihood of adoption.

The values of the constants are in logarithmic so it is often difficult to interpret, so values have been converted to exponential (e^B) each of which reflects the odds ratio (Odds Ratio) occurs due to the increase adoptions independent factor by one unit. And also determine the relative importance of the independent variables corresponding, where percentage more than (1) refers to an increase in the likelihood of adoption, while percentage less (1) refers to a decrease in these odds, the percentages near (1) refer to a weak predictive factor corresponding effect on the likelihood of adoption, at the same time indicating the equal ratio of one to the lack of this effect.

The independent factors are:

- Farmers experience (x_1): The experience of the farmers in their Farm is increasing the likelihood of adoption to 51.6%, specifically, the increase of farm experience for one year leads to increase in the likelihood of adoption by 1.6%.
- Personal knowledge of farms in analyzes soil (x_2): The knowledge of farms in analyzed soil from indicative impacted negatively on the adoption of soil analysis which leads to the lower likelihood of adoption (48%).

- Irrigated area (x_3): increase in irrigated area leads to decrease the likelihood of adoption to (47.7%) and in particular the increase in agricultural land irrigated by one Donum will lead to decrease the possibility of adoption to (2.3% only) with the fixed of other influencing factors constant and this to interpret why farmer who has irrigated land, had the conviction that increasing the amount of fertilizer leads to increased production so it does not comply with the recommendations.
- Source taking sample through Agricultural Extension (x_4): The knowledge of farms analyze the soil through agricultural extension in the region increases the likelihood of adoption to 75.3%.
- Source taking sample through the farmers' schools (x_5): The adoption of farmers on farmer's schools as a source of analysis raises the possibility of adoption to 88.5%.
- Depending on the constants independent factors included in the model, we can write the logarithmic regression equation for the adoption of the following form:

$$\boxed{\mathbf{Log(Y/1-Y)} = -2.096 + 0.065\mathbf{X_1} - 0.062\mathbf{X_2} - 0.091\mathbf{X_3} + 1.115\mathbf{X_4} + 2.039\mathbf{X_5}}$$

4 Diseases caused by non-compliance with the recommendation fertilizer to the farm in the southern region:

The given fertilizer recommendations to the farmer by the content of the soil of nutrients and the results of laboratory analysis of the sample are based on the tables of private required elements for crops and fruit trees.

When farmers are non-compliant with the fertilizer recommendations given to the farmers, this will reflect negatively on the plant, soil and manifested symptoms of the lack of elements on the plant and general weakness, which allow for a plant to become susceptible to attack, insect pests, pathogens, and therefore death, that in the event of the poor soil of nutrients either if the content of the soil is good, including more nutrients, advised not to add fertilizer except nitrogenous for soil and if you did not comply with the fertilizer recommendation accumulate nutrients in the soil and produces the so-called contradistinction between them and discourage grow and prevent absorption of another element so appear symptoms shortage on the plant and it is also reflected on the soil where eventually it leads to degradation of the soil and a lack of productivity.

Organic fertilizer is obtained by purchasinged directly from breeders or facilities breeding cattle, sheep, and poultry. It is added during the fall and winter, and the method used for the fermentation of organic fertilizers by placing them in a suitable hole form and to add to them the appropriate amount of urea 46%, and flooded with water and then covered by Polyethylene and leave for three months (July–August–September), while it become the wet from time to time, and then get it from the hole and then added directly to the soil.

Some farmers have an incorrect opinion that fertilizer can stay on the land without any processing it will become a fermented fertilizer. While more farmers are adding animal waste in its fresh form on the soil causing weed growth in abundance because the seeds live in fresh waste.

The sample taken related to land area and topography and crop grown and the purpose of the analysis, according to a spot of injury or illness in the field, and taken into account when sampling from the fields of fruit trees to be deep depth proliferation maximum of roots which are up to 90 cm, which is divided into three horizons, each 30 cm. If the ground is homogeneous and there is no disease in the plant, but if the opposite must representation of the entire field (high–low-injury …), while field crops sample shall be taken at a depth of 30 cm only, and should be taking into account the above-mentioned conditions to the nature of the field.

The farmers are soil analyses after the end of the season and prepare for the new season, and for each crop separately to get the equation of fertilizer to keep the earth in balance and good productivity.

The farmer's answers varied about the amount of the increase in the production, which varied according to the type of crop and the age of the trees and the rainy season, which ranged between 15 and 20% increases in the event of a complete fertilizer application recommendation.

5. **The reasons for non-compliance with fertilizer recommendation:**

The reasons for non-compliance with the analysis and recommendations of the laboratory analysis, from the opinion of farmers, are 41% non-convenient analysis and in particular quantities of fertilizer recommended, because the farmers convinced that increasing the amount of fertilizer results in an increase in production, also 34% of the answers were the cause of non-compliance is the neglect and indifference and 15% of the answers were the cause of bad weather, and 10% because they didn't find fertilizer in the market. Fig. 19.1 shows these reasons.

When we asked farmers about the most important problems which they suffer in the field of soil analysis varied responses between the provinces and were confined to four basic problems. First is the lack of analysis of microelements to know minor elements in the soil it forms 42.9% of the farmers and this shows the interest of farmers subject of analysis of trace elements in the soil, due to the presence of diseases caused by lack of or increase these elements in the soil. The second

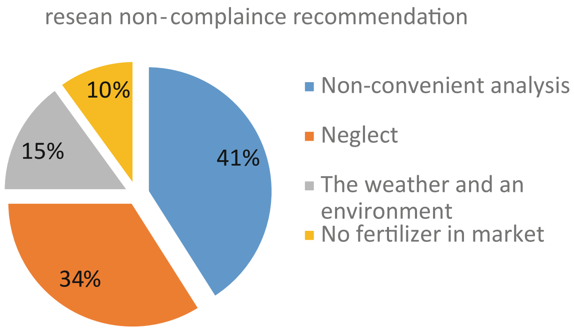


Fig. 19.1 Reasons for non-compliance with fertilizer recommendation by farmer's opinion. *Source* Sample survey

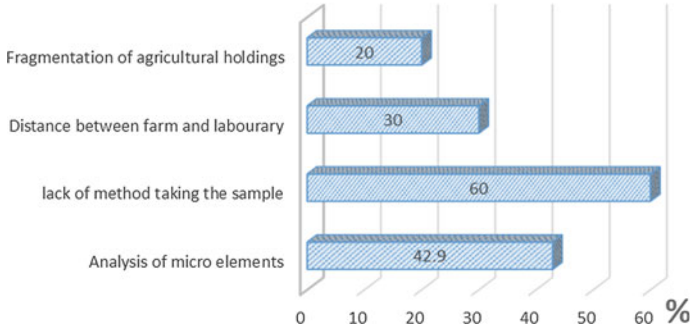


Fig. 19.2 Problems face by farmers in soil analysis by the farmer's opinion. *Source* Sample survey

problem was the difficulty of sampling or lack of knowledge in a way taken correctly, as believed in it more than 60% of them and they depend on their personal experience in taking the sample. While 30% said that the distance from their fields plays a vital role for the farmer and the lack of supervision to collection process and bringing the samples to the laboratory in a timely manner. And formed the problem of fragmentation of agricultural holdings 20% of farmers' problems in the analysis of the soil (Fig. 19.2).

When farmers were asked for their suggestions and views on the most important solutions that can help them in the field of soil analysis were the answers are as follows:

45% of farmers who have analyzed their soil indicated the need for a devices to analyze the components of soil, especially small ones and 15% of the farmers suggested the need for scientific publications and periodicals about the most important diseases facing the crops due to lack of or increase in micronutrients and major in soil and 10% of the farmers.

They found that it is preferable that the laboratory takes the sample. As reported by 15% of the farmers' need for guidance courses or field days to teach farmers the correct way to take a sample. And 5% of them stressed the importance of giving fertilizer by the Agricultural Bank building on the results of soil analysis.

– Most farmers 76% will continue dealing with laboratories to analyze the soil will continue to analyze soil and even if the analysis were not free.

19.5 Conclusions

– The lack of fertilizer in the market or provide some of them or provided in a period is not suitable as additional fertilizer and a link to this add-on for some amount of rainfall and the non-return of some farmers to take the results of the analysis are the most important reasons for non-compliance with the recommendations fertilizer recommended by the laboratory or the lack of trust between farmers and technicians and guidance are other reasons for non-compliance with the recommended fertilizer.

– Most farmers 76% will continue dealers with laboratories to analyze the soil will continue to analyze soil even if analysis were no longer free.
– Most farmers surveyed in the sample refer that has guided them to take soil sampling method for analysis by extension staff and agricultural research centers and finally to rely on personal experience.
– The regression equation to adopt a soil analysis showed that the experience of farms, sampling by extension, the farmer schools positively affect and are significant at the 5% level, while a negative impact on both the irrigated area and the lack of knowledge of farms analyzed the soil.
– The application of a complete fertilizer equation according to the recommendations of laboratory analysis gives an increase in production estimated at 15–20%, depending on the crop grown.

19.5.1 Recommendations

– More seminars and workshops for farmers to show the importance of conducting an intensive analysis of the soil for farmers to demonstrate its usefulness in providing fertilizer and increase production and thus achieve an economic return.
– The need for scientific and periodic bulletins about the most important diseases facing plants as a result of a decrease or increase in the minor and major elements in the soil.
– Conduct Extension sessions or days of the intensive field to teach farmers the correct way to take a sample from the laboratory and the extension staff.
– Give the fertilizer to the farmers at low prices, based on the results of soil analysis and provided in the appropriate period.
– Increase trust between the farmers and the laboratory, and encourage farmers to follow the instructions for the sampling method for the analysis and apply of fertilizer recommendations, which ensures an increase in production on farms ranging between 15 and 20% per unit area.

References

Abdul Latif, A. (1996). *The economics of land*. Syria: Aleppo University Press, College of Agriculture.

Deep, M. (1999). *Fertility and plant nutrition* (2nd ed.). Syria: University of Damascus.

FAO. (2015). *Project design and management training program for professionals in the water sector in the middle east*.
GCSAR. (2015). *Annual reports for the management of natural resources research, 2008–2015*.
MOAR. (2015). *Annual agricultural statistical abstract*. Damascus, Syria.
NAPC. (2014). *The state of food and agriculture in Syria*. National Center for Agricultural Policy.
Ryan, J. E. (2013). Soil and plant analysis laboratory manual. In *The International Center for Agricultural Research in the Dry Areas* (*ICARDA*).

Chapter 20
Revealed Comparative Advantage BRICS-EU 28: Some New Evidence

Georgios Xanthos and Argiro Moudatsou

Abstract The emergence of BRICS as major exporters on international markets is one of the drawing forces behind the industrialized countries' loss of global markets. China has clearly become the most serious challenge to the EU's industrial competitiveness. But the BRICs also provide formidable opportunities for exports. The motivation of our study is to focus on the trade relationship between BRICS and EU and through revealed comparative advantage indices to search for new opportunities and challenges created between those great partners. In the present study, focusing on the value of exports of BRICS (Brazil, Russia, India, China and South Africa) to EU28 for the period 2010–2016, we investigate first, in what and how many categories of goods each BRICS-member has a positive standard of normalized comparative effect and second we examined the trade pattern of these countries in respect to their exports to the European Union of 28. Using export data 1233 product groups 4 digits HS 2002 classification we constructed the Normalized Comparative Advantage (NRCA) index for each BRICS-member, and for each year of period 2001–2016.). The results suggest convergence of Brazil and S. Africa and divergence of Russia, China, India economies. Brazil is specialized in primary sector and minerals, Russia is specialized in basic metals, India and China are specialized in primary sector products but they have very strong presence in chemicals, semifinished products and manufacturing. Finally South Africa is specialized in primary sector, textiles and minerals.

Keywords Revealed comparative advantage · Balassa's and normalized indices Galtonian · Convergence · Emerging economies · BRICS

JEL Classification C1 · F14 · F

G. Xanthos · A. Moudatsou (✉)
TEI of Crete, University of Applied Sciences, Heraklion, Greece
e-mail: moudatsou@staff.teicrete.gr

G. Xanthos
e-mail: xanthosg@staff.teicrete.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_20

20.1 Introduction

BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa. The grouping was originally known as 'BRIC' before the inclusion of South Africa in 2010. The 'BRICs'[1] has been an increasingly popular concept after Golman Sachss officer Jim O'Neiil coined the acronym (2001), to characterize this group of emerging economies. The countries of this group share as common characteristics large populations, less developed but fast growing economies, and governments willing to embrace global markets by their significant influence on regional and global affairs.

Fundamentally, the BRICs phenomenon mirrors a general shift in the international balance of power, with the center of gravity moving from the North to the South. The implications of the rise of the BRICs are certainly large for the world economy.

It is evident that the rapid growth of the BRICs is supported by the integration of the domestic markets into the globalizing world economy. External factors, such as the global economic environment and the performance of foreign markets are also determinants of the sustainability of their growth.

Notwithstanding the current global crisis, their catching-up process is expected to continue, creating additional new opportunities as well as numerous challenges for the rest of the world and for the European Union (EU) in particular.

For several reasons, emerging economies of Brazil, Russia, India and China and South Africa have acquired important role in the world economy as producers of goods and services. The BRICS countries apart from complementing their respective economies in terms of resource exchange are also the major resource suppliers to the industrialized world.

National policies also often conflict with each other because of previous efforts to promote or defend the past, present, and future comparative advantages. The decisions of these conflicts and the establishment of coherent policies are hampered by the lack of information and the lack of analysis of the current comparative advantage model and the way it is likely to change in the future.

Our study is focused on the trade relationship between BRICS and EU and through revealed comparative advantage indices we search for new opportunities and challenges created between those great partners. The objectives of this study are twofold:

First to analyse in how many product groups each BRICS member has a comparative export advantage regarding EU28 and the World and second to identify how the pattern of exports is differentiated between Europe28 the world, in terms of convergence or divergence. The rest of the paper is organized as follows. Section 20.2 review relevant studies. Section 20.3 provides evidence on external trade between BRICS and EU28, Sect. 20.4 provides description and evaluation on

[1]http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0121-47722012000200010%20-%202

the Comparative Advantage Indices Sect. 20.5 provides evidence about the products that have been advantage to of each one of the BRICS in relation to trade with EU28, Sect. 20.6 concludes.

20.2 Literature Review

As far as we know there is not extend empirical work regarding the comparative advantage of BRICS in global economic relationships.

Chen (2012) uses the index of the "export revealed comparative advantage" (XRCA) and 2010 export data to identify the comparative advantage of the BRICs in certain products or product groups. The evidence show that BRIC economies. move to the lowest parts of the world value chain. The BRICs' comparative advantage is detected in natural resource intensive and unskilled labor intensive products with Brazil's and Russia's comparative advantage to be based in exporting natural resource intensive products and China's in exporting unskilled labor intensive low technology manufactures. India is the only economy of the BRICs that has human capital intensive products among its top ten export products. However, the technology contents of these products are quite limited.

Raghuramapatruni (2015), using the Balassa RCA and RID (revealed import dependence) indices in 14 distinct sectors, find evidence that the BRICS countries are complementary rather than competitive to each other in these sectors. Brazil has comparative advantage in food, fuels and mining, India in fuels and mining and pharmaceuticals, China in machinery and transport, telecommunications, textiles, clothing, steel and iron, Russia in fuels and mining, iron and steel and South Africa in chemicals, iron and steel, automotives. One significant observation is that Intra-BRICS trade is asymmetrical as it is driven largely by Chinese demand for inputs. Kocourek (2015), uses the index of Revealed Symmetric Comparative Advantage (a version of the classic Balassa's RCA) to estimate the structural changes that have taken place in BRICS' trade during the last two decades (1995–2013). The results show a continues shift from primary manufacturing and of products with low added value to more sophisticated ones.

Havlik and Stöllinger (2009) explore the opportunities and competitive challenge that the BRICS countries represent for the EU. Using the classic Balassa RCA index the authors analyse the trade patterns in manufacturing industry trade between BRICs and the TRIAD (EU, US, JAPAN) The evidence indicates that BRICS have revealed comparative advantage mainly in labour intensive industries, but it is not limited to these. Trade data of the BRICs indicate that they have also comparative advantages in marketing driven industries (except for Russia in trade with the EU and the United States and Brazil in trade with Japan)

Beyene (2014a) This study examined the revealed comparative advantage (RCA) of sub-Saharan Africa (SSA) and Latin America & Caribbean (LAC) on the export of five merchandise subsectors (during 1995–2010). The evidence reveals that SSA region has higher RCA in export of agricultural raw materials, fuel, and ores and metals than LAC. Both regions have revealed comparative disadvantage in the export of manufactures, though lesser in LAC.

Beyene (2014b), in another study examines the RCA between SSA and South Asia on the export of merchandise subsectors, shows that SSA has higher RCA in export of agricultural raw materials, fuel, and ores and metals than South Asia. While S. Asia has shown a change from RCA to comparative advantage position in export of ores and metals (even though SSA haw higher RCA)

Interestingly, the study reveals that both regions have lower competitive position in manufactured goods export. Sub-Saharan Africa's revealed competitive position is stronger than South Asia in merchandise export except in manufactured goods.

Beyene (2015) examines the comparative advantages of BRICS and SSA economic blocks with respect to the exportation of merchandise (food, agricultural raw materials, fuels, ores and metals, and manufactures). The evidence shows the BRICS's structural transformation towards higher valued-added commodities while in the case of sub-Saharan Africa, with the exception of manufactures exports, it is found to have comparative advantages in all merchandise exports.

20.3 BRICS-EU28 Extrenal Trade

The share of the value of exports directed to the countries of Europe28 from the BRICS countries (Brazil, Russia Federation, India, China, S. Africa) during the period 2001–2016 is presented on Table 20.1.

For Brazil, the share has a downward trend and in the year 2016 the share is reduced by 8.9 percentage points compared to 2001. Both India and South Africa share a downward trend. For India, its share in the year 2016 is 6.6 percentage points lower than in 2001. South Africa shows a moderate downward trend in 2001–2008 which becomes more intense from 2009 on and in 2016 the share is reduced by 15.4 percentage points compared to 2002. Finally, Russia differs from the other BRICS countries with a slight upward trend and 0.6 percentage points more in 2016 than in 2001.

Under the assumption of the revealed comparative export advantage focusing on the value of exports of the BRICS (Brazil, Russia, India, China and South Africa) to all 28 countries (EU28) for the period 2001–2016, we investigated for each BRICS member the following: (a) In how many product groups each BRICS member has a comparative export advantage regarding EU28 and the World, and (b) how the pattern of exports is differentiated between Europe28 and the world, in terms of convergence or divergence.

In order to investigate the above, we have used the BRICS export value data for all EU28 members for the period 2001 to 2016. The data were derived from the International Trade Center and concern 1233 product groups (4, digits HS 2002).

Table 20.1 Evolution of BRICS export 's shares to EU28

Countries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	26.7	25.9	25.8	25.6	22.9	22.6	25.3	23.6	22.4	21.5	20.8	20.3	19.7	18.8	17.8	17.8
Russian Fed	39.2	39.2	39.6	42.1	46.6	47.1	47.9	45.4	43.6	46.5	44.6	46.8	45.8	45.1	39.8	39.8
India	23.5	22.6	22.8	22.1	22.6	21.4	21.7	21.6	20.6	18.9	18.2	16.8	16.7	16.2	16.9	16.9
China	16.8	16.3	18.1	18.4	19.2	19.7	20.3	20.6	19.8	19.8	18.9	16.4	15.4	15.9	15.7	15.7
S. Africa	37.2	39.3	36.0	36.3	36.1	35.4	33.0	31.9	26.5	22.4	19.0	17.2	17.7	19.7	21.8	21.8

Source International Trade Center and authors' calculations

20.4 The Method: Revealed Comparative Advantage Indices and the Changes in Export Patterns

20.4.1 Comparative Advantage Indices

Comparative advantage is not a static phenomenon; rather it is subject to change over time. Dynamic comparative advantage is a process where the best mix by location of commodity production among countries changes consistently with changing relative supply and demand both at home and abroad.

Comparative advantage changes as development proceeds and as capital-labor ratios increase. Investment in physical and human capital alters a country's economic structure and its relations with the rest of the world. Thus, some of the most successful developing countries, those which have already attained or are rapidly approaching middle income status, have abandoned their comparative advantage to agriculture in the process of reallocating national resources.

Because patterns of comparative advantage change, countries need the capability to adjust the structure of internal production whenever their future comparative advantage does not conform with their past comparative advantage. An outward orientation toward foreign markets is therefore critical. For a country to survive and prosper when it is exposed to the international market, the pattern of domestic production must be based on the principle dynamic comparative advantage.

However, conflicts between private and social welfare frequently arise as the pattern of on the principle of dynamic comparative advantage changes.

National policies also often clash with each other because of previous efforts to promote or defend past, present and future comparative advantages. Resolutions of these conflicts and establishment of consistent policies are hampered by the paucity of information and the absence of analyses concerning the current pattern of comparative advantage and how it is likely to change in the future.

Analysis of comparative advantage (CA) is not a new idea. The notion of CA is attributed to the work of J. S. Mill, A. Smith and D. Ricardo. The most known ca index is that of Balassa (1965).

The index compares the share of a good in a country's total exports with the same share in total world exports. It is also possible to calculate a similar index for imports (it would measure import dependence).

$$\mathrm{BI}_{\mathrm{ic,t}} = \frac{\frac{\mathrm{X}_{\mathrm{ic,t}}}{\mathrm{X}_{\mathrm{c,t}}}}{\frac{\mathrm{X}_{\mathrm{iw}}}{\mathrm{X}_{\mathrm{wt}}}} \mathrm{BI}_{\mathrm{ic,t}} = \frac{\frac{\mathrm{X}_{\mathrm{ic,t}}}{\mathrm{M}_{\mathrm{ic,t}}}}{\frac{\mathrm{X}_{\mathrm{c,t}}}{\mathrm{X}_{\mathrm{c,t}}}}$$

Athough the Balassa (1965) index is considered to be the successor of the export performance index (Liesner 1958), the Balassa index is the Location Quotient (Florence 1948) which is used to determine the export base of a region (Isserman 1977). The value of the Balassa index is derived from (20.1):

$$BI_j^i = \frac{E_j^i/E^i}{E_j/E} \tag{20.1}$$

where E_j^i is the export of product j from country i E^i is the total country's exports, E_j is the total exports of product j from the reference countries and E is the total of exports of the reference countries. Several weaknesses have been highlighted for (20.1). His weakness regarding his non-symmetry was treated by logarithmic transformation (Vollrath 1991) provided that $E_j^i \neq 0$. The problem with zero exports and asymmetry of the index was treated with the following index based on the Balassa index (Dallum et al. 1988)

$$\mathrm{BI}_{ij}^{D} = \frac{\mathrm{BI}_j^i - 1}{\mathrm{BI}_j^i + 1} \tag{20.2}$$

Without solving the problem with the symmetry of the index (20.1), the weighted index of the comparative advantage (Proudman and Redding 1998) was made that makes comparisons between countries over time possible. In addition to multiplier form of the above indices, the additive form was also proposed in order to capture the comparative export advantage, with the explicit position that the country in question should not be included in the reference countries (Hoen and Oosterhaven 2006). For the properties of the indicators, more extensive reference can be found in Sanidas and Shin (2010), Bebek (2017).

The indices mentioned above essentially compare the exports of one country to the exports of countries of a reference group. Their proposed variants failed to improve the index's ability to be useful in comparisons between different countries at different times and at the same time be unaffected by the aggregation problem (Yeats 1985; Ballance et al. 1987; De Benedictis and Tamperini 2001).

Marquillas (1972), proposed, the normalized indicator of the revealed comparative advantage NRCA (Yu et al. 2009) which is symmetric and is not affected by aggregation and makes comparisons possible in space and time. The normalized index of the comparative export advantage taking values in the interval [−1/4, 1/4] and with a neutral zero point between is given by (3)

$$\mathrm{NRCA}_j^i = \frac{\mathrm{E}^i}{\mathrm{E}}\left(\frac{\mathrm{E}_j^i}{\mathrm{E}^i} - \frac{\mathrm{E}_j}{\mathrm{E}}\right) \tag{20.3}$$

where i = 1, 2, 3, … n is a set of reference countries and j = 1,2,3, m is a set of products exported from the reference countries. E_j is the total of exports of the product j from all reference countries, E is the total of exports of all products from the reference countries and $\mathrm{E}_j^i, \mathrm{E}^i$ are the corresponding figures for country i, i.e. exports of j i and all of its exports i. Also, the sum of the index values for all product categories is zero, i.e. $\sum_j^m \mathrm{NRCA}_j^i = 0$ since neither can a country have a comparative advantage in all its exportable products nor a all countries can have a comparative advantage in the same product J. So it is true that $\sum_{i}^{m} \mathrm{NRCA}_{j}^{i} = 0$

Index (3) was used in this study to identify the product groups in which each of the BRICS member countries has a comparative export advantage. The order of calculated NRCA index values reflects the importance of a product group for the export model of the country under consideration. For example, if for the product group j and j + 1 we have $\mathrm{NRCA}_{j}^{i} > \mathrm{NRCA}_{j+1}^{i}$ it is concluded that group j is more important for the country's export model than the j + 1 group.

(Because of the tables's size, the indices calculation tables are not reported here, but are available upon request)

20.4.2 Changes to Export-Pattern-Galtonian Regression Analysis

To examine further the changes in export-pattern we use two instruments. The Galtonian regression and the Kendall correlation coefficient. With Galtonian Regression (Hart and Prais 1956) we examine the convergence or divergence in the export pattern of an economy. If products with an export advantage are weakened while products that do not have an export advantage are strengthened, se say that we have the export pattern convergences. If products with an export advantage are further strengthened and products that do not have an export advantage are further weakened then the export pattern diverges. It is therefore particularly interesting to diagnose the current trend towards convergence or divergence. The diagnosis of convergence or deviation can be done between two time points t_1, t_2 for country i, assuming the normal distribution of the error term term ε_{ij}

$$\mathrm{NRCA}_{jt2}^{i} = a_i + \beta_i \mathrm{NRCA}_{jt1}^{i} + \varepsilon_{ij} \tag{20.4}$$

The estimated value β_i, the coefficient of determination R_i^2 and the ratio of variances $\sigma_{t2}^2/\sigma_{t1}^2$ of index values $\mathrm{NRCA}_{jt2}^{i}, \mathrm{NRCA}_{jt1}^{i}$ help to diagnose the convergence, divergence or stability of the export pattern, of the economy under consideration. (Hart 1995) based on

$$\frac{\sigma_{t2}^2}{\sigma_{t1}^2} = \frac{\beta_i^2}{R_i^2} \tag{20.5}$$

For these purpose we co-examine the values of β_i's, b_i/R_i and $\frac{\sigma_{t2}^2}{\sigma_{t1}^2}$

Critical values for the above tests:

(1) If $b_i > 1$ and $(b_i/R_i) > 1$ the export pattern of the country under consideration diverges

(2) If $b_i < 1$ and $(b_i/R_i) < 1$ the export pattern of the country under consideration converges
(3) If $b_i < 1$ and $(b_i/R_i) > 1$ the export pattern of the country under consideration diverges, (since $b_i/R_i > 1$ is necessary and sufficient condition)
(4) Finally, if $b_i < 0$ the range is reversed between years.
(5) If $\frac{\sigma_{t2}^2}{\sigma_{t1}^2} > 1$ the export pattern convergences, while if $\frac{\sigma_{t2}^2}{\sigma_{t1}^2} < 1$ the export pattern divergences

20.4.3 τ-Kendall Correlation Coefficient

The examination of the temporal changes in the index range reveals both export dynamics in the country under consideration and variations in the index range reflect the change in the importance of product groups to the country's export pattern.

We use the Kendall coefficient of correlation (Siegel 1956), which takes into account the order of all values and not just one pair of values. If the value of the index calculated for years t and t + 1 is positive and high we conclude that the series are correlated for the years under consideration. In other words it is concluded that the importance of the products to the country's export pattern, as derived from the NRCA price range, has not been differentiated between the two periods.If the value of the index is negative, the comparisons of values order lead to one-year series violations with respect to the other.

Therefore, the ranking of products based on the NRCA value, from the product with the most powerful comparative advantage to the weaker, is nothing but a reflection of the image of a country's export model. If this series over time does not differentiate the export pattern of the country in relation to the importance of the products remains stable.

20.4.4 Sectoral Distribution of Products with RCA

Before we proceed to indices results we present the sectoral distribution presentation, of products with RCS for each BRICS member.

It should be noted that according to the HS2001 code the products offered in international trade have been classified into **21 sections** and **98 chapters**. Each section contains different number of chapters and each chapter contains different number of product group.

I.e. In Section I (Live Animals—Animal Products) correspond 5 chapters, that is group of products, while in Section II (Vegetable products) correspond 19 chapters.

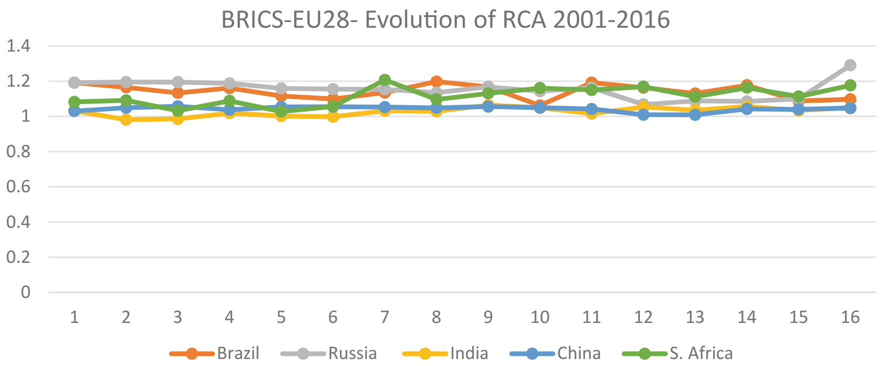
So, if one country has CA in one chapter this does referred to all product groups, but just to a percentage of these groups.

Regarding the appendix Table 20.14, the sectors of economic activity in which BRICS countries have RCA are: For Brazil: Primary sector and in Minerals. For Russia: Basic Metals. For China and India: Mainly Primary sector but they have very strong presence in chemicals, semifinished products and manufacturing For S. Africa: Primary sector, textiles and minerals.

20.5 Results

20.5.1 *Number of Products with Export Comparative Advantage and Exports-Shares Ratio*

Tables 20.2, 20.3, 20.4, 20.5 and 20.6 below lists (a) the number of product groups for which each BRICS member has a comparative export advantage each year regarding the EU28 and the World and (b) the share of the export value of products with comparative advantage which are directed to the EU28 and the share of export value of products with comparative advantage directed towards the world. If the ratio is greater than the unit, then the relative importance of export-oriented products directed to the EU28 is higher than the rest with a comparative advantage directed to the rest of the world.



For all BRICS members the comparative advantage in trade with the EU28 is greater than trade with the rest of the world.

Moreover for Brazil the trend as well as the number of product-group are declining.. The same results also arise for Russia. For India, the trend is slightly upward in favor of EU28 trade. Regarding the number of product-group in which it has an export advantage there is no trend For China, the trend is declining and balancing the trend in the number of product-group is upward. Finally for S. Africa,

Table 20.2 Brazil-EU28-World

Brazil	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	185	189	204	207	203	198	195	186	168	168	171	157	160	162	165	163
World	262	257	266	262	267	267	255	231	225	209	191	196	191	192	211	209
s/s*	1.192	1.165	1.134	1.161	1.116	1.099	1.136	1.198	1.168	1.062	1.192	1.163	1.130	1.177	1.088	1.088

s = Brazil's export value of products with RCA to EU28/total exports to EU28
s* = Brazil's export value of products with RCA to World/total exports to world

Table 20.3 Russia-EU28-World

Russian Fed	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	141	140	137	115	103	96	86	77	74	69	66	74	73	78	89	91
World	159	163	148	138	124	122	118	105	110	101	95	120	118	114	147	161
s/s^*	1.191	1.195	1.195	1.188	1.159	1.155	1.099	1.135	1.168	1.143	1.163	1.068	1.088	1.085	1.099	1.099

s = Russia's export value of products with RCA to EU28/total exports to EU28
s* = Russia's export value of products with RCA to World/total exports to world

Table 20.4 India-EU28-World

India	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	319	324	329	345	339	352	362	341	305	316	332	324	330	352	332	334
World	359	375	384	378	378	378	365	377	322	330	329	346	350	351	365	366
s/s*	1.032	0.981	0.985	1.019	1.002	0.998	1.032	1.029	1.128	1.049	1.078	1.053	1.035	1.057	1.033	1.033

s = India's export value of products with RCA to EU28/total exports to EU28
s* = India's export value of products with RCA to World/total exports to world

Table 20.5 China-EU28-World

China	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	383	385	373	373	395	413	413	424	396	410	435	443	452	439	423	435
World	506	489	469	485	501	513	512	522	513	538	551	555	564	567	552	547
s/s^*	1.030	1.049	1.057	1.038	1.053	1.055	1.053	1.048	1.056	1.049	1.042	1.010	1.009	1.042	1.040	1.040

s = China's export value of products with RCA to EU28/total exports to EU28
s* = China's export value of products with RCA to World/total exports to world

Table 20.6 South Africa-EU28-World

S. Africa	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	189	202	201	196	185	179	183	178	189	173	161	175	174	176	157	156
World	273	310	293	259	270	258	227	231	246	309	271	297	290	305	298	278
s/s*	1.082	1.091	1.032	1.088	1.028	1.057	1.207	1.096	1.131	1.161	1.150	1.169	1.112	1.163	1.113	1.113

s = S. Africa's export value of products with RCA to EU28/total exports to EU28
s* = S. Africa's export value of products with RCA to World/total exports to World

the trend is increasing while the number of groups of products in which it has an export advantage is declining.

20.5.2 Galtonian Regression Results: Export-Patterns Changes

Regarding the convergence or deviation of the export pattern

Brazil: Between the years 2001 and 2016 the export pattern of the country in relation to its exports to the EU28 *converges* because $\frac{\sigma_{16}^2}{\sigma_t^2} = 0.537 < 1$, $b_i = 0.606 < 1$ and $b_i/R_i = 0.733 < 1$ (Table 20.7).

Russia: Between the years 2001 and 2016 the export pattern of the country in relation to its exports to the EU28 *diverges* because $\frac{\sigma_{16}^2}{\sigma_t^2} = 1.383 > 1$, $b_i = 1.015 > 1$, $b_i/R_i = 1.176 > 1$ (Table 20.8).

India: Between the years 2001 and 2016 the export pattern of the country in relation to its exports to the EU28 *diverges* because $\frac{\sigma_{16}^2}{\sigma_t^2} = 1.648 > 1$, even though $b_i = 0.9521 < 1$, since $b_i/R_i = 1.284 > 1$ (necessary and sufficient condition) *there* is evidence that India's export pattern regarding EU28 diverges (Table 20.9).

China: Between the years 2001 and 2016 the export pattern of the country in relation to its exports to the EU28 *diverges* because $\frac{\sigma_{16}^2}{\sigma_t^2} = 9.626 > 1.b_i = 2.548 > 1$ and $b_i/R_i = 3.103 > 1$ (Table 20.10).

S. Africa: Between the years 2001 and 2016 the export pattern of the country in relation to its exports to the EU28 *converges* because (Table 20.11)

$$\frac{\sigma_{16}^2}{\sigma_t^2} = 0.492 < 1, b_i = 0.415 < 1 \text{ and } \frac{b_i}{R_i} = 0.701 < 1$$

20.5.3 Kendall Correlation Coefficient Results

With regard to the τ-Kendall index, obviously the longer the distance from the year 2016, the lower the price. This can be attributed to changes in the importance of a product group to the export pattern of each country. The index values of all BRICS exhibits an upward trend. This trend indicates that the importance of group products for the country's export model is stabilized as we move towards 2016 (Table 20.12).

Table 20.7 Brazil, b_i, b_i/R_i, $\frac{\sigma_{16}^2}{\sigma_t^2}$

Brazil	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
b_i	0.606	0.664	0.632	0.628	0.671	0.742	0.733	0.624	0.665	0.603	0.537	0.696	0.669	0.791	0.935
b_i/R_i	0.733	0.789	0.760	0.730	0.802	0.891	0.836	0.732	0.747	0.693	0.635	0.765	0.753	0.852	0.963
σ_{16}^2/σ_t^2	0.537	0.623	0.578	0.533	0.643	0.794	0.700	0.536	0.558	0.480	0.403	0.585	0.567	0.726	0.927

Authors' calculations

Table 20.8 Russia b_i, b_i/R_i, $\frac{\sigma_{16}^2}{\sigma_t^2}$

Russia	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
b_i	1.015	0.893	0.771	0.619	0.476	0.456	0.494	0.422	0.511	0.473	0.446	0.447	0.467	0.501	0.736
b_i/R_i	1.176	1.044	0.913	0.740	0.562	0.530	0.548	0.485	0.585	0.530	0.506	0.504	0.523	0.572	0.845
σ_{16}^2/σ_t^2	1.383	1.090	0.834	0.548	0.316	0.281	0.300	0.235	0.342	0.281	0.256	0.254	0.274	0.327	0.714

Authors' calculations

Table 20.9 India, b_i, b_i/R_i, $\frac{\sigma_{16}^2}{\sigma_t^2}$

India	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
b_i	0.953	0.908	1.054	1.120	0.845	0.877	0.867	0.747	0.498	0.477	0.445	0.586	0.542	0.834	1.027
b_i/R_i	1.284	1.231	1.283	1.311	0.998	1.046	0.996	0.894	0.691	0.678	0.608	0.749	0.683	0.895	1.042
σ_{16}^2/σ_t^2	1.648	1.515	1.646	1.718	0.995	1.095	0.992	0.799	0.478	0.460	0.370	0.562	0.466	0.801	1.086

Table 20.10 China, b_i, b_i/R_i, $\frac{\sigma^2_{16}}{\sigma^2_t}$

China	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
b_i	2.548	2.150	1.350	1.079	0.894	0.856	0.910	0.802	0.821	0.691	0.748	0.823	0.887	0.855	0.948
b_i/R_i	3.103	2.607	1.659	1.344	1.103	1.046	0.982	0.903	0.901	0.798	0.853	0.906	0.951	0.905	0.956
$\sigma^2_{16}/\sigma^2_t\tau$	9.626	6.798	2.751	1.807	1.216	1.094	0.965	0.815	0.812	0.638	0.727	0.821	0.904	0.819	0.914

Table 20.11 S. Africa, b_i, b_i/R_i, $\frac{\sigma_{16}^2}{\sigma_t^2}$

S. Africa	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
b_i	0.415	0.334	0.394	0.371	0.338	0.391	0.424	0.435	0.670	0.721	0.721	0.918	0.982	1.042	1.119
b_i/R_i	0.701	0.794	0.751	0.691	0.630	0.681	0.691	0.691	0.991	0.926	0.944	1.177	1.239	1.195	1.138
σ_{16}^2/σ_t^2	0.492	0.631	0.564	0.478	0.397	0.464	0.478	0.477	0.982	0.857	0.891	1.385	1.534	1.428	1.295

Table 20.12 τ-Kendall correlation coefficient

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Brazil	0.641	0.665	0.657	0.67	0.673	0.682	0.716	0.744	0.771	0.784	0.791	0.807	0.82	0.838	0.887
Russia	0.68	0.708	0.717	0.737	0.758	0.763	0.798	0.801	0.832	0.834	0.837	0.837	0.855	0.881	0.902
India	0.578	0.582	0.604	0.612	0.646	0.675	0.704	0.731	0.724	0.784	0.813	0.820	0.857	0.870	0.901
China	0.617	0.638	0.645	0.672	0.694	0.701	0.739	0.770	0.801	0.820	0.841	0.863	0.881	0.900	0.923
S. Africa	0.629	0.637	0.639	0.649	0.683	0.69	0.724	0.714	0.749	0.781	0.8	0.818	0.839	0.873	0.887

20.6 Conclusion

For Brazil, the convergence trend is clear, which means that the groups of products in which it has an advantage in 2001 were weakened and the groups of products in which it has no advantage in 2001 were strengthened. The same results apply to S. Africa.

As far as the Russia, China and India are concerned, their export pattern to EU28 divergence, that is, the products with CA are strengthened further, while the products with no CA are further weakend.

20.7 Discussion

BRICS in their trade with EU28 demonstrate comparative advantage mainly in primary and secondary sector's products. Moreover, according to RCA-indices analysis: Brazil and S. Africa converge, that is, strengthen the products for which they have no CA before. This is indicative that they try to redefine their export-pattern to EU28. Russia, China and India diverge, that is, they strengthen the products with RCA. It seems that they keep the existing trade pattern to EU28.

What does this mean for the EU28 and BRICS regarding their further cooperation and the chances of improvement their economic positions and bargaining power? That is a question we try to answer and it is the next step of our research in this field.

Appendix

In the table below for each BRICS member are listed the percentages of product groups for which each country has a comparative export advantage in 2001 and continue for the same group to have a comparative advantage in the year 2016, by section and chapter in accordance with HS2001 classification (Tables 20.13 and 20.14).

Table 20.13 Products with an export RCA, years 2001–2016 by section (HS2001 classification)

SECTION I—LIVE ANIMALS; ANIMAL PRODUCTS	Brazil	Russian	India	China	Africa
CHAPTER 2—MEAT AND EDIBLE MEAT OFFAL	**40% m**			10%	10%
CHAPTER 3—FISH AND CRUSTACEANS, MOLLUSCS AND OTHER AQUATIC INVERTEBRATES			**29%**	14%	**43%**
CHAPTER 4—DAIRY PRODUCE; BIRDS' EGGS; NATURAL HONEY; EDIBLE PRODUCTS OF ANIMAL ORIGIN, NOT ELSEWHERE SPECIFIED OR INCLUDED	10%		10%	20%	
CHAPTER 5—PRODUCTS OF ANIMAL ORIGIN, NOT ELSEWHERE SPECIFIED OR INCLUDED	**40%**		**20%**	**30%**	
SECTION II—VEGETABLE PRODUCTS	Brazil	Russian	India	China	Africa
CHAPTER 6—LIVE TREES AND OTHER PLANTS; BULBS, ROOTS AND THE LIKE; CUT FLOWERS AND ORNAMENTAL FOLIAGE	25%		25%		**75%**
CHAPTER 7—EDIBLE VEGETABLES AND CERTAIN ROOTS AND TUBERS			14%	21%	
CHAPTER 8—EDIBLE FRUIT AND NUTS; PEEL OF CITRUS FRUITS OR MELONS	**50%**		21%		**57%**
CHAPTER 9—COFFEE, TEA, MATÉ AND SPICES	**50%**		**60%**	10%	
CHAPTER 10—CEREALS	13%		13%		
CHAPTER 11—PRODUCTS OF THE MILLING INDUSTRY; MALT; STARCHES; INULIN; WHEAT GLUTEN			11%		
CHAPTER 12—OIL SEEDS AND OLEAGINOUS FRUITS; MISCELLANEOUS GRAINS, SEEDS AND FRUIT; INDUSTRIAL OR MEDICINAL PLANTS; STRAW AND FODDER	21%		14%	21%	7%
CHAPTER 13—LAC; GUMS, RESINS AND OTHER VEGETABLE SAPS AND EXTRACTS	**50%**		**100%**		

(continued)

Table 20.13 (continued)

SECTION II—VEGETABLE PRODUCTS	Brazil	Russian	India	China	Africa
CHAPTER 14—VEGETABLE PLAITING MATERIALS; VEGETABLE PRODUCTS NOT ELSEWHERE SPECIFIED OR INCLUDED			33%	**33%**	
CHAPTER 15—ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS; PREPARED EDIBLE FATS; ANIMAL OR VEGETABLE WAXES	10%		14%	10%	5%
SECTION IV—PREPARED FOODSTUFFS; BEVERAGES, SPIRITS AND VINEGAR; TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES	Brazil	Russian	India	China	Africa
CHAPTER 16—PREPARATIONS OF MEAT, OF FISH OR OF CRUSTACEANS, MOLLUSCS OR OTHER AQUATIC INVERTEBRATES	40%				
CHAPTER 17—SUGARS AND SUGAR CONFECTIONERY	25%		25%		
CHAPTER 18—COCOA AND COCOA PREPARATIONS	33%				
CHAPTER 19—PREPARATIONS OF CEREALS, FLOUR, STARCH OR MILK; PASTRYCOOKS' PRODUCTS				20%	
CHAPTER 20—PREPARATIONS OF VEGETABLES, FRUIT, NUTS OR OTHER PARTS OF PLANTS	11%		22%	**56%**	**33%**
CHAPTER 21—MISCELLANEOUS EDIBLE PREPARATIONS	33%		17%		
CHAPTER 22—BEVERAGES, SPIRITS AND VINEGAR	11%				11%
CHAPTER 23—RESIDUES AND WASTE FROM THE FOOD INDUSTRIES; PREPARED ANIMAL FODDER	22%	11%			11%
CHAPTER 24—TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES	33%		33%		

(continued)

Table 20.13 (continued)

SECTION V—MINERAL PRODUCTS	Brazil	Russian	India	China	Africa
CHAPTER 25—SALT; SULPHUR; EARTHS AND STONE; PLASTERING MATERIALS, LIME AND CEMENT	24%	7%	21%	28%	17%
CHAPTER 26—ORES, SLAG AND ASH	19%	10%	10%		**38%**
CHAPTER 27—MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES		44%		13%	19%
SECTION VI—PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRIES	*Brazil*	*Russian*	*India*	*China*	*Africa*
CHAPTER 28—INORGANIC CHEMICALS; ORGANIC OR INORGANIC COMPOUNDS OF PRECIOUS METALS, OF RARE-EARTH METALS, OF RADIOACTIVE ELEMENTS OR OF ISOTOPES	14%	20%	10%	18%	18%
CHAPTER 29—ORGANIC CHEMICALS	7%	7%	**57%**	**50%**	5%
CHAPTER 30—PHARMACEUTICAL PRODUCTS	17%		**33%**	**33%**	
CHAPTER 31—FERTILISERS		60%			
CHAPTER 32—TANNING OR DYEING EXTRACTS; TANNINS AND THEIR DERIVATIVES; DYES, PIGMENTS AND OTHER COLOURING MATTER; PAINTS AND VARNISHES; PUTTY AND OTHER MASTICS; INKS	7%		20%	20%	13%
CHAPTER 33—ESSENTIAL OILS AND RESINOIDS; PERFUMERY, COSMETIC OR TOILET PREPARATIONS	14%		14%		14%
CHAPTER 34—SOAP, ORGANIC SURFACE-ACTIVE AGENTS, WASHING PREPARATIONS, LUBRICATING PREPARATIONS, ARTIFICIAL WAXES, PREPARED WAXES, POLISHING OR SCOURING PREPARATIONS, CANDLES AND SIMILAR ARTICLES, MODELLING PASTES, 'DENTAL WAXES' AND DENTAL PREPARATIONS WITH A BASIS OF PLASTER				29%	

(continued)

Table 20.13 (continued)

SECTION V—MINERAL PRODUCTS	Brazil	Russian	India	China	Africa
CHAPTER 35—ALBUMINOIDAL SUBSTANCES; MODIFIED STARCHES; GLUES; ENZYMES	29%				
CHAPTER 36—EXPLOSIVES; PYROTECHNIC PRODUCTS; MATCHES; PYROPHORIC ALLOYS; CERTAIN COMBUSTIBLE PREPARATIONS				17%	
CHAPTER 37—PHOTOGRAPHIC OR CINEMATOGRAPHIC GOODS			14%		
CHAPTER 38—MISCELLANEOUS CHEMICAL PRODUCTS	12%	4%	12%	8%	8%
SECTION VII—PLASTICS AND ARTICLES THEREOF; RUBBER AND ARTICLES THEREOF	Brazil	Russian	India	China	Africa
CHAPTER 39—PLASTICS AND ARTICLES THEREOF			4%	19%	
CHAPTER 40—RUBBER AND ARTICLES THEREOF	6%	6%	**29%**	6%	
SECTION VIII—RAW HIDES AND SKINS, LEATHER, FURSKINS AND ARTICLES THEREOF; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)	Brazil	Russian	India	China	Africa
CHAPTER 41—RAW HIDES AND SKINS (OTHER THAN FURSKINS) AND LEATHER	9%				**45%**
CHAPTER 42—ARTICLES OF LEATHER; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)			**80%**	60%	20%
CHAPTER 43—FURSKINS AND ARTIFICIAL FUR; MANUFACTURES THEREOF		25%		50%	

(continued)

Table 20.13 (continued)

SECTION IX—WOOD AND ARTICLES OF WOOD; WOOD CHARCOAL; CORK AND ARTICLES OF CORK; MANUFACTURES OF STRAW, OF ESPARTO OR OF OTHER PLAITING MATERIALS; BASKETWARE AND WICKERWORK	Brazil	Russian	India	China	Africa
CHAPTER 44—WOOD AND ARTICLES OF WOOD; WOOD CHARCOAL	24%	19%		19%	10%
CHAPTER 45—CORK AND ARTICLES OF CORK					
CHAPTER 46—MANUFACTURES OF STRAW, OF ESPARTO OR OF OTHER PLAITING MATERIALS; BASKETWARE AND WICKERWORK				100%	
CHAPTER 47—PULP OF WOOD OR OF OTHER FIBROUS CELLULOSIC MATERIAL; RECOVERED (WASTE AND SCRAP) PAPER OR PAPERBOARD	14%				14%
CHAPTER 48—PAPER AND PAPERBOARD; ARTICLES OF PAPER PULP, OF PAPER OR OF PAPERBOARD	5%	9%		9%	5%
CHAPTER 49—PRINTED BOOKS, NEWSPAPERS, PICTURES AND OTHER PRODUCTS OF THE PRINTING INDUSTRY; MANUSCRIPTS, TYPESCRIPTS AND PLANS			9%	27%	
SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 50—SILK	14%		**43%**	**71%**	
CHAPTER 51—WOOL, FINE OR COARSE ANIMAL HAIR; HORSEHAIR YARN AND WOVEN FABRIC			15%	**54%**	38%
CHAPTER 52—COTTON			**58%**	8%	
CHAPTER 53—OTHER VEGETABLE TEXTILE FIBRES; PAPER YARN AND WOVEN FABRICS OF PAPER YARN			**45%**	9%	
CHAPTER 54—MAN-MADE FILAMENTS			**38%**	25%	
CHAPTER 55—MAN-MADE STAPLE FIBRES			25%	19%	

(continued)

Table 20.13 (continued)

SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 56—WADDING, FELT AND NONWOVENS; SPECIAL YARNS; TWINE, CORDAGE, ROPES AND CABLES AND ARTICLES THEREOF			**44%**		
CHAPTER 57—CARPETS AND OTHER TEXTILE FLOOR COVERINGS			**80%**	20%	
CHAPTER 58—SPECIAL WOVEN FABRICS; TUFTED TEXTILE FABRICS; LACE; TAPESTRIES; TRIMMINGS; EMBROIDERY			**45%**	9%	
CHAPTER 59—IMPREGNATED, COATED, COVERED OR LAMINATED TEXTILE FABRICS; TEXTILE ARTICLES OF A KIND SUITABLE FOR INDUSTRIAL USE			9%	27%	9%
SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 60—KNITTED OR CROCHETED FABRICS					
CHAPTER 61—ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, KNITTED OR CROCHETED			**59%**	**88%**	
CHAPTER 62—ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, NOT KNITTED OR CROCHETED			**71%**	**88%**	
CHAPTER 63—OTHER MADE-UP TEXTILE ARTICLES; SETS; WORN CLOTHING AND WORN TEXTILE ARTICLES; RAGS			**60%**	**70%**	
CHAPTER 64—FOOTWEAR, GAITERS AND THE LIKE; PARTS OF SUCH ARTICLES	17%		**33%**	**83%**	
CHAPTER 65—HEADGEAR AND PARTS THEREOF			29%	**71%**	
CHAPTER 66—UMBRELLAS, SUN UMBRELLAS, WALKING-STICKS, SEAT-STICKS, WHIPS, RIDING-CROPS AND PARTS THEREOF				**100%**	

(continued)

Table 20.13 (continued)

SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 67—PREPARED FEATHERS AND DOWN AND ARTICLES MADE OF FEATHERS OR OF DOWN; ARTIFICIAL FLOWERS; ARTICLES OF HUMAN HAIR			25%	**75%**	
SECTION XIII—ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS; CERAMIC PRODUCTS; GLASS AND GLASSWARE	Brazil	Russian	India	China	Africa
CHAPTER 68—ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS	20%		27%	20%	
CHAPTER 69—CERAMIC PRODUCTS			7%	29%	
CHAPTER 70—GLASS AND GLASSWARE			10%	15%	5%
SECTION XIV—NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL, AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN	Brazil	Russian	India	China	Africa
CHAPTER 71—NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL, AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN	11%	6%	28%	11%	22%
SECTION XV—BASE METALS AND ARTICLES OF BASE METAL	Brazil	Russian	India	China	Africa
CHAPTER 72—IRON AND STEEL	17%	38%	17%		17%
CHAPTER 73—ARTICLES OF IRON OR STEEL			27%	**42%**	
CHAPTER 74—COPPER AND ARTICLES THEREOF	6%	12%	18%	12%	6%
CHAPTER 75—NICKEL AND ARTICLES THEREOF		25%			

(continued)

Table 20.13 (continued)

SECTION XV—BASE METALS AND ARTICLES OF BASE METAL	Brazil	Russian	India	China	Africa
CHAPTER 76—ALUMINIUM AND ARTICLES THEREOF	6%	19%	6%	6%	13%
CHAPTER 78—LEAD AND ARTICLES THEREOF			20%		
CHAPTER 79—ZINC AND ARTICLES THEREOF					17%
CHAPTER 80—TIN AND ARTICLES THEREOF					
CHAPTER 81—OTHER BASE METALS; CERMETS; ARTICLES THEREOF	15%	31%		**54%**	8%
CHAPTER 82—TOOLS, IMPLEMENTS, CUTLERY, SPOONS AND FORKS, OF BASE METAL; PARTS THEREOF OF BASE METAL			**33%**	**80%**	7%
CHAPTER 83—MISCELLANEOUS ARTICLES OF BASE METAL			18%	**64%**	
SECTION XVI—MACHINERY AND MECHANICAL APPLIANCES; ELECTRICAL EQUIPMENT; PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 84—NUCLEAR REACTORS, BOILERS, MACHINERY AND MECHANICAL APPLIANCES; PARTS THEREOF	1%	1%	5%	16%	1%
CHAPTER 85—ELECTRICAL MACHINERY AND EQUIPMENT AND PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES	2%		8%	46%	

Table 20.13 (continued)

SECTION XVII—VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT	Brazil	Russian	India	China	Africa
CHAPTER 86—RAILWAY OR TRAMWAY LOCOMOTIVES, ROLLING-STOCK AND PARTS THEREOF; RAILWAY OR TRAMWAY TRACK FIXTURES AND FITTINGS AND PARTS THEREOF; MECHANICAL (INCLUDING ELECTRO-MECHANICAL) TRAFFIC SIGNALLING EQUIPMENT OF ALL KINDS				11%	11%
CHAPTER 87—VEHICLES OTHER THAN RAILWAY OR TRAMWAY ROLLING-STOCK, AND PARTS AND ACCESSORIES THEREOF	6%			25%	6%
CHAPTER 88—AIRCRAFT, SPACECRAFT, AND PARTS THEREOF	20%				20%
CHAPTER 89—SHIPS, BOATS AND FLOATING STRUCTURES		13%		13%	13%
SECTION XVIII—OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; CLOCKS AND WATCHES; MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES THEREOF	Brazil	Russian	India	China	Africa
CHAPTER 90—OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; PARTS AND ACCESSORIES THEREOF				24%	
CHAPTER 91—CLOCKS AND WATCHES AND PARTS THEREOF				29%	
CHAPTER 92—MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES OF SUCH ARTICLES				**86%**	

(continued)

Table 20.13 (continued)

SECTION XIX—ARMS AND AMMUNITION; PARTS AND ACCESSORIES THEREOF	Brazil	Russian	India	China	Africa
SECTION XIX—ARMS AND AMMUNITION; PARTS AND ACCESSORIES THEREOF	Brazil	Russian	India	China	Africa
CHAPTER 93—ARMS AND AMMUNITION; PARTS AND ACCESSORIES THEREOF				14%	
SECTION XX—MISCELLANEOUS MANUFACTURED ARTICLES	Brazil	Russian	India	China	Africa
CHAPTER 94—FURNITURE; BEDDING, MATTRESSES, MATTRESS SUPPORTS, CUSHIONS AND SIMILAR STUFFED FURNISHINGS; LAMPS AND LIGHTING FITTINGS, NOT ELSEWHERE SPECIFIED OR INCLUDED; ILLUMINATED SIGNS, ILLUMINATED NAME-PLATES AND THE LIKE; PREFABRICATED BUILDINGS				**67%**	
CHAPTER 95—TOYS, GAMES AND SPORTS REQUISITES; PARTS AND ACCESSORIES THEREOF				**50%**	
CHAPTER 96—MISCELLANEOUS MANUFACTURED ARTICLES	6%		28%	**67%**	6%
SECTION XXI—WORKS OF ART, COLLECTORS' PIECES AND ANTIQUES	Brazil	Russian	India	China	Africa
CHAPTER 97—WORKS OF ART, COLLECTORS' PIECES AND ANTIQUES					33%

International Trade Center and authors' calculations

Table 20.14 BRICS RCA-Products-sectoral distribution

SECTION I—LIVE ANIMALS; ANIMAL PRODUCTS	Brazil	Russia	India	China	S. Africa
CHAPTER 2—MEAT AND EDIBLE MEAT OFFAL	**40% m**			10%	10%
CHAPTER 3—FISH AND CRUSTACEANS, MOLLUSCS AND OTHER AQUATIC INVERTEBRATES			**29%**	14%	**43%**
CHAPTER 5—PRODUCTS OF ANIMAL ORIGIN, NOT ELSEWHERE SPECIFIED OR INCLUDED	**40%**		20%	**30%**	
SECTION II—VEGETABLE PRODUCTS	Brazil	Russia	India	China	S. Africa
CHAPTER 6—LIVE TREES AND OTHER PLANTS; BULBS, ROOTS AND THE LIKE; CUT FLOWERS AND ORNAMENTAL FOLIAGE	25%		25%		**75%**
CHAPTER 8—EDIBLE FRUIT AND NUTS; PEEL OF CITRUS FRUITS OR MELONS	**50%**		21%		**57%**
CHAPTER 9—COFFEE, TEA, MATÉ AND SPICES	**50%**		**60%**	10%	
CHAPTER 13—LAC; GUMS, RESINS AND OTHER VEGETABLE SAPS AND EXTRACTS	**50%**		**100%**		
CHAPTER 14—VEGETABLE PLAITING MATERIALS; VEGETABLE PRODUCTS NOT ELSEWHERE SPECIFIED OR INCLUDED			33%	**33%**	
SECTION IV—PREPARED FOODSTUFFS; BEVERAGES, SPIRITS AND VINEGAR; TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES	Brazil	Russia	India	China	S. Africa
CHAPTER 20—PREPARATIONS OF VEGETABLES, FRUIT, NUTS OR OTHER PARTS OF PLANTS	11%		22%	**56%**	**33%**

Table 20.14 (continued)

SECTION V—MINERAL PRODUCTS	*Brazil*	*Russian*	*India*	*China*	*Africa*
CHAPTER 26—ORES, SLAG AND ASH	19%	10%	10%		**38%**
CHAPTER 27—MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES		**44%**		13%	19%
SECTION VI—PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRIES	Brazil	Russia	India	China	S. Africa
CHAPTER 29—ORGANIC CHEMICALS	7%	7%	**57%**	**50%**	5%
CHAPTER 30—PHARMACEUTICAL PRODUCTS	17%		**33%**	**33%**	
SECTION VIII—RAW HIDES AND SKINS, LEATHER, FURSKINS AND ARTICLES THEREOF; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)	Brazil	Russian	India	China	Africa
CHAPTER 41—RAW HIDES AND SKINS (OTHER THAN FURSKINS) AND LEATHER	9%				**45%**
CHAPTER 42—ARTICLES OF LEATHER; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)			**80%**	**60%**	20%
CHAPTER 43—FURSKINS AND ARTIFICIAL FUR; MANUFACTURES THEREOF		25%		**50%**	
SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russia	India	China	S. Africa
CHAPTER 50—SILK	14%		**43%**	**71%**	
CHAPTER 51—WOOL, FINE OR COARSE ANIMAL HAIR; HORSEHAIR YARN AND WOVEN FABRIC			15%	**54%**	**38%**
CHAPTER 52—COTTON			**58%**	8%	
CHAPTER 53—OTHER VEGETABLE TEXTILE FIBRES; PAPER YARN AND WOVEN FABRICS OF PAPER YARN			**45%**	9%	

(continued)

Table 20.14 (continued)

SECTION XI—TEXTILES AND TEXTILE ARTICLES	Brazil	Russia	India	China	S. Africa
CHAPTER 54—MAN-MADE FILAMENTS			**38%**	25%	
CHAPTER 55—MAN-MADE STAPLE FIBRES			25%	19%	
CHAPTER 56—WADDING, FELT AND NONWOVENS; SPECIAL YARNS; TWINE, CORDAGE, ROPES AND CABLES AND ARTICLES THEREOF			**44%**		
CHAPTER 57—CARPETS AND OTHER TEXTILE FLOOR COVERINGS			**80%**	20%	
CHAPTER 58—SPECIAL WOVEN FABRICS; TUFTED TEXTILE FABRICS; LACE; TAPESTRIES; TRIMMINGS; EMBROIDERY			**45%**	9%	
SECTION XV—BASE METALS AND ARTICLES OF BASE METAL	Brazil	Russia	India	China	S. Africa
CHAPTER 72—IRON AND STEEL	17%	38%	17%		17%
CHAPTER 73—ARTICLES OF IRON OR STEEL			27%	**42%**	
CHAPTER 81—OTHER BASE METALS; CERMETS; ARTICLES THEREOF	15%	31%		**54%**	8%
CHAPTER 82—TOOLS, IMPLEMENTS, CUTLERY, SPOONS AND FORKS, OF BASE METAL; PARTS THEREOF OF BASE METAL			**33%**	**80%**	7%
CHAPTER 83—MISCELLANEOUS ARTICLES OF BASE METAL			18%	**64%**	

(continued)

Table 20.14 (continued)

SECTION XVIII—OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; CLOCKS AND WATCHES; MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES THEREOF	Brazil	Russia	India	China	S. Africa
CHAPTER 90—OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; PARTS AND ACCESSORIES THEREOF				**24%**	
CHAPTER 91—CLOCKS AND WATCHES AND PARTS THEREOF				**29%**	
CHAPTER 92—MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES OF SUCH ARTICLES				**86%**	
SECTION XX—MISCELLANEOUS MANUFACTURED ARTICLES	Brazil	Russia	India	China	S. Africa
CHAPTER 94—FURNITURE; BEDDING, MATTRESSES, MATTRESS SUPPORTS, CUSHIONS AND SIMILAR STUFFED FURNISHINGS; LAMPS AND LIGHTING FITTINGS, NOT ELSEWHERE SPECIFIED OR INCLUDED; ILLUMINATED SIGNS, ILLUMINATED NAME-PLATES AND THE LIKE; PREFABRICATED BUILDINGS				**67%**	
CHAPTER 95—TOYS, GAMES AND SPORTS REQUISITES; PARTS AND ACCESSORIES THEREOF				**50%**	
CHAPTER 96—MISCELLANEOUS MANUFACTURED ARTICLES	6%		28%	**67%**	6%

International Trade Center and authors' calculations

Comments to the Table 20.14:BRICS-EU28-Revealed comparative advantage-dominant sectors

Sections	Dominate countries
SECTION I—Live animals; animal products	Brazil (I two groups, 40%) China (one group 30%) S. Africa (one group, 43%)
SECTION II—vegetable products	Brasil (3 groupς 50%) India (2 groups 60%, 100%) India (2 groups, 75%, 57%)
SECTION IV—Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes	China (one group 56%), S Africa (one group 33%)
SECTION V—Mineral products	Brazil (one product 44%, S. Africa one product 38%)
SECTION VI—Products of the chemical or allied industries	India (2 groups 57%, 33%), China (2 groups 50%, 33%)
SECTION VI—products of the chemical or allied industries	India (2 groups 57%, 50%), China (2 groups, 50%, 33%)
SECTION VIII—Raw hides and skins, leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)	India (one group 80%, China 2 groups 60%, 50%)
SECTION XI—Textiles and textile articles	India (7 groups, the percentages fluctuate between 40 and 80%) China (2 groups, 71%, 54%) S. Africa (one group, 38%)
SECTION XV—Base metals and articles of base metal	Russia (2 groups, 36%, 31%), India (one group 33%) China (4 groups the percentages fluctuate between 42 and 80%)
SECTION XVIII—Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof	China (two groups, 86%, 31%)
SECTION XX—Miscellaneous manufactured articles	China (chapter 94, 67%)-Chapter 95, 50%, Chapter 96, 67%

References

Balassa, B. (1965). Trade liberalization and “revealed” comparative advantage. *Manchester School, 33,* 99–123.

Ballance, R. H., Forstner, H., & Murray, T. (1987). Consistency tests of alternative measures of comparative advantage. *Review of Economics and Statistics, 69,* 157–161.

Benedictis, L. D., & Tamberi, M. (2001). *A note on the Balassa index revealed comparative advantage*. Working papers #158, Dipartimento di Economia Universita Politecnica delle Marche I.

Bebek, U. G. (2017). *RCA: Choosing the right measure*.

Beyene, H. (2014a). Trade integration and revealed comparative advantages of Sub-Saharan Africa and Latin America & Caribbean merchandise export. *The International Trade Journal, 28*(5), 411–441. https://doi.org/10.1080/08853908.2014.952851.

Beyene, H. (2014b). Trade integration and revealed comparative advantages of Sub-Saharan Africa and South Asian merchandize export. *Foreign Trade Review, 49*(2), 163–176. https://doi.org/10.1177/0015732514525170.

Beyene, H. (2015). BRICS and Sub-Saharan Africa trade interdependence and peace: evidence based on revealed comparative advantages. *Journal of Law, Society and Development*, 4–28.

Chen, L. (2012). The BRICS in the global value chains: an empirical note. *Cuadernos de Economia, 31*, no.spe57 Bogotá June/December 2012.

Dallum, B., Laursen, K., & Villumsen, G. (1988). Structural change in OECD export specialization patterns: De-specialization and stickiness. *International Review of Applied Economics, 12,* 447–467.

Florence, P. S. (1948). *Investments location and size of plant*. England: University Press Cambridge.

Havlik, P., & Stöllinger, R. (2009). EU and BRICs: Challenges and opportunities for European competitiveness and cooperation. The Vienna Institute for International Economic Studies (wiiw). August 2009.

Hart, P. E, & Prais S. J. (1956). The analysis of Business concentration: A statistical approach. *Journal of the Royal Statistical Society Series A, 119*, 150–191.

Hart, P. E. (1995). The convergence of labour productivity in British and German industries. *International Journal of the Economics of Business, 2*(3), 453–464.

Hoen, A. R., & Oosterhaven, J. (2006). On the measurement of comparative advantage. *The Annals of Regional Science, 40*, 677–691.

Isserman, A. M. (1977). The location quotient A roach to estimating regional economic impacts. *Journal of the American Institute of Planners, 43*, ff-41.

Kocourek, A. (2015). Structural changes in comparative advantages of the BRICS. *Procedia Social and Behavioral Sciences, 172*(2015), 10–17.

Liesner, H. (1958). The European common market and British industry. *Economic Journal*, 302–16, *Weltwirtschaftliches Arch, 127*, 265–280.

Marquilias, E. J. M. (1972). Shift share analysis revisited. *Regional and Urban Economics, 2,* 249–261.

Proudman, J., & Redding, S. (1998). *Opennes and growth*. The bank of England.

Sanidas, E., & Shin, Y. (2010). *Comparison of revealed comparative advantage indices with application to trade tendencies of East Asian countries*. Paper Presented at the 9th Korea and the World Economy Conference, Incheon.

Siegel, S. (1956). *Non parametric statistics for the behavioral science*. London: Mc Graw Hill Book Company.

Vollrath, T. L. (1991). A theoretical evaluation of alternative trade intensity measure of revealed comparative advantage. *Weltwirtshaftliches Arch, 127,* 265–280.

Raghuramapatruni, R. (2015). Revealed comparative advantage and competitiveness: A study on BRICS. *Arabian Journal of Business and Management Review, 2015*(5), 5.

Yeats, A. J. (1985). On the appropriate interpretation of the revealed advantage index: Implications of a methodology based on industry sector analysis. *Weltwirtshaftliches Arch, 121,* 61–730.

Yu, R., Cai, J., & Leung, P. (2009). The normalized revealed comparative advantage index. *Annals of Regional Science, 43* (No. 1 2009), 267–282.

Chapter 21
The Effect of a Sovereign Credit Rating Change on Share Prices of the South African Retail Banks

M. C. de Wet and I. Botha

Abstract The increasing role of credit rating agencies in emerging markets and the various impacts that these rating agencies have on emerging market economies have become of great interest in modern finance. Recent empirical evidence suggests that credit rating downgrades have the potential to disrupt economies. To minimise and control such disruption, it is essential to establish what exactly these disruptions entitles. This study aims to determine whether a South African sovereign credit rating downgrade caused abnormal returns in the shares of local retail banks. Furthermore, the study sets out to determine whether A South African sovereign credit rating downgrade resulted in significant volatility spillover on the shares of South African retail banks. An event study analysis will be implemented to determine whether a downgrade caused abnormal returns, and the presence of volatility spillovers will be determined by means of a GARCH-BEKK model. The main findings indicates that a South African sovereign credit downgrade did result in negative cumulated abnormal returns, and that a change in the South African sovereign credit rating did cause volatility in the shares of South African retail banks. These share price effects can have various implications, such as spillovers to other parts of the equity market, as well as negative spillovers to the real economy. In order to mitigate the potential implications of a South African sovereign credit rating change through the South African retail banking sector, the effects of such a change must first be determined, making this an important study to conduct.

21.1 Introduction

The presence of rating agencies in developing countries has increased dramatically in the past two decades, and the importance of credit rating agencies in emerging markets, as well as their potential to cause extreme volatility and economic

M. C. de Wet (✉) · I. Botha
Department of Accountancy, University of Johannesburg,
Johannesburg, South Africa
e-mail: miland@uj.ac.za

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_21

disruption in these markets have been a major topic of debate and research. Sovereign credit ratings are seen by investors as a good measurement of the political, economic and financial state of a country, and therefore largely determine the extent of foreign investment and the required rate of return on those investments in a country (Orhan and Yusuf 2014). Williams, Alsakka, & Gwilym, (2015) therefore states that sovereign and corporate credit ratings improve the capacity of a country's public and private sector to attain foreign capital in various forms.

Accordingly, Williams et al. (2015) writes that rating agencies have a critical role to play in developing countries, as they can reduce the information asymmetries between developed countries and developing ones. Investment opportunities in developing countries typically carry high risk and low information quality relative to investment opportunities in developed markets (Williams et al. 2015). Foreign investors therefore depend heavily on sovereign credit rating agencies to provide information on the risk and, by implication, the required return levels of investment opportunities in developing economies. This information bridge created by rating agencies allows both public and private entities in developing countries to attract foreign capital. It is widely believed that an increase in foreign investments and loanable funds will speed up development in emerging markets, and in so doing, create a range of economic benefits (Bumann, Hermes, & Lensink, 2013).

Despite the important role credit rating agencies play in attracting foreign capital, credit rating agencies have received great criticism and blame in recent years for causing major disruptions and distortions in emerging economies. Vernazza and Nielsen (2015), Vaaler and McNamara (2004) and Shen, Huang, & Hasan, (2012) argue that the rating process implemented by credit rating agencies when rating sovereign credit is particularly harsh on emerging market sovereign credit and found that the process tends to be negatively biased towards emerging markets. Furthermore, Vernazza and Nielsen (2015) states that credit rating agencies should adapt their rating methodology when rating the debt of sovereigns in emerging markets, because the dynamics in these markets are significantly different than that of developed countries. However, sovereign credit rating agencies typically falter to do so, and can cause major disruption in smaller economies that actually perform fairly well. This has proven to especially be the case in the local banking sector of an economy (Correa, Lee, Sapriza, & Suarez, 2014).

The 2007/2008 financial crisis has provided evidence that investors very closely relate the banking sector of an economy to the performance of the local government. One of the prominent reasons found by Correa et al. (2014) for this relationship is that investors expect government to bail out poorly performing banks. Consequently, banks that are known to be heavily dependent on the financial support of their government, and that depend on their government to bail them out in a case of bankruptcy, will be affected more severely than others in the case of a sovereign credit downgrade. Furthermore, banks are extremely sensitive to interest rate fluctuations, given the natural duration mismatch between assets and liabilities (Fabozzi 2007). Therefore, because of the sovereign ceiling phenomena typically restricts the credit rating of banks to the sovereign credit rating, a sovereign credit rating change will likely affect the prevailing market interest rates, as well as the cost to raise their own capital (Correa et al. 2014).

Correa et al. (2014) considered the share price of banks worldwide, and established that sovereign credit downgrades have a greatly negative effect on the share returns of these banks. Williams et al. (2015) supports Correa et al. (2014), finding that the cumulative abnormal returns of local emerging market banks are 4.67% on average after a sovereign credit rating downgrade by S&P. Almeida, Cunha, Ferreira, & Restrepo, (2017) found evidence that a sovereign credit rating downgrade typically caused the fundamentals of banks to deteriorate over a length of time. Other researchers such as Borensztein, Cowan, & Valenzuela, (2013), Christopher, Kim, & Wu, (2012), Brooks, Faff, Hillier, & Hillier, (2004) and Kaminsky and Schmukler (2002) found similar results.

Given the evidence found by these researchers, a sovereign credit rating downgrade typically have a negative impact on the banking sector of an economy. This in combination with the findings that sovereign credit rating changes have amplified effects on emerging markets render it is essential to know what the impact of a sovereign credit rating change is on the local banking sector of emerging markets. This will afford policy makers, and market participants a better idea of how to manage any such effects. Given the recent political instability and considerable amount of sovereign credit rating downgrades South Africa experienced over the past decade, it is essential for policy makers and market participants to know how to mitigate any negative effects resulting from future sovereign credit rating downgrades.

However, even though empirical findings by other researchers suggest that these rating downgrades are likely to have a negative impact on the South African retail banks, the South African banking industry is argued to be exceptionally well developed as well as very robust and sound compared to the banking industry of most other emerging markets, and that it can compete with that of developed countries (IMF 2014; Mlambo and Ncube 2011). Therefore, even though South Africa is an emerging economy, the results might differ to that of other research done in emerging markets regarding this matter. It is thereto necessary to first determine what the typical impact of a South African credit rating change is on the shares of South African retail banks, in order to develop and use tools to manage such effects. The remainder of this paper is structured as follows: Section 21.2 describe the data as well as the methods used in this paper. The empirical results will then be depicted in Sect. 21.3, and finally, the last section will provide a conclusion.

21.2 Data and Method

The study will be based on the largest four South African retail banks as measured by total market capitalisation, determined by the latest financial statements of each bank. The four largest South African retail banks as measured by market capitalisation is: Standard Bank; FirstRand, which is the holding company of First

National Bank (FNB); ABSA and Nedbank Group. These four retail banks have a total South African market share of approximately 83.2%, and are therefore often argued in literature to be a good sample for South African retail banks (Baker 2015).

21.2.1 Data Description

This study will specifically focus on the three most recent South African sovereign credit rating downgrades by the S&P credit rating agency. Firstly, an event study analysis will be conducted to determine whether a South African sovereign credit rating downgrade caused any abnormal returns in the share prices of South African retail bank. The data for this section will also be collected from Thomson Reuters Eikon and Thomson Reuters DataStream. Variables to be included in the event study is the share price of each bank, as well as the South African All share index as a market proxy. The daily returns of each variable will be calculated. The sample for this analysis will range from 05 April 2012 to 15 April 2017. According to Lakshmi and Joshi (2016) as well as Makiono (2016), an event study typically consists of three distinct time periods, and these three time periods needs to be identified before the study could commence. In this case there are three South African downgrades, and therefore three events. Table 21.1 depicts the time periods for each event.

Secondly, the volatility spillover effect of a South African sovereign credit rating downgrade on the share price return of each respective bank will be determine. Data will be sourced from Thomson Reuters Eikon and Thomson Reuters DataStream. Daily share price returns for each bank and the daily change in the South African five-year credit default swap (CDS) from 22 June 2007 to 23 June 2017 will be used. As stated by Mohammadi and Tan (2015), the data used to estimate a GARCH-BEKK model needs to be high frequency data, for example daily data. Since sovereign credit ratings do not change on a daily basis, a change in the South African five-year CDS's will be used as a proxy for the South African sovereign credit rating change. CDS data is available on a daily basis and according to Fabozzi (2007), the CDS on a debt instrument and the change thereto provides a good representation of the change in the perceived creditworthiness of that asset.

Table 21.1 Event study time frames

Event day	12 October 2012	13 June 2014	03 April 2017
Estimation period	05 April 2012 to 27 September 2012	05 December 2013 to 29 May 2014	23 September 2016 to 17 May 2017
Event window	28 September 2012 to 26 October 2012	30 May 2014 to 27 June 2014	20 Mar 2017 to 15 April 2017

Source Standard & Poor (2017)

21.2.2 Event Study Methodology

The market model will be used to calculate expected returns, and are specified as follows, in accordance with Lakshmi and Joshi (2016), Makiono (2016) and Nading (2015):

$$R_{ert} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{21.1}$$

where:

R_{ert} expected return at time t
α_i the intercept, thus, the average fluctuation in the return of a share not driven by market fluctuations
R_{mt} market return
β_i sensitivity of bank share returns to fluctuations in the South African All Share Index.

The actual return of each time series will be calculated as follows:

$$R_{at} = (A_t - A_{t-1})/A_{t-1} \tag{21.2}$$

where:

R_{at} return on asset at time t
A_t price of the asset at time t
A_{t-1} price of the asset one period before

Based on the estimated expected return the abnormal return will be calculated. This will be done by deducting the actual market return realised by each bank during the period of analysis from the expected return. This could be expressed as follows:

$$R_a = R_r - R_e \tag{21.3}$$

where

R_a Abnormal return
R_e Expected return
R_r Realised return

To determine the total effect of a South African sovereign credit rating downgrade on the South African retail banks over, the cumulative abnormal returns (CAR) for each bank will calculated by means of adding all the abnormal returns of each respective day in the event window up (Lakshmi and Joshi 2016). This will allow one to establish the total effect of a South African sovereign credit rating downgrade, and not merely its effect on each respective day. After determining whether a South African sovereign credit rating downgrade cause any negative abnormal returns in the shares of South African retail banks it should be determined whether a South African sovereign credit rating downgrade caused any volatility spillovers to the shares of the banks under analysis. The second part of the analysis will be conducted by means of estimating a GARCH-BEKK model.

21.2.3 GARCH-BEKK Methodology

The GARCH-BEKK model could be structured with various lag structures, however, the GARCH(1,1)-BEKK model is by far the most commonly used in literature. Liu, An, Huang, & Wen, (2017) argue that a GARCH(1,1)-BEKK model is sufficient to estimate volatility spillovers between two time series. The GARCH (1,1)-BEKK model indicate that one lagged squared residual and one lagged variance of the residual are included in the model. Liu et al. (2017) and Mohammadi and Tan (2015) specify the mean equation of the multivariate GARCH (1,1)-BEKK model adopted in this study as follows:

$$R_t(i) = \begin{bmatrix} R_{SP,t}(i) & 0 \\ R_{CR,t}(i) & 0 \end{bmatrix} + \begin{bmatrix} \varepsilon_{SP,t}(i) & 0 \\ \varepsilon_{CR,t}(i) & 0 \end{bmatrix} \tag{21.4}$$

where:

$R_t(i)$ a (2 × 1) vector of share price return and a change in the South African sovereign credit rating at time *t*.

According to Liu et al. (2017) and Mohammadi and Tan (2015), the variance equation of the multivariate GARCH(1,1)-BEKK model adopted in this study is specified as follows:

$$H_t(i) = C'C + A'_{\in_{t-1}(i)\in'_{t-1}}(i)A + B'H_{t-1}(i)B \tag{21.5}$$

where:

$H_t(i)$ a (2 × 2) vector representing the conditional variance matrix at scale i
C a constant coefficient matrix
A the coefficient of conditional residual matrix, and
B the coefficient of conditional covariance matrix.

Expressed in matrix terms as:

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, B = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \text{and } C = \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix}$$

The main condition for volatility models is that the data must be stationary (Gujarati and Porter 2009). Before conducting the GARCH(1,1)-BEKK this condition must be met. An Augmented Dickey-Fuller unit root test will be conducted as a formal test to determine whether the time series of the return of each variable is stationary preliminary to conducting any volatility model. If the variables under analysis are found to be stationary, each variable to be included in the GARCH-BEKK model will first be tested for autoregressive conditional heteroscedasticity (ARCH) effects before estimating the formal GARCH(1,1)-BEKK model (Liu et al. 2017). This will be done to discern whether volatility clusters exist in the returns of each bank's share price and the change in the South African sovereign credit rating. Liu et al. (2017) argue that the GARCH-BEKK model should only be conducted if all the variables included in the model contain volatility clusters.

With the GARCH(1,1)-BEKK model, the conditional variance of the share return of each bank could be deconstructed into its ARCH and GARCH constituents. For example, the A(scrd, n) shows how the ARCH volatility of Nedbank share returns depends on the shocks on the South African sovereign credit rating (Liu et al. 2017). Furthermore, B(scrd, n) shows how the GARCH volatility of Nedbank shares also depends on the shocks in the South African sovereign credit rating. The significance of the coefficient of conditional residual matrix and the coefficient of conditional covariance matrix will be tested to determine whether there are significant volatility spillovers between a change in the South African sovereign credit rating and the share price of each bank under analysis. In accordance with Liu et al. (2017) and Mohammadi and Tan (2015), if the coefficient of conditional residual matrix and the coefficient of conditional covariance matrix are significant then a change in the South African sovereign credit rating had a volatility spillover to both the ARCH and GARCH terms of each share price under analysis. The results obtained by implementing the above mentioned methodology will now be considered.

21.3 Data Analysis and Results

This section will commence with the event study as a means to determine whether a South African sovereign credit rating downgrade caused any abnormal returns in the share price of South African retail banks. Thereafter the GARCH-BEKK (1,1) model will be estimated to determine whether a South African sovereign credit rating downgrade caused any volatility spillovers in the shares of South African retail banks.

21.3.1 Evens Study Analysis

Firstly, it is necessary to estimate the market model as the share price returns of the respective banks under analysis will be measured relative to the market returns. The market model will produce the necessary coefficients to do so.

21.3.1.1 Estimating the Market Model

In this model the return on each bank's share price will be the dependent variable and the return on the JSE All Share Index will be the explanatory variable. The significance of the cumulative abnormal returns will also be considered. Table 21.2 represents the coefficients of each bank's market model based on the estimation window prior to each Standard & Poor's South African sovereign credit rating downgrade respectively.

The coefficients in Table 21.2 will be substituted into the market model in order to estimate expected returns for each bank under analysis. The expected returns for each downgrade calculated by the market model are listed in the appendix from Tables 21.12, 21.13 and 21.14. The potential abnormal returns caused by South African sovereign credit rating downgrades by S&P will now be considered.

21.3.1.2 Abnormal Returns

The first window is the South African sovereign credit rating downgrade by S&P on the 12th of October 2012 and this window will now be considered.

S&P 12th of October 2012 Downgrade

Consider Tables 21.3 and 21.4, depicting abnormal returns caused by a South African sovereign credit rating downgrade by S&P on the 12th of October 2012. Nedbank experienced four days of significant returns within the event window. Two of these significant abnormal returns occurred within the 10 days prior to the South African sovereign credit rating downgrade and both abnormal returns were negative. The other two significant abnormal returns occurred within the 10 days

Table 21.2 Market model outputs

	Nedbank	FNB	Standard Bank	Absa
12 October 2012				
β_i	0.963	−0.132	−0.161	−0.245
α_i	0.001	0.002	0.000	0.000
ε_{it}	0.092	0.111	0.105	0.114
13 June 2014				
β_i	1.172	−0.187	−0.173	−0.106
α_i	0.001	0.000	0.001	0.000
ε_{it}	0.105	0.134	0.125	0.146
03 April 2017				
β_i	1.023	−0.206	−0.102	0.043
α_i	0.00	0.002	0.002	0.001
ε_{it}	0.178	0.164	0.196	0.173

Source Eviews estimates

Table 21.3 Bank abnormal returns prior to a South African sovereign downgrade (12th of October 2012)

	Bank			
Day	Ned	FNB	Std	ABSA
−10	−5.87%*** (−6.473)	0.10% (0.092)	0.27% (0.27)	0.34% (0.392)
−9	0.69% (0.761)	−0.09% (−0.087)	−0.11% (−0.082)	0.56% (0.527)
−8	0.48% (0.523)	0.30% (0.267)	0.24% (0.173)	0.14% (0.126)
−7	1.158% (1.261)	1.11% (0.964)	−1.11% (−0.832)	−0.27% (−0.265)
−6	−0.21% (−0.237)	0.56% (0.488)	−0.42% (−0.326)	1.67% (1.574)
−5	1.47% (1.612)	−3.66%*** (−3.187)	−0.85% (−0.645)	−2.52%** (−2.375)
−4	−1.77%** (−2.013)	−5.39%*** (−4.694)	−2.03%* (−1.669)	−0.49% (−0.469)
−3	−0.19% (−0.217)	0.52% (0.458)	−0.05% (−0.044)	1.22% (1.145)
−2	0.25% (0.275)	0.35% (0.315)	1.12% (0.846)	−2.62%** (−2.464)
−1	−0.03% (−0.033)	0.98% (0.852)	1.21% (0.916)	0.89% (0.847)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on the t-statistic
Source Excel outputs

after the South African sovereign credit rating downgrade by S&P. One of these significant abnormal returns was positive and one negative. The biggest abnormal return prior to the downgrade was negative −5.87% at a 99% confidence level, and occurred 10 days prior to the downgrade. The biggest abnormal return after the downgrade was negative −1.72% at a 90% confidence level and occurred six days after the downgrade. Note that the abnormal return on the event day was insignificant.

FNB experienced four days of abnormal returns within the event window. Two of these significant abnormal returns occurred within the 10 days prior to the South African sovereign credit rating downgrade and both abnormal returns were negative. The other two significant abnormal returns occurred within the 10 days after the South African sovereign credit rating downgrade by S&P. Two of these significant abnormal returns occurred within the 10 days prior to the South African sovereign credit rating downgrade and both abnormal returns were negative. After the event day, one significant positive and one significant negative abnormal return were found.

This downgrade resulted in one day of significant negative abnormal returns for Standard Bank and ABSA. For both these banks, the significant abnormal return transpired before the event day and was negative; 2.02 and 2.62% respectively.

Table 21.4 Bank abnormal returns on the day of a South African sovereign downgrade and the abnormal returns thereafter (12th of October 2012)

	Bank			
Day	Ned	FNB	Std	ABSA
Day of downgrade	−1.11% (−1.235)	0.84% (0.738)	−0.39% (−0.391)	0.86% (0.813)
1	1.53%* (1.721)	−0.09% (−0.074)	0.56% (0.425)	−0.13% (−0.113)
2	−0.63% (−0.693)	0.45% (0.365)	0.48% (0.367)	0.69% (0.647)
3	0.96% (1.065)	1.26% (1.094)	0.51% (0.386)	0.12% (0.111)
4	−0.42% (−0.468)	−1.73% (−1.514)	−1.59% (−1.23)	−0.62% (−0.574)
5	0.49% (0.525)	−1.90%* (−1.665)	−0.13% (−0.095)	−0.30% (−0.287)
6	0.66% (0.738)	2.53%** (2.221)	0.81% (0.604)	−1.05% (−0.990)
7	−1.73%* (−1.924)	0.39% (0.334)	−0.52% (−0.384)	0.03% (0.011)
8	−1.26% (−1.389)	1.08% (0.954)	0.77% (0.584)	−0.17% (−0.165)
9	−1.02% (−1.129)	0.22% (0.195)	0.47% (0.366)	−0.30% (−0.275)
10	1.38% (1.514)	−0.48% (−0.148)	−0.28% (−0.244)	0.04% (0.031)
CAR	−4.39%*** (−7.652)	−4.76%*** (−8.234)	−3.38%*** (−6.433)	−1.91%* (1.726)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value
Source Excel output

These results speak to the individual days within the event window, however, these results do not speak to the aggregate effect of a South African sovereign credit rating downgrade on the share price of each retail bank under analysis during the event window. A consideration of the aggregate effect of a South African sovereign credit rating downgrade on the retail banks under analysis during the event window will be done by considering the cumulative abnormal returns of each bank during that period.

The cumulative abnormal returns for Nedbank, FNB, Standard Bank and ABSA are −4.39, −4.76, −3.38, −1.91% respectively. All of these cumulative returns are significant at a 99% confidence interval. The second window under consideration is the South African sovereign credit rating downgrade by S&P on the 13th of June 2014.

S&P 13th of June 2014 Downgrade

Consider Tables 21.5 and 21.6, depicting abnormal returns resulting from a South African sovereign credit rating downgrade by S&P on the 13th of June 2014. Nedbank experienced three days of significant returns within the event window. Two of these significant abnormal returns occurred within the 10 days prior to the South-African sovereign credit rating downgrade. One of these abnormal returns was negative and the other was positive. On the day of the South African sovereign credit rating downgrade the Nedbank share price experienced a negative abnormal return that was significant at a 95% confidence level.

In the case of FNB, five days within the event window proved to render abnormal returns. No abnormal returns occurred prior to the South African sovereign credit rating downgrade, however, FNB shares experienced significant negative abnormal returns on the day of the downgrade and four more significant abnormal returns, two of which were negative and two positive.

Standard Bank experienced one day of significant abnormal returns within the event window. This abnormal return was negative (1.93%) and significant at a 90%

Table 21.5 Bank abnormal returns prior to a South African sovereign downgrade (13th of June 2014)

	Bank			
Day	Ned	FNB	Std	Absa
−10	−2.65%** (−2.262)	0.54% (0.322)	−0.73% (−0.611)	0.42% (0.401)
−9	1.0% (0.734)	−1.83% (−1.546)	−0.61% (−0.542)	−0.34% (−0.327)
−8	−0.8% (−0.602)	−0.92% (−0.834)	−0.91% (−0.751)	0.15% (0.142)
−7	−0.34% (−0.266)	−0.44% (−0.259)	1.00% (0.837)	0.29% (0.275)
−6	0.31% (0.245)	−0.39% (−0.227)	1.53% (1.253)	0.23% (0.255)
−5	3.0%** (2.282)	−1.02% (−0.942)	1.30% (1.055)	0.11% (0.153)
−4	−0.94% (−0.657)	−1.65% (−1.135)	−0.8% (−0.661)	−0.21% (−0.197)
−3	0.37% (0.212)	−1.8% (−1.476)	0.34% (0.287)	−0.06% (−0.050)
−2	−1.22% (−1.076)	0.97% (0.892)	−0.51% (−0.424)	0.89% (0.848)
−1	1.82% (1.584)	−0.28% (−0.166)	0.04% (0.035)	−0.71% (−0.670)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value
Source Excel output

Table 21.6 Bank abnormal returns on the day of a South African sovereign downgrade and the abnormal returns thereafter (13th of June 2014)

	Bank			
Day	Ned	FNB	Std	Absa
Day of downgrade	−2.19%** (−2.069)	−2.54%** (−2.164)	−0.46% (−0.371)	0.68% (0.637)
1	0.0% (0.001)	0.33% (0.198)	0.0% (0.000)	0.05% (0.468)
2	0.7% (0.544)	0.34% (0.191)	−0.84% (−0.684)	−0.03% (−0.29)
3	−0.2% (−0.144)	0.26% (0.154)	−0.82% (−0.665)	−0.94% (−0.881)
4	−1.1% (−0.896)	−6.28%*** (−9.353)	0.78% (0.643)	0.04% (0.033)
5	1.3% (1.029)	−8.6%*** (−4.946)	−0.71% (−0.582)	0.16% (0.154)
6	0.2% (0.154)	12.51%*** (7.174)	1.1% (0.917)	0.1% (0.099)
7	−0.6% (−0.456)	4.59%** (2.636)	0.33% (0.273)	0.45% (0.425)
8	−1.87% (−1.592)	0.42% (0.248)	−0.25% (−0.212)	−0.37% (−0.356)
9	0.2% (0.138)	0.29 (0.177)	−1.93%* (−1.764)	0.35% (0.332)
10	0.5% (0.361)	−1.9% (−1.612)	−0.4% (−0.331)	−0.29% (−0.273)
CAR	−1.28%*** (−3.813)	−7.14%*** (−2.714)	−2.5%*** (−8.124)	0.74% (1.56)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value
Source Excel output

confidence level. Note that ABSA did not experience any significant abnormal returns during the event window.

The cumulative abnormal returns were −1.28, −7.14, −2.5 and 0.74% for Nedbank, FNB, Standard Bank and ABSA respectively. The cumulative abnormal returns for Nedbank, FNB and Standard Bank were all significant at a 99% confidence level; conversely, the cumulative abnormal returns for ABSA were not significant. The third window is the South African sovereign credit rating downgrade by S&P on the 3rd of April 2017.

S&P 3rd April 2017 Downgrade

Consider Tables 21.7 and 21.8, depicting abnormal returns resulting from a South African sovereign credit rating downgrade by S&P on the 3rd April 2017.

Table 21.7 Bank abnormal returns prior to a South African sovereign downgrade (3rd of April 2017)

	Standard & Poor (2017) downgrade			
Day	NED	FNB	STD	ABSA
−10	0.57% (−1.102)	0.15% (0.084)	0.51% (0.270)	0.67% (0.346)
−9	−0.60% (−0.42)	0.01% (0.000)	1.29% (0.704)	0.23% (0.117)
−8	−0.90% (−0.635)	−1.76% (−0.986)	0.64% (0.343)	−3.12%* (−1.661)
−7	−0.68% (−0.487)	1.23% (0.689)	−1.27% (−0.697)	0.74% (0.395)
−6	−0.44% (−0.316)	2.76%* (1.912)	2.12% (1.155)	3.72%* (1.946)
−5	−1.05% (−0.736)	1.52% (0.858)	2.17% (1.186)	1.33% (0.695)
−4	−2.04%** (−2.144)	−1.02% (−0.569)	−0.55% (−0.293)	1.40% (0.734)
−3	−1.31%* (−1.660)	−0.80% (−0.441)	−0.66% (−0.366)	−0.56% (−0.291)
−2	−0.61% (−0.434)	−0.89% (−0.492)	2.05% (1.114)	0.91% (0.473)
−1	0.54% (0.386)	1.18% (0.654)	−0.60% (−0.335)	−0.66% (−0.344)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value
Source Excel output

Nedbank experienced five days of significant returns within the event window. Two of these significant abnormal returns occurred within the 10 days prior to the South African sovereign credit rating downgrade. Both significant abnormal returns during the 10 days prior to the downgrade were negative. On the day of the South African sovereign credit rating downgrade the Nedbank share price experienced a negative abnormal return of 5.79% and was significant at a 99% confidence level. Two days within the 10 days subsequent to the South African sovereign credit rating downgrade proved to render significant negative abnormal returns.

In the case of FNB, six days within the event window proved to render abnormal returns. One positive significant abnormal return occurred prior to the South African sovereign credit rating downgrade. Furthermore, FNB shares experienced a significant negative abnormal return of 2.11% on the day of the downgrade and four more significant negative abnormal returns succeeding the downgrade.

The shares of Standard Bank were not subject to any significant abnormal returns prior to the South African sovereign credit rating downgrade or on the day of the downgrade. The shares of Standard Bank did, however, experience four significantly negative abnormal returns in the event window after the South African sovereign credit rating downgrade.

Table 21.8 Bank abnormal returns on the day of a South African sovereign downgrade and the abnormal returns thereafter (3rd of April 2017)

Day	NED	FNB	STD	ABSA
Day of downgrade	−5.79%*** (−4.485)	−2.12%* (−1.694)	−0.93% (−0.517)	−0.12% (−0.067)
1	−2.71%*** (−2.613)	−4.41%** (−2.456)	−3.85%** (−2.116)	−3.79%* (−1.979)
2	1.91% (1.343)	1.69% (−0.934)	0.04% (0.025)	2.43% (1.265)
3	−1.49%** (−1.98)	−4.61%*** (−2.693)	−3.59% (−1.994)**	−1.49% (−0.782)
4	2.09% (2.08)	0.59% (0.338)	1.00% (0.552)	−0.07% (−0.040)
5	−0.79% (−0.556)	−4.64%*** (−2.697)	−7.36%*** (−4.013)	−7.85%*** (−4.081)
6	−1.01% (−1.212)	−2.23%* (−1.724)	−0.95% (−0.513)	1.90% (0.981)
7	−1.21% (−1.568)	0.98% (−0.548)	−1.31% (−0.716)	0.20% (0.109)
8	1.66% (1.176)	1.94% (−1.185)	−3.61% (−1.973)*	−4.58%** (−2.388)
9	0.26% (0.184)	−1.83% (−1.117)	2.52% (1.378)	−2.63% (−1.374)
10	−0.93% (−0.632)	−1.24% (−0.911)	−0.35% (−0.183)	1.66% (0.842)
CAR	−8.54%*** (−6.93)	−9.45%*** (−5.32)	−8.77%*** (−9.28)	−9.68%*** (−10.16)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value
Source Excel output

The shares of ABSA were subject to two significant abnormal returns prior to the South African sovereign credit rating downgrade and three significant abnormal returns succeeding the downgrade. With the exception of the abnormal return occurring six days before the downgrade, which was positive, all the significant abnormal returns were negative.

The cumulative abnormal returns were −14.54, −9.45, −12.77, −9.68% for Nedbank, FNB, Standard Bank and ABSA respectively. All these cumulative abnormal returns are significant at a 99% confidence level. The study will now further the evidence on the impact of a South African sovereign credit rating on the shares of retail banks in South Africa by estimating a GARCH-BEKK model.

21.3.2 *Volatility Spillovers Caused by a South African Sovereign Credit Rating Downgrade*

The section will start with the necessary stationarity test results for the volatility spillover analysis. To establish a preliminary idea of whether the data used in this analysis is stationary and whether volatility clusters exist in each time series, the returns of each variable under consideration are plotted in Fig. 21.1. None of these four graphs indicates that a trend exists in the returns of these banks. Furthermore, the change in the South African five-year CDS indicates that no trend exists. It is therefore expected that each series will be stationary and could therefore be used in volatility models. Secondly, there seem to be periods of high volatility and periods of low volatility, in other words, clusters of volatility in all five datasets. Formal tests will now be conducted to confirm the findings suggested by Fig. 21.1.

21.3.2.1 Augmented Dickey-Fuller Unit Root Test

Table 21.9 depicts the Augmented Dickey-Fuller test results for each series included in the analysis. The returns of Nedbank, FNB, Standard Bank and ABSA are stationary at a 99% confidence level since the null hypothesis (series contains a unit root) can be rejected.

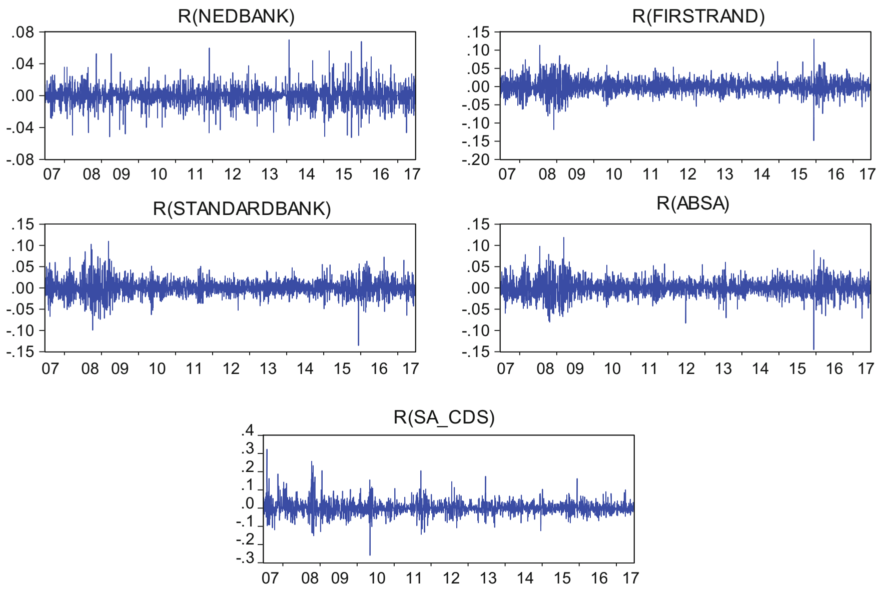


Fig. 21.1 Returns for the South African banks. *Source* Eviews output

Table 21.9 Augmented Dickey-Fuller test results

	Returns (Nedbank)	Returns (FNB)	Returns (Standard Bank)	Returns (ABSA)	Change (CDS)
P-value	0.009***	0.001***	0.004***	0.000***	0.005***

*, **, and *** denote significance level at the 10, 5, and 1% levels, respectively
Source Eviews output

Furthermore, the time series of the change in South Africa's sovereign five-year CDS is also stationary at a 99% confidence level. As a result, these variables could be used in volatility models such as an ARCH model or a GARCH-BEKK model. The results obtained by the univariate non-linear ARCH model will now be considered.

21.3.2.2 Testing for Volatility Clusters

Table 21.10 displays the results of the heteroscedasticity ARCH model, conducted with the aim of determining whether each variable under analysis contains volatility clusters. It is clear that the null hypothesis, which is no ARCH effect or no volatility clusters, could be rejected at a 99% confidence level. Volatility clusters are therefore present in the returns of each South African retail bank under analysis and the change in the South Africa five- year CDS. The base model in each test is the return on each bank as dependent variable and the constant as an explanatory variable (Gujarati and Porter 2009).

As suggested by Liu et al. (2017), given that all the variables in the analysis contain volatility clusters, the study could commence with the analysis that sets out to determine whether a South African sovereign credit rating downgrade caused volatility spillovers to the share returns of each bank under analysis.

21.3.2.3 GARCH-BEKK Analysis

Considering the results in Table 21.11, as depicted by A′, the coefficient of conditional residual matrix, a South African sovereign credit rating change in the previous period had a significant spillover effect on the residual's variance of

Table 21.10 Volatility cluster test results

	Returns (Nedbank)	Returns (FNB)	Returns (Standard Bank)	Returns (ABSA)	Change (CDS)
ARCH-LM test p-values	0.001***	0.008***	0.005***	0.002***	0.009***

*, **, and *** denote significance at the 10, 5, and 1% levels, respectively
Source Eviews output

Table 21.11 GARCH(1)-BEKK outputs

	Nedbank	FNB	Standard Bank	ABSA
A(1, .)	0.23*** (0.00)	0.20*** (0.00)	0.067** (0.01)	0.11*** (0.00)
B(1, .)	0.36*** (0.00)	0.21** (0.03)	0.11** (0.02)	0.18** (0.01)
C(1, .)	−0.02 (0.72)	0.00 (0.85)	−0.01 (0.63)	0.00 (0.71)

*, **, and *** denote statistical significance at the 10, 5, and 1% levels, respectively, based on *p*-value

Note A(1, i) and B(1, i) are corresponding ARCH and GARCH parameters of a sovereign credit rating downgrade for bank i. C(1, i) is a constant coefficient matrix

Source Rats output

Nedbank's, FNB's, Standard Bank's and ABSA's share returns. In other words, a South African sovereign credit rating change had a significant lagged impact on the ARCH parameter for each bank. Furthermore, B′, the coefficient of conditional covariance matrix, indicates that a South African sovereign credit rating change had a significant spillover effect on the GARCH parameter of each bank under analysis. This provides evidence that a South African sovereign credit rating change had a significant spillover effect on the volatility on the share returns of all four banks under analysis.

Because the A′ and B′ coefficients indicate how the conditional variance depends on the squared and cross product of previous shocks in the South African credit rating proxy, Liu et al. (2017) and Mohammadi and Tan (2015) state that the A′ and B′ coefficients of each bank need to be squared. The reported coefficients are therefore squared coefficients. The response of Nedbank's, FNB's, Standard Bank's and ABSA's ARCH parameter to a one unit squared standardised innovation in the South African sovereign credit rating proxy series is 0.23, 0.20, 0.07 and 0.11 respectively. Furthermore, the response of Nedbank's, FNB's, Standard Bank's and ABSA's GARCH parameter to a one unit squared standardised innovation in the South African sovereign credit rating proxy series is 0.36, 0.21, 0.11 and 0.18 respectively. Liu et al. (2017) write that it should be noted that the coefficients of each matrix are difficult to interpret because the coefficient does not refer to a specific unit of analysis. It is therefore argued by Liu et al. (2017) that the significance of each matrix's coefficient is the most important to consider and that significance indicates volatility spillovers. However, Liu et al. (2017) write that the value of each coefficient can be used to compare the relative magnitude of the volatility spillover effect of one variable to another. It is therefore shown that a South African sovereign credit rating change had the largest volatility spillover effect on Nedbank's shares relative to the shares of the three other banks under analysis.

21.4 Conclusion

Similar to the findings by Correa et al. (2014), Borensztein et al. (2013), Christopher et al. (2012), Brooks et al. (2004) and Kaminsky and Schmukler (2002), this study found that a local sovereign credit rating downgrade generally had a negative impact on the shares of the local retail banking industry. South African sovereign credit rating downgrades resulted in significantly negative cumulated abnormal returns in the shares of all four banks under analysis, with the exception of the 13 June 2014 S&P South African sovereign credit rating downgrade that proved not to result in a significant cumulative abnormal return in the shares of ABSA. This means that relative to the rest of the market, shares of South African retail banks where particularly negatively impacted by a South African sovereign credit rating downgrade. Furthermore, the results obtained by the GARCH(1,1)-BEKK model provided evidence that a volatility spike in the South African sovereign credit rating proxy had a significant spillover effect on both the ARCH and GARCH parameters of each bank's share prices. This indicates that a South African sovereign credit rating change did have a volatility spillover effect on the share price of the banks under analysis. Furthermore, despite the argument and evidence that show that the South African retail banks are well developed and more robust relative to typical retail banks in emerging markets, a South African credit rating change still had a significant spillover effect on the shares of these banks, and caused these shares to underperform relative to the market.

This evidence indicates that investors should pay particular caution to shares of South African retail banks in periods where a downgrade might occur. Because shares of retail banks underperform relative to the rest of the market, investors should underweight these shares in their portfolio in times where a downgrade is expected, and overweigh these shares in times where an upgrade is expected. A systematic asset allocation adjustment by investors prior to a sovereign downgrade should result in a methodical decline in South African retail bank share prices, and thereby reduce any sudden volatility created by a downgrade because the downgrade was already priced in. As considered before, market volatility and panic in the banking sector can cause major liquidity problems for retail banks that can trigger system wide banking crises. An argument could be made that South African depositors are less likely to panic and demand their deposits if the share price of retail banks are fairly stable after a South African sovereign credit rating downgrade. Therefore, this study provides justification for investors in South African retail banks to price in an expected change in the South African credit rating by reducing their portfolio exposure to the retail banking industry. This will reduce the likelihood of panic on the day of a sovereign credit rating downgrade, which in turn reduces the risk of a system wide banking liquidity crisis that can potentially be triggered by such a downgrade.

Appendix

See Tables 21.12, 21.13 and 21.14.

Table 21.12 Expected return during 2012 S&P sovereign credit rating downgrade

Day	Standard & Poor (2017) downgrade			
	Ned (%)	FNB (%)	Std (%)	Absa (%)
−10	0.85	−0.11	−0.14	−0.21
−9	−0.66	0.09	0.11	0.16
−8	−0.70	0.10	0.12	0.18
−7	0.20	−0.03	−0.03	−0.05
−6	0.93	−0.13	−0.16	−0.23
−5	−0.15	0.02	0.03	0.04
−4	0.47%	−0.06	−0.08	−0.12
−3	0.93	−0.13	−0.15	−0.23
−2	0.78	−0.11	−0.13	−0.20
−1	−0.57	0.08	0.10	0.14
Day of downgrade	−0.70	0.09	0.12	0.17
1	0.48	−0.07	−0.08	−0.12
2	−0.75	0.10	0.13	0.19
3	0.72	−0.10	−0.12	−0.18
4	0.11	−0.02	−0.02	−0.03
5	−0.32	0.04	0.05	0.08
6	0.32	−0.04	−0.05	−0.08
7	0.40	−0.05	−0.07	−0.10
8	0.02	0.00	0.00	−0.01
9	0.57	−0.08	−0.10	−0.14
10	0.74	−0.10	−0.12	−0.18

Source Self constructed based on Excel outputs

Table 21.13 Expected return during 2014 S&P sovereign credit rating downgrade

Day	Standard & Poor (2017) downgrade			
	Ned (%)	FNB (%)	Std (%)	Absa (%)
−10	0.40	0.40	0.30	0.40
−9	1.60	1.60	1.60	1.60
−8	−0.40	−0.40	−0.60	−0.40
−7	0.20	0.30	0.10	0.20
−6	0.10	0.10	−0.10	0.10
−5	−0.20	−0.20	−0.40	−0.20

(continued)

Table 21.13 (continued)

	Standard & Poor (2017) downgrade			
Day	Ned (%)	FNB (%)	Std (%)	Absa (%)
−4	0.30	−0.30	−0.50	0.30
−3	0.00	0.10	−0.10	0.00
−2	−0.40	−0.30	−0.50	−0.40
−1	−1.50	−1.40	−1.70	−1.50
Day of downgrade	0.50	0.60	0.40	0.50
1	0.40	0.40	0.30	0.40
2	1.20	1.30	1.20	1.20
3	0.00	0.00	−0.20	0.00
4	−0.30	−0.20	−0.40	−0.30
5	0.40	0.40	0.30	0.40
6	0.80	0.80	0.70	0.80
7	−0.60	−0.50	−0.70	−0.60
8	−0.60	−0.60	−0.80	−0.60
9	0.20	0.30	0.10	0.20
10	0.80	0.90	0.80	0.80

Source Self constructed based on Excel outputs

Table 21.14 Expected return during 2017 S&P sovereign credit rating downgrade

	Standard & Poor (2017) downgrade			
Day	Ned (%)	FNB (%)	Std (%)	Absa (%)
−10	0.46	1.07	0.93	0.71
−9	1.35	0.93	0.79	0.63
−8	0.90	1.00	0.86	0.67
−7	−0.56	1.22	1.08	0.79
−6	0.75	1.02	0.88	0.68
−5	0.42	1.07	0.93	0.71
−4	0.69	1.03	0.89	0.69
−3	2.22	0.80	0.66	0.56
−2	1.20	0.95	0.81	0.64
−1	0.49	1.06	0.92	0.71
Day of downgrade	0.44	1.07	0.93	0.71
1	1.80	0.86	0.72	0.59
2	1.35	0.93	0.79	0.63
3	1.63	0.89	0.75	0.61
4	0.74	1.02	0.88	0.68
5	0.76	1.02	0.88	0.68
6	1.53	0.90	0.76	0.62

(continued)

Table 21.14 (continued)

	Standard & Poor (2017) downgrade			
Day	Ned (%)	FNB (%)	Std (%)	Absa (%)
7	1.77	0.87	0.73	0.60
8	0.94	0.99	0.85	0.67
9	0.81	1.01	0.87	0.68
10	0.90	1.00	0.86	0.67

Source Self constructed based on Excel outputs

References

Afonso, A., Gomes, P., & Taamouti, A. (2014). Sovereign credit ratings, market volatility and financial gains. *Computational Statistics & Data Analysis, 76,* 20–33.

Almeida, H., Cunha, I., Ferreira, M. A., & Restrepo, F. (2017). The real effects of credit ratings: The sovereign ceiling channel. *Journal of Finance, 71*(1), 249–290.

Baker, L. (2015). The evolving role of finance in South Africa's renewable energy sector. *Geoforum, 68,* 146–156.

Bikhchandani, S., & Sharma, S. (2001). Herd behaviour in financial markets. *International Monetary Fund, 3*(47), 279–310.

Borensztein, E., Cowan, K., & Valenzuela, P. (2013). Sovereign ceilings "lite"? The impact of sovereign ratings on corporate ratings. *Journal of Banking & Finance, 37*(11), 4014–4024.

Brooks, C. (2013). *Introductory econometrics for finance* (3rd ed.). Cambridge: Cambridge University Press.

Brooks, R., Faff, R. W., Hillier, D., & Hillier, J. (2004). The National market impact of sovereign rating changes. *Journal of Banking & Finance, 28,* 233–250.

Bumann, S., Hermes, N., & Lensink, R. (2013). Financial liberalisation and economic growth: A meta-analysis. *Journal of International Money and Finance, 33,* 255–281.

Christopher, R., Kim, S. J., & Wu, E. (2012). Do Sovereign credit ratings influence regional stock and bond market interdependencies in emerging countries? *Journal of International Financial Markets, Institutions and Money, 22*(4), 1070–1089.

Correa, R., Lee, K., Sapriza, H., & Suarez, G. A. (2014). Sovereign credit risk, banks' government support, and bank stock returns around the world. *Journal of Money, Credit and Banking, 46* (1), 93–121.

Fabozzi, J. F. (2007). *Fixed income analysis* (2nd ed.). New Jersey: Wiley.

Gatev, E., Schuermann, T., & Strahan, P. E. (2009). Managing bank liquidity risk: How deposit-loan synergies vary with market conditions. *The Review of Financial Studies, 3*(22), 995–1020.

Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5th ed.). New York: McGraw-Hill.

International Monetary Fund. (2014). *Financial system stability assessment*. South Africa. No 14 (340).

Kaminsky, G., & Schmukler, S. L. (2002). Emerging markets instability: Do sovereign ratings affect country risk and stock returns? *World Bank Economic Review, 16*(2), 171–195.

Koop, G. (2009). *Analysis of economic data* (3rd ed.). West Sussex: Wiley.

Lakshmi, V. D. M. V., & Joshi, M. (2016). Market reaction to listing of stockson F&O segment of NSE: Application of event study methodology. *The IUP Journal of Applied Economics, 15*(3), 37–76.

Lee, N., & Lings, I. (2008). *Doing business research: A guide to theory and practice*. London: SAGE Publications Ltd.

Liu, X., An, H., Huang, S., & Wen, S. (2017). The evolution of spillover effects between oil and stock. *Physica A: Statistical Mechanics and its Applications, 465*(1), 374–383.

Makiono, R. (2016). Stock market responses to chemical accidents in Japan: An event study. *Journal of Loss Prevention in the Process Industries, 40*(1), 453–458.

Mlambo, K., & Ncube, M. (2011). Competition and efficiency in the banking sector in South Africa. *African Development Review, 23*(1), 4–15.

Mohammadi, H., & Tan, Y. (2015). Return and volatility spillovers across equity markets in Mainland China, Hong Kong and the United States. *Econometrics, 3*(2), 215–232.

Nading, A. (2015). An empirical study of stock split announcements of select BSE sectors using event study methodology. *SDMIMD Journal of Management, 6*(1), 1–12.

Orhan, E., & Yusuf, V. (2014). Understanding the sovereign credit ratings of emerging markets. *Emerging Market Review, 20*(1), 42–57.

Shen, C. H., Huang, Y. L., & Hasan, I. (2012). Asymmetric benchmarking in bank credit rating. *Journal of International Financial Markets, Institutions and Money, 22*, 171–193.

Standard & Poor. (2017). *S&P global ratings*. Available: https://www.Standardandpoors.com/en_web/guest/home. (Accessed: 17 June 2017).

Vaaler, P. M., & McNamara, G. (2004). Crisis and competition in expert organizational decision making: Credit-rating agencies and their response to turbulence in emerging economies. *Organizational Science, 6*(15), 687–703.

Williams, G., Alsakka, R. & ap Gwilym, O. (2015). Does sovereign creditworthiness affect bank valuations in emerging markets? *Journal of International Financial Markets, Institutions and Money, 36*(1), 113–129.

Vernazza, D. R., & Nielsen, E. F. (2015). The damaging bias of sovereign ratings. *Economic Notes, 44*(2), 361–408.

Vaaler, P. M., & Hanusch, M. (2013). Credit rating agencies and elections in emerging democracies: Guardians of fiscal discipline? *Economic Letters, 119,* 251–254.

Chapter 22
Impact of Macroeconomic Variables on Exchange Rate: An Evidence from Pakistan

Muhammad Mohsin, Li Naiwen, Muhammad Kashif Majeed and Sobia Naseem

Abstract The purpose of this research is to provide the evidence on the relationship between Real Exchange rate (REXR) against US dollar and macroeconomic variables in Pakistan. This study has taken real exchange rate is dependent variable and some other macroeconomic variables are as independent variables. To examine this relationship the ordinary least square regression (OLS) technique is used. This technique was used by Zamir et al. (2017). The results shows that current balance (CB) is negatively significant at 10% level, the inflation and foreign direct investment (FDI) is also negatively significant at 5, 1% respectively. But the Gross domestic product per capita (GDP) is positively significant at 5% level. The Trade openness (OP) shows no important relation with real exchange rate (REXR). Further the ARCH LM test provides result there is no serial correlation and to check the heteroskedasticity whit test is used this test shows the result there is no heteroskedasticity. This study is helpful for international investor and also to increase export for a country.

Keywords OLS · REXR · Macroeconomic variables · ARCH-LM test White test

22.1 Introduction

In the era of globalization and financial liberalization, exchange rate plays an important role in international trade and finance for a small open economy like Pakistan. This is because movements in exchange rates affect the profitability of

M. Mohsin (✉) · L. Naiwen
College of Business Administration, Liaoning Technical University, Liaoning 125105, Xingcheng, China
e-mail: mohsinlatifntu@gmail.com

M. K. Majeed · S. Naseem
Liaoning Technical University, Fuxin, People's Republic of China

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_22

Multinationals and increase exchange exposure to enterprises and financial Institutions. A stable exchange rate may help enterprise and financial institutions in Evaluating the performance of investments, financing and hedging and thus reducing their operational risks. Fluctuations in the exchange rate may have a significant impact on the macroeconomic fundamentals such as interest rates, prices, wages, unemployment, and the level of output. Volatility of exchange rates put in plain words the uncertainty in international transactions both in goods and in financial assets. Exchange rates are modeled as forward-looking relative asset prices that reflect unexpected variations in relative demand and supply of domestic and foreign currencies, so exchange rate volatility replicate agents' expectations of changes in factors of money supplies, interest rates and incomes.

Exchange rate management has been a topical issue among academics and policy makers for a very long time. This started predominantly when the Gold standard collapsed in the 1930s and subsequent emergence of the Britton wood system of adjustment peg from the 1940s, through the espousal of flexible exchange rate given by the developing nation in 1970 and those carrying out structure reforms in the 1980s as well as in the wake of the currency crises in developing economies in the 1990s. Flexible exchange rate is accompanied by the fluctuation of exchange rate making it the major focus in the debate due to its impact on business outcome as nations' business partners would prefer a stable exchange rate to a volatile one. It has been recognized in previous studies that maintaining a relatively stable exchange rate is important in boosting economic growth. Volatility of exchange rate induces uncertainty and risk in investment decision with destabilizing impact on the macroeconomic performance (Mahmood and Ali 2011). Mordi (2006) studied about the concern of private sectors about the volatility of exchange rate because the fluctuations in exchange rate effect the investments or interest of investors which become the cause of capital gain or losses. Macroeconomic variables symmetrically affect exchange rate volatility. Aliyu's (2009) investigations are indicated that appreciations in exchange rate increase import and decrease export and vice versa. Although, appreciation and depreciation of exchange rate highly effected trade and economic growth of the exporting and importing countries.

Exchange rate deprecation has a negative effect on developing countries Iyeli and Utting (2017). In this paper researcher will explore the relationship between macro economic variables and exchange rate fluctuations in response to these variables. I will find out which macro economic variables are more closely correlated with exchange rate fluctuations. Theoretically there are preplanned relationship between macro economic variables and exchange rate fluctuations. In this paper I will find out whether these relationships hold true in practical sense or not. Apart from this the introduction, the rest of this paper is organized as follows: section two focuses on the literature and empirical review while Section three relates to the methodology employed. Section four dwells extensively on analysis and discussion of findings. The last section presents the summary, conclusion and recommendations.

22.1.1 Significance of Study

It is important to know the impact of macroeconomic variables on Real exchange rate for the forecasting of exchange rate. This study will help Pakistani as well as foreign companies, banks, individuals, foreign currency dealers, and investment management firms etc to forecast the exchange rate by using macroeconomic variables.

22.1.2 Objective of Study

To check the relationship of macroeconomic variables with real exchange rates against US dollar of Pakistan.

22.2 Literature Review

The review of literature plays a significant role in identifying the backdrop of the study being conducted. It also gives direction about the problem and eradicates the possibility of needless repetition of the efforts. In addition, precious information on research skill is obtained from the previous research description. The main purpose of this section is to assess the related literature review.

Bhutt et al. (2014) reported that interest rate and inflation rate has high effect on the fluctuation of exchange rate while gross domestic product and current account has low impact on exchange fluctuation. Jilani et al. (2013) found that the there is no clear evidence of the relationship between exchange rate and economic growth because it varies from country to country. This paper determined the relationship between exchange rate and economic growth and according to the results this paper concludes that there is positive and significant relationship between exchange rate and economic growth of Pakistan in long term. According to this research impact of exchange rate in terms of real exchange rate on economic growth is significant and the relationship is positive with the economic growth therefore high exchange rate should be maintained in order to boost the economic growth.

By Craig S. Hakkio (1980) indicate that Fisher relationship showed changes in real interest rates are caused due to the change in nominal interest rates. Changes in real interest rates attract domestic and foreign investment opportunities. If U.S. real interest rate is higher than the foreign real interest rate, the market must be expecting the real exchange rate to depreciate. Changes in real interest rates were the dominant influence on nominal interest rates and the dollar. Iqbal et al. (2011) indicate that the presence of positive impact of exchange rate volatility on GDP growth rate and trade openness. While negative impact of exchange rate volatility on foreign direct investment is found. Dallas S. define that the expectation of future appreciation or depreciation of a currency is linked closely to the expectation of future inflation in one country relative to another country. Oforegbunam Thaddeus and Nnneka (2014) define that the exchange rate is a dynamic variable, the main factors influencing its formation being the following: GDP, inflation rate, money supply, interest rate and balance of payments. Analysis of the factors influencing the exchange rate must take into account their interdependence, the connection between them, which ultimately leads to currency appreciation or depreciation. Honohan and Lane (2004) found that exchange rate depreciation passes through into inflation more quickly than does exchange rate appreciation. West (2003) reported that exchange rate fluctuation is helpful in future economic variables such as money, income, prices and interest rates. The exchange rates can help forecast fundamental macroeconomic indicators. Barkoulas et al. (2000) investigate about the impact of exchange rate fluctuation on the volume and trade flow's variability. Expansion of trade is discouraged by volatility of exchange rate and minimizing its incentives.

Guo (2008) carried out a comparative study and found that appreciation of exchange rate increases GDP in Russia while it reduces GDP in Japan and China.

22.2.1 Hypothesis

H0 = There is no significant relationship between macroeconomic variables (CB, INR, FDI, GDP and OP) and real exchange rate.
H1 = There is a significant relationship between macroeconomic variables (CB, INR, FDI, GDP and OP) and real exchange rate.

22.3 Data Description

For this research the time series secondary data from 1980 to 2017 was used. The date is obtained from State Bank of Pakistan, World Bank Development Indicator, Business recorder and also some findings and the information about data was gathered previous report, research paper and official websites.

22.3.1 Data Analysis Tool

E-Views 7 statistics application software was used for the empirical analysis of the data and hypothesis testing.

22.4 Methodology

To found the impact of macroeconomic variables on exchange rate the multiple econometric regressions is used. This model is also used by Zamer (2017). The model is constructed as follows.

$$\text{REXR} = f\ (\text{CB, INR, FDI, GDP, OP})$$

$$\text{REXRt} = f\ (\text{CBt, INRt, FDIt, GDPt, OPt})$$

The regression equation model and take natural logarithm is as follows.

$$\text{LREXRt} = \beta 0 + \beta 1\text{LCBt} + \beta 2\text{LINRt} + \beta 3\text{FDIt} + \beta 4\text{LGDPt} + \beta 5\text{OPt}$$

where,
L denotes log and t denotes time period.

REXR	Real Exchange Rate
CB	Current Balance account
INR	Inflation
FDI	Foreign Direct Investment
GDP	GDP per Capita
OP	Trade Openness
μi	Error Term

22.5 Empirical Findings

22.5.1 Descriptive Statistics of Real Exchange Rate (REXR)

Table 22.1 represents the outline of descriptive statistics of all variables. The results of the descriptive statistics shows the number of observation, mean, maximum, minimum values, stander deviation, Kurtosis and Jarque-Bera Test.

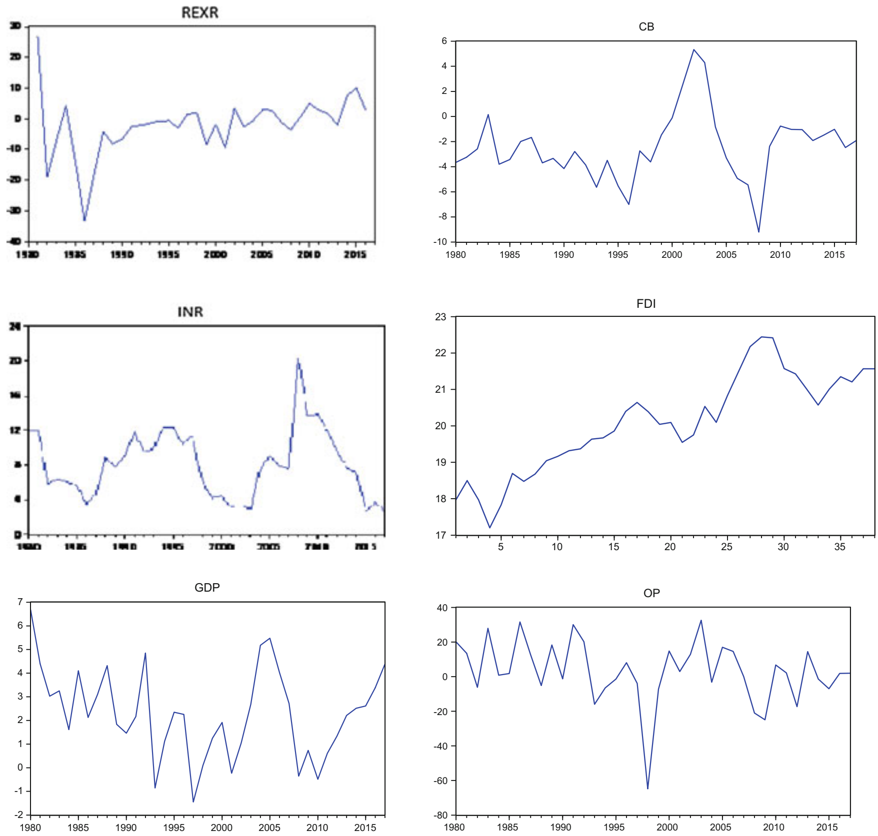
Table 22.1 Descriptive statistics

	REXR	CB	INF	FDI	GDP	OP
Mean	4.79738	−2.45096	1.96877	20.0927	0.79334	3.15389
Median	4.72685	−2.66393	2.04982	20.094	0.92107	1.92571
Maximum	5.42273	5.33006	3.00994	22.4443	1.89995	32.5613
Minimum	4.53785	−9.20432	0.93197	17.1984	−2.35306	−64.8513
Std. Dev.	0.25901	2.72586	0.53072	1.34671	0.80796	18.1201
Skewness	1.20074	0.5843	−0.40392	−0.18793	−1.86141	−1.21963
Kurtosis	3.20955	4.69226	2.2705	2.25088	5.09463	6.5294
Jarque-Bera	9.20075	6.6965	1.87588	1.11221	54.745	29.1439
Probability	0.01005	0.03515	0.39143	0.57344	0.0000	0.0000
Sum	182.3	−93.1365	74.8134	763.524	26.1801	119.848
Sum Sq. Dev.	2.48223	274.921	10.4217	67.1044	20.8894	12148.5
Observations	38	38	38	38	38	38

H0 = the data is normally distributed
H1 = the is not normally distributed.

In case of CB, INF and FDI the Jarque-Bera insignificant the null hypothesis is not rejected mean that the date is normally distributed. In case of REXR, GDP and OP are significant shows the date data is not normally distrusted. The result of Kurtosis and Skewness shows that distributions are symmetry.

22.5.2 Graphically Representation of Data



22.5.3 Multiple Regression Models

In Table 22.2 found that the relationship between macroeconomic variables and exchange rate. The result shows that current balance account (CB) is negatively significant at 10% level, the inflation rate (INR) is negatively significant at 5% level, Gross domestic product per capita (GDP) is positively significant at level 5% and foreign direct investment (FDI) is negatively significant at 1% level but the Trade openness is insignificant. The value of Coefficient of determination (R-squared) is 77.92% mean that 77.92% of the variation dependent variables with the regression equation. The value of F-statistics is 19.05904 is significant at the level of 1% means that the model is good fit.

22.5.4 The ARCH LM Test

The result of ARCH LM shows that's the value of R-squared is insignificant means that there is no serial correlation. So we are not able to reject the null hypothesis (Table 22.3).

Table 22.2 Regression equation (OLS)

Variable	Coefficient	Std. error	t-Statistic	Prob.
C	8.189618	0.391267	20.93101	0.1869
CB	−0.023416	0.013213	−1.772224	0.0876[C]
INR	−0.081716	0.060339	−1.354279	0.0469[b]
FDI	−0.16669	0.018503	−9.008985	0.0000[a]
GDP	0.104587	0.043248	2.418314	0.0226[b]
OP	−0.00321	0.001949	−1.646741	0.1112
R-squared	0.779223	Mean dependent var		4.82294
Adjusted R-squared	0.738338	S.D. dependent var		0.26717
S.E. of regression	0.136667	Akaike info criterion		−0.97957
Sum squared resid	0.504305	Schwarz criterion		−0.70748
Log likelihood	22.16287	Hannan-Quinn criter.		−0.88802
F-statistic	19.05904	Durbin-Watson stat		1.85742
Prob(F-statistic)	0.00000[a]			

[a]1% level of significant
[b]5% level of significant
[c]10% level of significant

Table 22.3 Breusch-Godfrey serial correlation LM test

F-statistic	0.569606	Prob. F	0.5722
Obs * R-squared	1.407437	Prob. Chi-Square(2)	0.4947

H0 = There is no serial correlation
H1 = There is serial correlation

Table 22.4 Heteroskedasticity test-white

F-statistic	1.359442	Prob. F	0.275
Obs * R-squared	23.20041	Prob. Chi-Square	0.2791
Scaled explained SS	27.48754	Prob. Chi-Square	0.1221

H0 = There is Homoscedasticity
H1 = There is Heteroskedasticity

22.5.5 Heteroskedasticity Test: White

In Table 22.4 found that the value of R-squared is insignificant means that there is homoscedasticity. So we are not able to reject the null hypothesis.

22.6 Conclusion

The exchange rate is the one of the most important determinates of a country relative level of economic growth. Exchange rate plays a vital role for a country to level the trade which is the critical for every market economy in the world. Pakistan is a developing country and exchange rate with US dollar is important for trade with other countries. To check the relationship between exchange rate and macroeconomic variables the OLS model is used. The current balance (CB) is negatively significant at 10%, the inflation (INR) and Foreign direct investment (FDI) is also negatively significant at 5, 1% level but the Gross domestic product per capita (GDP) is positively significant at 5% level. The Trade openness (OP) shows no important relation with real exchange rate (REXR). The CB, INF, FDI is negatively forced the exchange rate mean that when the values of these variable is decrease the value of exchange is up but in case of GDP is Vice versa. To control exchange rate volatility for the boost of economy must be look and valuate the importance of macroeconomic variables.

References

Adeniran, J. O., Yusuf, S. A., & Adeyemi, O. A. (2014). The Impact of exchange rate fluctuation on the Nigerian economic growth: An empirical investigation. *International Journal of Academic Research in Business and Social Sciences*, *4*(8), 224–233.

Aliyu, S. (2009). Impact of oil price shock and exchange rate volatility on economic growth in Nigeria: an empirical investigation. *Research Journal of Internatıonal Studıes*, (11), 4–15.

Barkoulas, J. T., Baum, C. F., & Caglayan, M. (2000). Exchange rate effects on the volume and variability of trade flows. *Journal of International Money and Finance,* 481–496.

Bhutt, S. K., Rehman, M. U., & Rehman, S. U. (2014). Analysis of exchange rate fluctuations: A study of PKR VS USD. *Journal of Managerial Sciences*, 42–60.

Chinn, M. D., & Wei, S. J. (2013). A faith-based Initiative: Does a flexible exchange rate regime really facilitate current account adjustment?. *Review of Economics and Statistics,* 168–184.

Engel, C., & West, K. D. (2003). Exchange rate and fundamentals. Working Paper, 1–50.

Guo, J. (2008). The Impact of oil price shock and exchange rate volatility on economic growth: a comparative analysis for Russia Japan and China. *Research Journal of International Studies*, (8), 98–111.

Hakkio, C. S. (1980). Expectations and the forward exchange rate. National bureau of economic research, Working paper, 1–43.

Honohan, P., & Lane, P. R. (2004). Exchange rates and inflation under Emu: an update. *IIIS Discussion Paper No.*, *31*, 1–19.

Honohan, P., & Lane, P. R. (2014). Exchange rates and inflation under EMU: An update. *Institute for International Integration Studies*, 1–16.

Iqbal, M., Ehsanullah, E., & Habib, A. (2011). Exchange rate volatility and macroeconomic variables in Pakistan. *Business Management Dynamics, 11*(2), 11–22.

Iyeli, I. I., & Utting, C. (2017). Exchange rate volatility and economic growth in Nigeria. *International Journal of Economics, Commerce and Management*, 583–595.

Jilani, S., Cheema, F.-E.-A., & Asim, M. (2010). Exploring impact of macro economic variables on GDP of Pakistan. *Journal of Management and Social Science*, 65–73.

Jilani, S., Shaikh, S. A., & Cheema, F.-E.-A., & Shaikh, A.-U.-H. (2013). Determinants of national savings in Pakistan: an exploratory study. *Asian Social Science*, *9*(5), 254–262.

Mahmood, I., & Ali, S. (2011). Impact of exchange rate volatility on macroeconomic performance of Pakistan. *International Research Journal of Finance and Economics*, 54–65.

Mordi, C. N. (2006). Challenges of exchange rate volatility in economic management in Nigeria; in dynamics of exchange rate in Nigeria Central Bank of Nigeria Bullion. *Journal of Finance and Economics, 30*(3), 17–25.

Oforegbunam Thaddeus, E., & Nnneka, A. (2014). Exchange rate, inflation and interest rates relationships: An autoregressive distributed lag analysis. *Journal of Economics and Development Studies, 2,* 263–279.

West, K. (2003). Monetary policy and the volatility of real exchange rates in New Zealand. National Bureau of economic research working paper number 10280, 1–32.

Zamir, M., Amin, A., Uallah, S., & Khan, S. (2017). Exchange rate volatility in Pakistan and its impact on selected macroeconomic variables, 167–187 (Scientific Research Publications).

Chapter 23
A Stimulating Export Oriented Policy of Agricultural Sector of Developing Countries on Example of Georgia

Nino Rukhaia-Mosemgvdlishvili

Abstract This topic is about regional and agricultural policies in small and developing countries, where the agro field is in difficult situation, and governments don't have enough resources, to develop rural regions and agricultural sector. Economists consider agriculture as a precondition for the development of the industrial sector, as it actively uses products produced in other fields: large agricultural equipment, pesticides and other necessary equipment. The amount of agricultural product stimulates the development of the processing and refrigeration industries. In addition, this field is one of the largest areas of employment. The development of agriculture stimulates the growth of large farms and cartels as well as the effectiveness of small entrepreneurs. Consequently, it is important that agricultural policy would include not only agricultural and farming development strategies, but also be an integral part of regional policy. No matter how many laws are written in the government creating effective models for the development, it is crucial to have a powerful team who have great desire, knowledge and experience for participation and implementation of the plan. Unfortunately, today there is no such commitment. This is confirmed by the fact that all existing projects enjoy support, i.e. existing farmers who have already had their own businesses wanted to expand existing ones. Theoretically, on the one hand, it is not as bad, probably good; however, real outcome can be achieved only with the large scale effect; therefore, all mini-agricultural lands should be involved in agricultural production. The biggest problem in Georgian agricultural sector is fragmental patches of land, where practically is impossible to carry out profitable economic activities. Relevantly establishing various forms and development of farmers' cooperation should be an essential component of the agricultural policy. Finally, there is

This work was supported by Shota Rustaveli National Science Foundation (SRNSF) YS-2016-23 Young Scientists Research Grant.

N. Rukhaia-Mosemgvdlishvili (✉)
David Agmashenebeli National Defence Academy of Georgia, Gori, Georgia
e-mail: ninorukhaia@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_23

determined the stimulating regional policy combined with the agricultural policy priorities and main instruments for its implementation in Georgia.

Keywords Agriculture economics · Cluster · Georgian agriculture

23.1 Introduction

Economists consider agriculture as a precondition for the development of the industrial sector, as it actively uses products produced in other fields: large agricultural equipment, pesticides and other necessary equipment. The amount of agricultural product stimulates the development of the processing and refrigeration industries. In addition, this field is one of the largest areas of employment. The development of agriculture stimulates the growth of large farms and cartels as well as the effectiveness of small entrepreneurs (Gurova 2014).

Establishing the right agrarian policy is especially important for developing countries, for which agriculture is of particular importance in the structural transformation of the economy (Gollin et al. 2002).

Georgia is a small country in the Caucasus region with a great history. Georgia was among the first republics of the Former Soviet Union to proclaim independence in 1991. Prior to independence, the Georgian economy had been closely integrated with the Soviet Union with trade accounting for an estimated 40% of GDP, and nearly all exports directed to and three quarters of imports coming from the Soviet republics. The industrial sector accounted for about one third of the economy and although Georgia lacked cheap sources of energy, it produced steel pipes, locomotives, and other energy-intensive products for export. The competitiveness of Georgia's heavy industry was dependent on the supply of natural gas from Turkmenistan at artificially low prices and on inflated prices for final products.

The role of exports in the country's economic development is doubtless to anyone; we believe that the growing negative balance of Georgia in international trade is the matter of concern to any Georgian economist. According to the comparative advantages Georgia can become competitive in the field of agricultural production by its produce. Production of competitive products will result in the efficient use of resources, obtaining domestic and international market share, increasing the welfare effects of the population (Fig. 23.1).

According to the comparative advantages, Georgia can become competitive in the production of agricultural products. Production of competitive products leads to efficient use of resources, domestic and international increase in market share, improving the welfare of the effectiveness of the population.

At present, the agricultural sector of any developed country is of particular importance. In European countries the performance indicators are generally on the rise despite the fact that the agricultural sector's share in gross domestic product structure is characterized by the reduction tendency in time.

External Trade

(Mil. USD)

	2010	2011	2012	2013	2014	2015	2016	2017*	2018 January-March*
External Trade Turnover	6913.3	9258.7	10433.0	10933.1	11462.9	9505.0	9407.7	10710.6	2823.8
Export (FOB)	1677.3	2186.4	2376.6	2910.3	2861.0	2204.7	2113.1	2728.0	740.3
Import (CIF)	5236.0	7072.3	8056.4	8022.7	8601.8	7300.3	7294.6	7982.7	2083.4
Balance	-3558.7	-4885.8	-5679.7	-5112.4	-5740.8	-5095.6	-5181.5	-5254.7	-1343.1
Export excluding re-export	1380.3	1693.0	1606.4	1812.1	1873.3	1637.4	1657.1	2063.0	554.8

*preliminary data

Fig. 23.1 Export-import balance in Georgia. *Source* www.geostat.ge (National Statistics office of Georgia)

It is essential to have a target market for export-oriented enterprises development. Georgian agricultural products have their consumers and are well known through the CIS member countries; these are inertial markets which have been maintained since the USSR collapse. However, due to current political situation, these markets are unsteady. Consequently, the issue for the necessity of expanding the economy arises. We strongly believe that such kind of opportunity is the agreement signed with the EU Association and a deep and comprehensive EU Free Trade Agreement which not only allows the country to new markets, but also facilitates financial support for the development of the field. It is essential to allow the spending of the amount in the right direction within coordinated policy framework in order to obtain real development of the sector and not a temporary effect.

The present project provides the conduct of the research, which should include agriculture-related all parties and positions for infrastructure, the manufacture, sales and commercialization of produce, including the production of import substitute and competitive products at foreign markets.

The research method either for research or theory problems in the agricultural sector is planned by analysis, synthesis and comparison, as well as with other methods of empirical social research.

In order to check the established theories in different areas of the agricultural sector, the quantitative marketing research was held examining such large audiences as small farmers and peasants living in the region. And with the help of in-depth qualitative research interviews, studies were scheduled to agricultural cooperatives, large scale farmers, the farmers' associations at agricultural sector and non-governmental organizations.

23.2 Weaknesses of Agriculture Sector of Georgia

The agricultural sector is the most difficult challenge—66.7% of farmers are not able to resist competitiveness as far as imported products are distinguished by their low prices. The main reason for above mentioned is the low level of competitiveness of the agricultural sector and agricultural products.

While importers are major competitors in the sector, the increase of competitiveness for Georgian agricultural products must not be done by imposing barriers on imported products, but by raising competitiveness of locally produced products and export potential.

There is a huge gap in the export-import balance, despite strong growth in exports. In the beginning of the 1990s, Georgian food imports exceeded export by around 70%. Since then, the situation has changed, during last decade, the shares of agricultural goods (foods) in total imports decreased much faster than the shares of agricultural (food) exports. At present Georgia still depends on imported agricultural products. Imported food products amount to more than 50% of the total consumer market, resulting in a low food self-sustainability rate.

The main agriculture export products include beverages, spirits and vinegars, (10.9% of total food export), edible fruit and nuts; peel of melons or citrus (7.9%), oil seeds and oleaginous fruits; industrial or medicinal plants (2.1%). Among the main imported products are: wheat and wheat flour (2.6% in total food import), sugars and sugar confectionery (1.4%), tobacco and manufactured tobacco substitutes (1.8%), meat and edible meat offal (1.4%).

This structure of trade results from the favorable climate for agriculture production of wine, fruits and citruses and of mineral water. Russia, ranked as the first trade partner, was favored export of wine and spirits and mineral waters, fruits and vegetables till 2006. The tense of Russia-Georgian relations, as well as the export restrictions of several Georgian products to the Russian Federation, resulted in a reduction in exports of these goods. At present the agriculture and food sector exports to Russia have seen a great reduction. The problem is that Georgian farmers lost its wine, mineral water, fruit and subtropics culture market share in Russia and could not reorient quickly enough to other markets because of the high competition (e.g. in EU markets) and due to poor marketing policy of Georgian producers. During these years of course, farmers find new markets in other countries, but there are another difficulties: the quality if the product, the amount of exports and others.

The main obstacles for Georgian companies include supply constraints, satisfied EU regulations on safety (mineral waters), the recognition of Georgian brands (wines, mineral waters) by EU (except for the Baltic States and Poland) and USA consumers, non-tariff requirements, lack of resources and skills for marketing and different preferences of the foreign consumers in comparison with those of traditional markets, mainly the CIS. The brand names of Georgian mineral waters have been decisive in their ability to reach foreign markets. People in the Baltic countries mainly buy Georgian mineral water because they remember the brand from Soviet times.

For further improvement of trade, there is a need to modernize agricultural technology, equipment and infrastructure, change out-dated irrigation and drainage systems, develop livestock feed and seed production businesses, attract skilled labor, as well as packaging and sorting technologies. The current absence of these attributes creates barriers to farmers who want to produce for export. For the agro-food sector, it is well known that the most important constraints on trade are not tariffs, but product standards and regulations. With regard to the agro-food sector, there is a need to increase incentives to adopt regulations and higher quality standards (Gvelesiani and Gogorishvili 2012).

Besides of above, I think the only way to save the Georgian agriculture sector is a complex of the promotion and certain subsidization runs. Otherwise it is impossible to attract as much funds as the rehabilitation of the sector needs, but as European example shows, we need some balance, to stimulate the public control and medium-sized businesses as much as possible to avoid the monopoly and less effective market in the field.

Of course, there is a possibility of returning to the Russian market, but even in this case, Georgian products may not be competitive with foreign importers, because they are subsidized by the high level. The other case is that, because of the improvement of infrastructure (roads, transport, set, etc.) imported products will easily reach to the whole country and local agricultural industry will be in a more difficult position. And the major problem—high levels of unemployment, the great army of self-employed people in rural areas will be have only one way—to continue to forced labor on the land in which one can provide income for just to the minimum subsistence levels.

Georgian economists are dividing problems in agriculture in several ways:

1. Lack of capital:

Agriculture in Georgia relies mainly on small-scale farming with low production efficiency. On average 0.88 ha of arable land is owned by one farmer. These small farms produce more than 80% of the total production. Large scale farms produce about 10% of the total agricultural production and almost all is destined for the market. At present small farms dominate the agricultural sector. They operate mainly for domestic consumption. The small size of land plots does not promote the increase of labor productivity. Until 2005, 75% of agricultural land and 2.5 million hectares of forests were under state ownership. In 2005, the Law on Privatization of State-Owned Agricultural Land was adopted in order to promote efficient use of land through private ownership and thus increase efficiency in the agricultural sector. Forests and other natural resources are being transferred more actively to private hands under long-term tradable licenses.

In addition, the share of farms that have privately owned farming equipment and agricultural machinery is a little more than 20%. In fact, in Georgia on average 53.2 tractors and 0.4 harvesters-threshers were employed per 1000 ha. Accordingly, approximately 85% of Georgia's rural population is entirely dependent upon their farms for subsistence and they consume approximately 75% of their own production.

The agriculture sector, despite climate advantages, seems less attractive to banking investors. The share of the agriculture sector in total banking loans varies from 1 to 2%. The domestic banking system is very reluctant to give long-term credits to farmers. Banks are preferentially focusing on short-term trade financing.

Foreign direct investment's share in agriculture in Georgia today is also small. Agriculture in total FDI in 2007 amounted to 0.8%, in 2008 to 0.5% and in 2009 to 1.2%, this as a result of the high risk and low profitability of the sector. Improving the environment for foreign direct investment as an alternative to short-term bank credits has become crucial. At present FDI enters the nut industry (the Italian confectionery company Ferrero started operation in 2007), winemaking (Italy, Russia, Korea) and water bottling sectors (Turkey).

2. No professional staff:

- Unfortunately, the agro-sector is significantly affected by the lack of professionalism. The knowledge and experience that was accumulated in the historically agronomic country was either lost or grew old (due to new technologies, new types of seeds and seedlings, creation of different greenhouse farms). In fact, the market is experiencing the lack of professional agronomists, fruit makers and winemakers—in fact, all old agricultural professional training facilities were stopped or closed.
- It is also important that the salaries of employees in agro-sector (in any field) are significantly low and 30–40% lower than those employed in other sectors of the economy, not to mention the seasonal nature of the job. In these circumstances, the qualified person is not really interested in it.

3. Production (Technical) Problems:

- A significant problem is the absence of irrigation systems that make it unusable large areas of fertile lands. The existing network has been amortized for many years already and its rehabilitation requires colossal amounts of money, which not only for a particular peasant or community, even for the state is a serious problem.
- It is quite expensive to rent the equipment necessary to cultivate the land. sometimes peasants cannot process the land timely or take the harvest on time due to insufficient quantity of agricultural techniques.
- The problem of pastures is particularly acute nowadays. Since the Georgian sheep is very popular in the Middle East and Central Asia, in fact, the biggest problem, finding market, is solved, but due to the lack of infrastructure and material resources, it is impossible to increase production, market development and full satisfaction of demand.
- Undeveloped infrastructure is a hindering factor in the development of production. 55% of rural roads have no cover, and about 50% of the road cover is in bad condition. Because of this, the cost of the production and expenses of population using these roads increases significantly.

4. Marketing Problems:

The product produced by the non-fashioned methods in the peasant's small ground is much more expensive and non-competitive than the cost of imported food. Small entrepreneurs and peasants are unable to sell their own harvest, they do not have the appropriate knowledge and experience, and do not have enough money to market their goods (which are already expensive and less competitive as we mentioned) on the market.

In most cases, they even do not have the equipment to store and save their harvest, so most of the rural population will only get a small amount of harvest, which is often not enough to meet their personal needs.

5. Social Problems:

The last place in the list is social problem, but I believe that it is not the most insignificant. One of the most problematic issues, on the contrary is a sharp difference in the rural and urban living conditions.

- At present, most of the Georgian villages are not supplied with water; they do not have gas and are in short supply of electricity.
- Not only in the villages, but in small towns and regional centers there are no cinema, theater and café-restaurant, club or similar entertainment establishment, even there is no internet. Young people do not have the opportunity to self-actualization. Which deprives them of the development of interest, they are extinguished in the swamp and drug addiction, which significantly reduces the possibility of their socialization and successful farmers.

Due to all the above reasons today a large amount of Georgian villages are empty and the population is looking for a source of income in the city.

23.3 European Concepts of Agrarian Sector Development

During the period of last 30–35 years, FAO's experts in the formation of unified agrarian policies of the European Union embrace 3 concepts of agrarian sector development:

1. Sectorial Development Concept, the main cornerstone of which is the continuous development and advancement of the agrarian sector as a whole, increasing the competitiveness of agro-production through increasing the volume of production and/or diversification.
   This theory was the most popular in the 1980s and as already mentioned, the main cornerstone of this model is the development of agro-production as a business. Increase competitiveness of manufacturing structures by enhancing technological improvement and productivity. The purpose of this model is to do so in a short way: "Professional" agriculture development. As for the geographical region

itself, its development is subject to the development of "business" because people living in rural areas do not have other opportunities for development without strong manufacturing complexes. Agricultural territories are perceived as a combination of resources for the development of agrarian production.

One of the disadvantages of this theory is that agriculture and food sectors are only considered in the macroeconomic context; And the issues, such as local development, rural development, the difference between different agrarian regions and others—are not always in the framework of the concept of interest. However, this method has always been quite influential groups of lobbyists, with virtually all decisions and agreements included in the sector development elements. Politicians need votes in elections and this one comes from short-term regional development and not from investments in the long run development.

2. Convergence conception involves policy of supporting less developed agricultural regions, to equate living levels with industrial regions. This model explains the necessity of helping less developed agricultural regions.

   In this concept, agrarian regions are considered as less developed and therefore the focus is on the needs of the specific region.

   The development strategy implies diversification of business in these regions. Of course, stimulation of agriculture activities is good, but it is obvious that the income earned by farming or livestock can not be equal to the level of one earned in other economies and the quality of life can not be close to industrialized regions. This problem is eradicated with stimulating of economic sectors such as agro-tourism, small industries processing agricultural services and service businesses in particular regions. More often, this policy is used for development of mountainous and low-income regions and infrastructure.

   The main instrument is the direct compensation and structural support elements. The rule of compensation arrangement is quite interesting:-compensation is paid in case of damaging or decreasing crops due to unfavorable climatic events, only to farmers, who are permanently resident in this area, and are going to cultivate the land for at least 5 years.

3. The concept of regional development identifies agricultural sector and rural development. This concept considers that people, environment, landscape and natural resources should be considered in a common context.

   This model does not consider the agrarian sector as the driving force of the regional and rural development. On the contrary, it implies the modernization of the village through structural reform (Экономика Европейского союза 2012).

The establishment of this method has been contributed from factors such as:

- The crisis of the sectorial concept, when the support of the funds was over and over again, and the massive supplies of manufactured products were produced.
- Increasing differentiation between the agricultural territories itself. Studies carried out by the Organization for Economic Co-operation and Development have shown that there are many "non-urban" regions in Europe, where high levels of living and output are per capita. These results were directly contrary to the

previous two concepts of agricultural sector development, which meant that the agrarian regions were a “weak link” of the economy, and therefore constantly requires resources (including human resources).
- Studies have shown that multifunctional farms and diversification of revenues have become increasingly popular and it is capable of self-development without subsidy.
- Last but not least, are the new theoretical elements, which say, that it is not necessary that the agrarian sector argue in such a way that it will change the structure of the entire economy. It is quite possible to mobilize alternatives in rural areas through total non-agricultural and non-agrarian businesses (IFOAM EU Regional Group 2002).

23.4 Export Oriented Agrarian Policy in Georgia

The objectives of agrarian policy are derived from the reality in which the country is today and it is not necessarily related to agricultural production, but with regional economy and social sphere. There are 141,000 families registered in the database of socially vulnerable and 120,000 families are living in the regions and most of them have a land plot that is either unproductive or so small that it is not enough to overcome the poverty level of the family.

The issue of mountainous regions is even more acute. More than half of Georgia’s border line is mountainous regions with a large part of the danger of emigration. The second part is ethnically populated by non-Georgians, which also creates a threat to the border line.

Thus, it is important that agrarian policy should include not only stereotypes of agricultural and farming development but also be an integral part of regional policy.

Based on the conducted research and European experience, we have set up four main strategic goals that comprise tactical goals (Fig. 23.2).

Improve awareness and involvement of the population in implementation of reforms: No matter how many laws are written in the government creating effective models for the development, it is crucial to have a powerful team who have great desire, knowledge and experience for participation and implementation of the plan. Unfortunately, today there is no such commitment. This is confirmed by the fact that all existing projects enjoy support, i.e. existing farmers who have already had their own businesses wanted to expand existing ones. Theoretically, on the one hand, it is not as bad, probably good; however, real outcome can be achieved only with the large scale effect; therefore, all mini-agricultural lands should be involved in agricultural production. The biggest problem in Georgian agricultural sector is fragmental patches of land, where practically is impossible to carry out profitable economic activities. Relevantly establishing various forms and development of farmers’ cooperation should be helping them to become more competitive in global economy, to study new technologies and become a part of profitable organization.

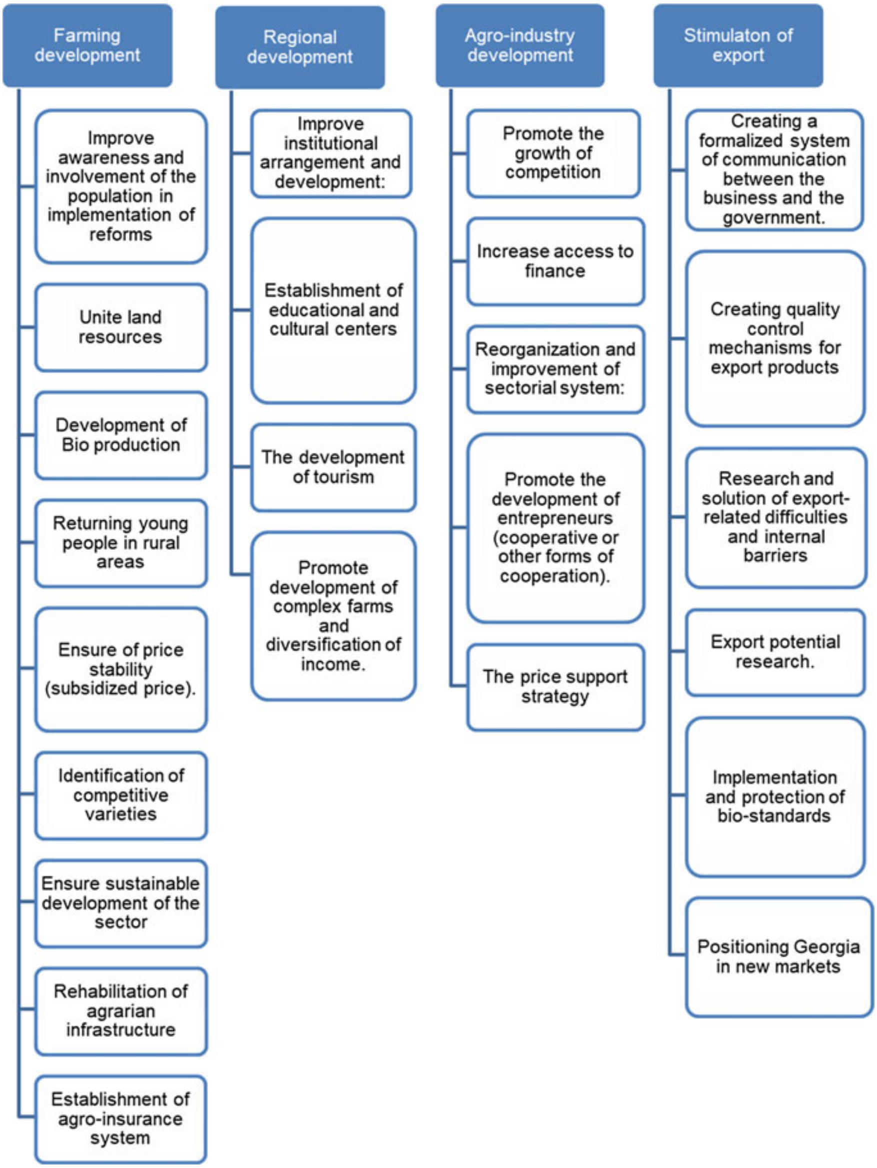


Fig. 23.2 Agrarian policy goals in Georgia

Land Resources: The biggest problem of the Georgian agrarian sector is the fragmented land, in which is actually impossible to generate profitable economic activities. Therefore, the necessary component of agrarian policy should be the formation and development of various forms of cooperation between farmers.

Development of Bio production: It is essential to have a target market for developing export-oriented enterprises. Georgian agricultural products have their consumers and are well known through the Commonwealth of Independent States (CIS) member countries; However, due to current political situation, these markets are unsteady. Consequently, the issue for the necessity of expanding the economy arises. We strongly believe that such kind of opportunity is the DCFTA agreement signed with the EU, which not only allows the country to new markets, but also facilitates financial support for the development of the field. The European consumer is in line with the quality of product quality and increases the standard of living, increasing demand for ecologically clean food products. This is not a very fast market, because the supply of fresh produce is limited. Which may be a competitive advantage for Georgia.

Returning young people in rural areas by raising living standards and arranging infrastructure is a necessary condition without which all other reforms will lose sense, as far as it will not have a target audience. Today there is a significant "aging" process of villages. Youth cannot stay in a region where there are no basic living conditions for development or entertainment and are moving to regional centers or in the capital. And the result is Tbilisi as a giant metropolis where almost 40% of the Georgian population lives and deserted regions.

Ensure of price stability (subsidized price): Production of fruit, vegetables or other raw materials creates good environment for the development of the agricultural industry, but there is a conflict of interests between raw supplier and processing enterprise: peasant interest is to sell the harvest as expensive as possible and the manufacturer wants a lower price to obtain the competitive price for final product.

Identification of competitive varieties: Needed to finance fundamental research on international demand for agricultural products to reveal, the production of which is possible in different regions of Georgia according to its natural and climatic conditions.

Ensure sustainable development of the sector: Land and natural resources require a fairly fascinating approach, since it may cause irreparable damages that will make it unusable after years. Excessive grazing, loss of forest cover and unplanned lands for urban development—are the main factors causing land degradation. Soil erosion, which in some cases is a natural phenomenon, is hardened by a man's unsustainable soil. In addition, the society should know and understand the importance of environmental protection, and what threats can be addressed in an unprofitable environment.

Rehabilitation of agrarian infrastructure: According to the functional loading of agriculture, the industrial infrastructure is divided into two main areas: the first area is agriculture production service, and the second serves to deliver final delivery to agriculture products and to customers. The first area includes repair and maintenance services and enterprises, as well as transport, amelioration, agro, veterinary and other services. And the second is the process of processing, transporting, storage and organization of agricultural products. They belong to warehousing and refrigeration farms, grain elevators, packaging, sorting and other types of enterprises and organizations.

Establishment of agro-insurance system: The insurance system is very important in the agrarian sector, as there is a danger of loss and damage due to unwanted climate or other natural conditions. This hinders the lending of the sphere, and even motivates small farmers, for which one hail might cost you all year. Consequently, the development of insurance may become a motivator for attracting sector lending, franchise contracts and resources.

Improve institutional arrangement and development: Currently, agrarian policy is carried out by the Ministry of Agriculture of Georgia and LEPLs included:

- National Food Agency;
- National Wine Agency;
- Agricultural Cooperative Development Agency;
- Agriculture Project Management Agency;
- United Amelioration Systems Company of Georgia;
- LLC “Mechanizator”.

Which ensure the implementation and monitoring of projects, initiated by the governments or international organizations. Infrastructure projects are implemented by regional self-governments.

It is necessary to increase the efficiency of these organizations. And Improve the control of project implementation and enhancement of staff qualifications.

Besides, it is necessary to support the development of private sector (non-profit, non-commercial or commercial organizations) at the coordinated level. This will enable the Ministry to define the needs of individual farmers and facilitate targeted development with fewer resources.

Establishment of educational and cultural centers: According to the data obtained from the survey, farmers of every sector note that they do not have access to modern technologies, new knowledge and methods of production, which significantly reduces the amount of their income and expenses. Therefore it is necessary to develop technical institutions and retraining centers in the regions.

The development of tourism will lead to diversification of revenues in the regions and expansion of service sector. The last one will stimulate small businesses and family farming. As a result, there are new jobs and additional income for rural residents.

Georgia has rich resources of agro-tourism products. Their reasonable use can play a positive role in the economic development of the country. Agro tourism is the foundation for the development and effectiveness of tourism products with cultural tourism.

- Ancient civilization,
- The existing legends,
- Traditions,
- Geographical location,

- Strategic trade routes,
- Rich Flora and Fauna,
- Special hospitality and others.

This type of business is not related to any special expenditures for traditional Georgian villages, which makes it possible to provide cheap products and services. Compared to agricultural products, low prices will be available for tourists from Central and Eastern European countries.

One important circumstance is worth considering; 54.4% of the Georgian territory is located at 1000 m above sea level. The possibilities of intensive agricultural production are limited in most parts of these territories. The development of local non-intensive, ecologically clean products and traditions, flora and fauna, can play a decisive role in the development of beautiful natural habitats agro-tourism in economic growth of mountain and mountainous areas.

The role of the state is crucial in stimulating the delivery of competitive agro-products. Among the problems of economic development of high mountain regions, we should consider the uncertainty and strict natural and economic conditions of the economic environment, which is also a problem of border mountainous masses. Consequently, in the development of prospective destinations of socio-economic development of regions, in particular tourism development, there is a decisive role in the country's active economic policy, namely the package of laws that support the development of mountainous regions.

Promote development of complex farms: As we have already mentioned, this is a complex development model in Europe that implies not only the development of agrarian production but also includes raising living standards, promoting agro-tourism development and increasing diversification of household income. I think in our case it is necessary to use a similar model.

Solving these issues at a glance seem to be beyond the scope of the agrarian policy and require more consideration in the context of regional policy. However, without solving these problems simply will not exist the human resources, for implementation of agrarian policy.

Promote the growth of competition: On the one hand, the important challenges faced by the state are to prevent restrictions on the competition on the market, on the other hand, do not hamper business development with unnecessary regulations and bureaucracy, do not hamper the company's growth.

Increase access to finance: Providing finances is vital for the development of any sector. Therefore, agrarian policy should include measures for attracting investments in the field, cheap credit and state subsidies. For the purpose of attracting finances in the field, specific and targeted projects will be developed, in which the state becomes a co-owner of the guarantor or loan interest in order to make the necessary financial resources available for small and medium businesses.

Reorganization and improvement of sectorial system: It is necessary to analyze the field of agricultural sector of Georgia and define its compliance with modern goals and strategies. The efficiency indicators of the sector should be determined by each of these areas.

Promote the development of entrepreneurs (cooperative or other forms of cooperation): It should be continued to increase efficiency of cooperatives and to stimulate their product quality control, as well as their export potential. To this end, stimulation of the "regional union" type of cooperation, stimulating the establishment of managing and coordinating organizations. This may be the grant approval for research organizations to find markets and others.

The price support strategy should be implemented in the priority sector and processing products for export. It may be possible to subsidize the price of some strategic export products only if their manufacturers are entrusted. This will increase the export of finished products and promote the growth of internal product.

Creating a formalized system of communication between the business and the government: There is a need for formalized communication between the business and the government. The mechanism should provide feedback on economic issues and get involved in economic solutions.

Creating quality control mechanisms for export products: The essential requirement for access to the European market is the food safety and the need to meet certain standards. In addition to the performance of quality requirements, to rich the high quality is quite difficult and very expensive procedure for small farmers. That is why the state needs some kind of support in this direction.

Today, European standards are known in Georgia as Global Gaph and HACCP, the latter is mandatory for companies whose annual turnover exceeds 200,000 lari. However, without these certificates, exporting of products to European countries is in fact impossible. But obtaining those standards needs large amount of financial expenses for individual farmers and small cooperatives. The union initiated by us will be effective in this case - the interested farmers will be coordinated within the union, which will significantly reduce the expenses incurred during inspection for each of them.

It is also necessary that the agricultural laboratory be equipped with modern technology of food safety research, exporting priority areas. For example: (honey safety, antibiotic content, etc.)

It is necessary to introduce quarantine rules in livestock so as not to remove diseased goods from the country and its good image.

Research and solution of export-related difficulties and internal barriers: Incomplete legislative regulations, artificial obstacles and various barriers reduce the export potential of the companies. State agencies must cooperate with business so as to eliminate such obstacles and stimulate exports by internal means.

Research of export potential: In order to boost the export, it is necessary to find new markets or expand existing market. As we mentioned in the previous chapters, Georgia's largest export markets are CIS countries, but due to the current political situation, these markets are very fragile and risky. The less likely is their ability to grow and develop.

The Deep and Comprehensive Free Trade Agreement with the EU countries is a means of utilizing Georgia to expand the scale of the economy. Moreover, the agrarian sector in the EU is the most regulated and financing sector and after signing the Association Agreement, Georgia will be included in the EAPP funding sphere. In addition, we believe that the Deep and Comprehensive Trade Agreement will be an additional incentive to attract investments in the field.

It is imperative that the state will fund research activities, market demand and efficient products and stimulate their production in the country.

Implementation and protection of bio-standards: Implementation of bio standards requires very serious investments, which do not have the ability of Georgian small farmers and cooperatives to implement. Here it is necessary and necessary to implement the state support measures.

Since effective management issues are essentially related to environmental management and sustainable use of natural resources, it is necessary to organize information seminars, to inform farmers and raise their awareness on environmental issues. As well as financing projects for farmers willing to sustainable development and even subsidizing as it is practiced in European countries.

Positioning Georgia in new markets: The development of export potential needs strong marketing support: Creating Georgia as a brand and then its promotion outside the country. In the State apparatus, a group working on these goals, such as wine agency, should be created.

23.5 Implementators of Agrarian Policy

Currently, in Georgia agrarian policy is carried out by the Ministry of Agriculture of Georgia and LEPLs within it: National Food Agency; National Wine Agency; Agricultural Cooperative Development Agency; Agricultural Projects Management Agency; United Amelioration Systems Company of Georgia; LLC “Mechanization”; Which ensure the implementation and monitoring of projects initiated by the Ministry or international organizations. Infrastructure projects are implemented by regional self-governments.

The private sector is ineffective in the stages of formation of agrarian sector and agricultural policy. Considering their opinions and discussing their remarks and suggestions only depends on the good will of the officials.

We believe that this model does not provide effective communication and has resulted in a number of inconsistencies and inadequate activities that reduce efficiency of implemented projects. For example, when farmers were given vouchers for agricultural activities, it was not enough mechanization, which led to queues, price increases for land works and others. Another discrepancy caused a moratorium on land sale (political decision). While the agricultural sector was declared as a priority in the country and the Ministry of Economy worked to attract investments in the country, it was impossible to buy agricultural land or take it on long lease. This fact has undoubtedly underestimated the motivation of investing.

Due to the above, we believe that coordination between the various governmental and regional structures is necessary and the capacity of jointly implemented projects. In addition, it is necessary to create a cooperation system between entrepreneurs and governments. On the one hand, it will facilitate the spending of budget resources to farmers in priority directions, stimulate the formation of farmers' and business associations and increase the possibility of effective solutions in the field (Nino Rukhaia-Mosemgvdlishvili 2017a).

Based on the consultation with Georgian businessmen and the study of European experience, we have set up a schematic model of regional policy management, where we tried to create the necessary system for the integrated work of stakeholders.

Currently, in the Ministry of Economy and Ministry of Agriculture separately operates 2 different LEPLs: "Export Agency" and "National Wine Agency". Actually, the functions and obligations of these two organizations are mutually in many fields and none of them are working on crossing the internal barriers of export, execution of legislative and standardization work.

In the model proposed by us, the LEPL is formally out of subordination of a particular Ministry, subject to the Head of the Government of Georgia and its function is to study export issues at macroeconomic and marketing levels.

Under the auspices of the agency should be arranged (several times a year) conferences, meetings and discussions to identify and analyze specific problems, opportunities and dangers. The function of the same agency will be with business associations and government agencies as well as close cooperation with relevant committees of Parliament for the elaboration and presentation of new legislative initiatives. The representatives of the agrarian sector in this organization should be the farmers' unions. This is another additional incentive to form, unify and strengthen similar unions. The source of funding of the Agency will be the state budget and grants received from donor organizations.

The functions of the Agency in our opinion should include but not limited to:

1. Economic and political analysis of existing export markets, studying their enlargement opportunities;
2. Identify opportunities and problems of diversification of products in the existing markets;
3. Identify new, potential markets in cooperation with business and prepare relevant standards and legislative framework concepts;
4. Protecting the image of the country from unscrupulous exporters who create a threat to the loss of the market by exporting inappropriate products;
5. Decisions concerning quality of products and quality control;
6. Preparation of proposals for the purpose of formation of a legal product for the development of export product and development of entrepreneurship, based on consultations with business representatives;
7. Consultation and recommendation services for exporters;
8. Coordinate with the Ministry of Education to invite experts on modern techniques and technologies, as well as structure of world market demand and organize training;
9. Stimulation of establishment of international quality certification organizations;
10. Active cooperation with the scientific community and business for the expansion and expansion of the export potential of the country;

11. Preparation and initiation of special projects for stimulating production of products demanded on the world market;
12. Consultations with the Ministry of Regional Development and Infrastructure and regional self-governments in order to provide priority to the restoration of the type of infrastructure in which exporters and farmers associations are concerned;
13. Control of regional clusters and large exporters so that they do not use the entire or partially monopolized state and buy raw materials from the population at the acceptable cost. (In case of necessity a petition may be paid by the State for reimbursement) (Fig. 23.3) (Nino Rukhaia-Mosemgvdlishvili 2017b).

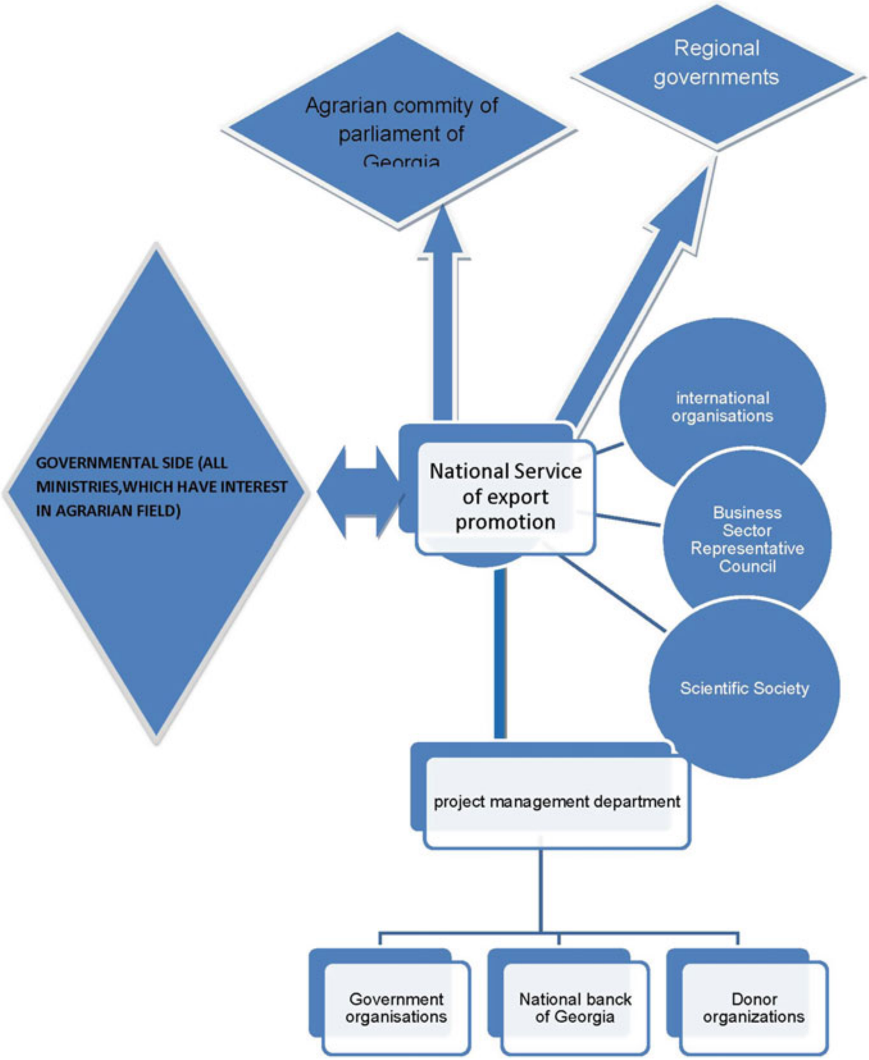


Fig. 23.3 Schematic model of management of agrarian policy

23.6 Conclusion

Based on the problems in the field, the goals we have set out and the examples of different countries, we have developed strategy and tools for implementing agrarian policies of Georgia.

The first and most important step is to develop a special campaign for increasing public awareness and involvement in reforms, which includes the following measures:

- Carry out active campaign of public relations on the role and impact of expected reforms in order to ensure the maximum attendance and involvement of farmers on informational training and qualification raising lectures.
- Organize trainings and seminars on the expected results of the reform, the role of farmers in this process and the expected benefits they will receive in various projects. This will particularly increase the quality of transparency of the project and public control.
- Co-financing and full funding projects for the acquisition of knowledge.
- Selection of interested people to receive a thorough knowledge and retraining courses or for a higher education institution. On the one hand, the existence of the competition will reveal the potential of the interested people, as well as the more serious approach to the project and increase the responsibility of the participants. In fact, these people should be driving motors that will ensure the implementation of state policy in the region, whether it is stimulating cooperative relations, establishment of associations or promoting food safety and bio-standards.
- The first steps for the development of land resources and the establishment of cost-effective farms have already been taken. Cooperatives are formed and their creation continues. The second step should be to increase efficiency of cooperatives by deepening their mutual cooperation and for the development of sectorial or regional associations and "regional clusters";
- Grants should also be issued to associations to create entrepreneurs' registers and formation of stock systems. Nowadays this function has been assigned to the Cooperative Development Agency. In our opinion, this commercial project should become a function and transfer to commercial organizations or unions. In the event of proper implementation, a good base will be created for the formation of a commodity exchange over time.
- Establishment of tax benefits for associations with appropriate temporary (e.g., first 3 or 5 years). In case of associations, as well as cooperatives, the income tax rate should not be determined by annual turnover, for instance LLC 200,000 GEL;
- Projects initiated by regional clusters and farmers associations should have some advantage over the development of the regional development plan and the formation of the budget.

- In order to support the agrarian business, it is necessary to change the laws of taxation of the country. Taxes and regulatory systems do not create any stimulus for the replacement of existing land use and small characteristics.
- Under the Food Safety Strategy, Georgia should continue to implement reforms in sanitary and phytosanitary spheres. In the European Union there is quite popular and has a high price for bio-products, which must become the cornerstone of Georgian export catalog. This type of production facilitates the sustainable use of the environment and the funds for its promotion may be sought from the Ministry of Environmental Protection projects. Promotion of bio-production development should be carried out by the farmers' monetary compensation for environmental and sustainable development activities, setting up premiums for non-pesticides and chemical fertilizers, and most importantly, with a high subsidized price of raw material. Subsidized price should be placed on products that show export potential. Decision on setting the price should be made on the basis of special studies. In addition, the price should be paid only when handing raw material in the processing plant. The price of the sale of the market should be formulated in accordance with market laws.
- In order to rehabilitate the agrarian and regional infrastructure, it is necessary to set the priorities correctly. It is necessary to encourage regions and villages where cooperatives are registered and where they need support for associations or cardholders. Identification of proposals will be simplified in case of implementation of our proposed management model.
- Today, 100% of the population living in the regions is supplied with electric energy, but it is necessary to continue the gasification and water supply projects, where the supply index is approximately 50%. Road rehabilitation and provision of internet in the regions are the means of encouraging young people to stay in the region and get income there. Nowadays we have a picture when the old people are cultivating the land. It is necessary to introduce and search for innovations in the dynamic market marathon to be a modern thinker, active businessman.
- Legislative regulations on living less favorable areas of living, and their support strategy, as well as the Association Agreement with the European Union, are also acceptable.
- The development of industrial infrastructure has already begun in the country and is quite good in terms of transport and communications.

Very voluminous work has been carried out, but it still remains difficult and requires development:

- Completion of amelioration systems;
- Modernization of irrigation systems. This is especially important in 2 directions: first reduces water consumption and, secondly, reduces the risk of soil damage, salinization and exposure. That is why this event may be implemented within the framework of the Sustainable Development Program.

- Inadequate agricultural equipment and machine tools remain still a problem. In order to solve this problem, we think it will be effective to implement a special project for cooperatives and cartels that will help them purchase their preferential terms or leasing techniques.
- The development of agro-tourism includes the greatest potential for the development of regional infrastructure development, as well as the increase of income of rural communities and the intersectoral links.

References

Экономика Европейского союза. (2012). ред. Щенина М.

Evaluation of the structural effects of direct support. (2013). European Commission.

Gollin, D., Parente, S., & Rogerson, R. (2002). The role of agriculture in development. *American Economic Review*.

Gurova, I. P. (2014). *World economy* (trans. S. Veshapidze). Tbilisi.

Gvelesiani, R., & Gogorishvili. I. (2012). *Economic policy*, *Book 1*. Tbilisi.

IFOAM EU Regional Group. (2002). *A sustainable agricultural policy for Europe*. Position paper on CAP review and reform. April, 2002.

Nino Rukhaia-Mosemgvdlishvili. (2017a). The ways of increasing profitability and competitiveness of farming in the caucasus region on example of Georgia Republic. 2017 Prague, International Academic Conference proceedings.

Nino Rukhaia-Mosemgvdlishvili. (2017b). "How to sell"—Opportunity for small farmers to global market. In *Proceedings of IAC in Vienna 2017*.

Profitability and efficiency of indian dairy farms. www.fao.org/WAIRDOCS/LEAD/X6170E/x6170e36.html.

Schiff, M., & Valdez, A. (1992). *The plundering of agriculture in developing countries*. Washington, DC: World Bank.

Хайек, Ф. А. (1992). Пагубная самонодеянность, М.

Chapter 24
Bayesian Estimation of GARCH(1,1) Model Using Tierney-Kadane's Approximation

Yakup Arı

Abstract The Generalized Autoregressive Conditionally Heteroscedastic (GARCH) process models the dependency of conditional second moments of financial time series. The maximum likelihood estimation (MLE) procedure is most commonly used for estimating the unknown parameters of a GARCH model. In this study, the parameters of the GARCH models with normal innovations are discussed for estimations using the Bayesian approach in which the parameters of the GARCH model are assumed as random variables having known prior probability density functions. The prior probability density functions of the parameters satisfy the conditions on GARCH parameters such as positivity and stationarity. The Bayesian estimators are not in a closed form. Thus Tierney-Kadane's approximation that is a numerical integration method to calculate the ratio of two integrals is used to estimate. The Bayesian estimators are derived under squared error loss function. Finally, simulations are performed in order to compare the ML estimates to the Bayesian ones and furthermore, an example is given in order to illustrate the findings.

Keywords Bayes · Tierney-Kadane · GARCH · MLE

24.1 Introduction

Bollersley (1986) extended the ARCH model to the Generalized Autoregressive Conditionally Heteroscedastic (GARCH) model which assumes that the conditional variance depends on its own p past values, and q past values of the squared error terms. The MLE method is the favored approach for making inferences for the GARCH model. It is appealing because it is easy to implement and is available in economic packages; furthermore, Bollereslev et al. (1994), Lee and Hansen (1994) have shown that the estimators are asymptotically optimum. Another approach of

Y. Arı (✉)
Alanya Alaaddin Keykubat University, Alanya, Turkey
e-mail: yakup.ari@alanya.edu.tr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_24

making inferences about the GARCH models is the Bayesian one. Ardia and Hoogerheide (2010) outline that the Bayesian approach is especially well suited for GARCH models and provides some advantages compared to classical estimation techniques according to inference and prediction. In the Bayesian approach the parameters of the model are assumed to be random variables and thus a probability density function is assigned, known as the prior probability function. The posterior distribution combines the prior information about the distribution of the parameters along with the data. For the GARCH model it is found that the posterior distribution is analytically intractable, and thus numerical methods or a proper approximation method is required. Markov chain Monte Carlo (MCMC) methods enable to draw samples from the posterior and predictive distributions, thus sample averages can be used to approximate expectations. There are various ways of constructing the required Markov chain; particularly, Metropolis-Hastings algorithm or Metropolis-within-Gibbs sampler, introduced in Metropolis et al. (1953) can be used. Müller and Pole (1998), Nakatsuma (2000), Ardia and Hoogerheide (2010) used MCMC procedures to explore the joint posterior distribution of the GARCH (1,1) model. Bauwens et al. (1998) used the Griddy Gibbs sampler approach in the estimation of GARCH models. Gilks et al. (1995) proposed the adaptive rejection Metropolis sampling method that is used to estimate GARCH-t models by Kim et al. (1998). Mitsui and Watanabe (2003) introduced a Taylored approach based on the acceptance-rejection Metropolis-Hastings algorithm for parametric ARCH-type models. Marín et al. (2015) use the data cloning methodology which is an another Bayesian approach, one can obtain approximate maximum likelihood estimators of GARCH and continuous GARCH models avoiding numerically maximization of the pseudo-likelihood function. Asai (2006) compared the MCMC methods for estimating GARCH model. Ari and Papadopoulos (2016) proposed method for the estimation of GARCH model using Lindley's approximation that gives numerical solution for the ratio of two integrals. Virbickaite et al. (2015) review the existing literature on the most relevant Bayesian inference methods for univariate and multivariate GARCH models. The comparison of the Bayesian approach versus classical procedures are outlined according to the advantages and drawbacks of each procedure.

The purpose of this study is to derive Bayesian estimators under square error loss function for the parameters of the GARCH (1,1) model with normal innovations using Tierney-Kadane's approximation method. Tierney and Kadane (1986) presented a simple second-order approximation for posterior expectations of positive functions. They used Laplace's method for asymptotic evaluation of integrals. Although there do not exist any certain rules that one could follow to choose the loss function; nevertheless, this choice is of fundamental importance in Bayesian decision making. The symmetric SEL function is the usual choice due to its mathematical tractability. As it was pointed out by Moore and Papadopoulos (2000), "such a choice is arbitrary and its popularity is due to its analytical tractability".

24.2 Bayes Estimation

24.2.1 Squared Error Loss Function

Loss function defines the "penalty" that one pays when θ is estimated by $\hat{\theta}$. Bayesian estimates are based on minimization of the expected loss function. The expected loss is integrated over all possible settings of θ weighted by their relative probabilities and indicates how much loss can be expected when $\hat{\theta}$ is chosen as the estimate. The optimal decision procedure has to choose a $\hat{\theta}$ that minimizes this expected loss.

$$\hat{\theta}^{*} = E\left[L\left(\hat{\theta}, \theta\right)\right] = min_{\theta} \int L\left(\hat{\theta}, \theta\right) h(\theta|\underline{x}) d\theta$$

The Squared Error Loss Function $L(\hat{\theta}, \theta) = (\hat{\theta} - \theta)^2$ is a symmetrical loss function. The Squared Error Loss Function gives equal losses to over estimation and underestimation. The Bayes estimator under squared error loss function is $\hat{\theta} = E[\theta|\underline{x}]$.

24.2.2 Bayes Estimation of the Parameters of GARCH (1,1) Model with Normal Innovations

GARCH (1,1) model assumes that

$$\sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \text{ with } a_t = \sigma_t \varepsilon_t \tag{24.1}$$

Let $\vartheta = (\alpha_0, \alpha_1, \beta_1)$ and $\tau = (\alpha_1, \beta_1)$

Then under the normality assumption, the conditional likelihood function of an GARCH(1, 1) model is

$$f\left(a_{p+1}, a_{p+2}, \ldots, a_T|\underline{x}, \underline{\vartheta}\right) = \prod_{t=p+1}^{T} \frac{1}{\sqrt{2\pi\sigma_t^2}} e^{-\frac{a_t^2}{2\sigma_t^2}} \tag{24.2}$$

where σ_{t}^2 can be evaluated recursively from Eq. (24.1).

Log-likelihood function is

$$\begin{aligned} L &= \ln f\left(a_{p+1}, a_{p+2}, \ldots, a_T|\underline{x}, \underline{\vartheta}\right) \\ &= \sum_{t=p+1}^{T} \left\{-\frac{1}{2}\frac{1}{\sqrt{2\pi}} - \frac{1}{2}\ln\left(\alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2\right) - \frac{1}{2}\frac{a_t^2}{\left(\alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2\right)}\right\} \end{aligned}$$

Assume that α_0 has gamma prior ; $g_1(\alpha_0, r, \theta)$ with parameters (r, θ),

$$g_1(\alpha_0; r, \theta) = \frac{1}{\Gamma(r)\theta^r}\alpha_0^{r-1}e^{-\frac{\alpha_0}{\theta}} \quad \text{for } \alpha_0 > 0 \text{ and } r, \theta > 0 \tag{24.3}$$

where $\underline{\tau}$ has dirichlect prior $g_2(\tau; \omega_1, \omega_2, \omega_3)$ with parameters $(\omega_1, \omega_2, \omega_3)$

$$g_2(\tau; \omega_1, \omega_2, \omega_3) = \frac{1}{B(\underline{\omega})}\prod_{i=1}^{3}\tau_i^{\omega_i - 1} \tag{24.4}$$

where $\alpha_1 + \beta_1 = 1 - \tau_3$ satisfies $\alpha_1 + \beta_1 < 1$. The normalizing constant $B(\underline{\omega})$ is the multinomial beta function given as

$$B(\underline{\omega}) = \frac{\prod_{i=1}^{3}\Gamma(\omega_i)}{\Gamma\left(\sum_{i=1}^{3}\omega_i\right)}$$

where $\underline{\omega} = (\omega_1, \omega_2, \omega_3)$. Their joint prior distribution is

$$g(\alpha_0, \alpha_1, \beta_1) = \frac{1}{\Gamma(r)\theta^r}\frac{1}{B(\underline{\omega})}\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}\prod_{i=1}^{3}\tau_i^{\omega_i - 1} \tag{24.5}$$

The joint posterior function of α_0, α_1 and β_1

$$h_1(\underline{\vartheta}|\underline{x}) = \frac{\left\{\prod_{t=2}^{T}\frac{1}{\sqrt{2\pi\sigma_t^2}}e^{-\frac{a_t^2}{2\sigma_t^2}}\right\}\frac{\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}}{\theta^r\Gamma(r)}\frac{1}{B(\omega)}\prod_{i=1}^{3}\tau_i^{\omega_{i-1}}d\alpha_0 d\tau_1 d\tau_2}{\iiint\left\{\prod_{t=2}^{T}\frac{1}{\sqrt{2\pi\sigma_t^2}}e^{-\frac{a_t^2}{2\sigma_t^2}}\right\}\frac{\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}}{\theta^r\Gamma(r)}\frac{1}{B(\omega)}\prod_{i=1}^{3}\tau_i^{\omega_{i-1}}d\alpha_0 d\tau_1 d\tau_2}$$

The estimation of Normal- GARCH(1,1) parameters under SEL function is

$$\begin{aligned}\vartheta_{SEL}^{*} &= E[(\underline{\vartheta}|\underline{x})] = \iiint u(\underline{\vartheta})h_1(\underline{\vartheta}|\underline{x})d\vartheta \\ &= \frac{\iiint u(\underline{\vartheta})ln\left\{\prod_{t=2}^{T}\frac{1}{\sqrt{2\pi\sigma_t^2}}e^{-\frac{a_t^2}{2\sigma_t^2}}\right\}\frac{\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}}{\theta^r\Gamma(r)}\frac{1}{B(\omega)}\prod_{i=1}^{3}\tau_i^{\omega_{i-1}}d\alpha_0 d\tau_1 d\tau_2}{\iiint ln\left\{\prod_{t=2}^{T}\frac{1}{\sqrt{2\pi\sigma_t^2}}e^{-\frac{a_t^2}{2\sigma_t^2}}\right\}\frac{\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}}{\theta^r\Gamma(r)}\frac{1}{B(\omega)}\prod_{i=1}^{3}\tau_i^{\omega_{i-1}}d\alpha_0 d\tau_1 d\tau_2}\end{aligned} \tag{24.6}$$

The ratio of two integrals Eq. (24.6) cannot be solved analytically. A numerical integration method can be used to calculate the integrals or use approximate methods such as the approximate form due to Lindley (1980) or that of Tierney and Kadane (1986).

Lindley (1980) has proposed approximations for moments that capture the first-order error terms of the normal approximation. This is generally accurate enough, but, as Lindley points out, the required evaluation of third derivatives of the posterior can be rather tedious, especially, in problems with several parameters. Ari and Papadopoulos (2016) used Lindley's approximation to estimate the parameters of the ARCH and GARCH models under square error loss and linear exponential loss functions. Moreover, the error of Tierney and Kadane's approximate is of the order O(n − 2) while the error in using Lindley's approximate form is of the order O(n − 1). Therefore, the Tierney and Kadane (1986) is preferred approximation for this case. The regularity condition required for using Tierney–Kadane's form is that the posterior density function should be unimodal. When the shape parameter of the Gamma distribution is greater than one with the mode at k(r − 1) and all member of Dirichlet distribution is unimodal. Consequently, Tierney and Kadane's approximation can be applied for estimation. The estimation GARCH (1,1) parameters are given in below equation

$$u\left(\hat{\underline{\vartheta}}\right) = E[(\underline{\vartheta}|\underline{x})] = \frac{\iiint_{\underline{\vartheta}} e^{nL^{*}\left(\underline{\vartheta}\right)} d\underline{\vartheta}}{\iiint_{\underline{\vartheta}} e^{nL^{0}\left(\underline{\vartheta}\right)} d\underline{\vartheta}}$$

where,

$$L^{0}(\underline{\vartheta}) = \frac{1}{n}(L+g) = \frac{1}{n}\left[\ln f\left(a_{p+1}, a_{p+2}, \ldots, a_{T}|\underline{x}, \underline{\vartheta}\right) + g(\alpha_0, \alpha_1, \beta_1)\right]$$

and

$$L^{*}(\underline{\vartheta}) = L^{0}(\underline{\vartheta}) + \frac{1}{n} lnu(\underline{\vartheta})$$

Thus Bayes estimate is obtained as,

$$u\left(\hat{\underline{\vartheta}}\right) = \left(\frac{|\Delta_*|}{|\Delta_0|}\right)^{1/2} e^{n\left[L^{*}\left(\underline{\vartheta}^{*}\right) - L^{0}\left(\underline{\vartheta}^{0}\right)\right]}$$

where $\underline{\vartheta}^{*}$ and $\underline{\vartheta}^{0}$ maximize $L^{0}(\underline{\vartheta})$ and $L^{*}(\underline{\vartheta})$ respectively, and Δ_0 and Δ_* are the negative inverse of the Hessian matrices of $L^{0}(\underline{\vartheta})$ and $L^{*}(\underline{\vartheta})$. In this study, $L^{0}(\underline{\vartheta})$ is given as,

$$L^{0}(\underline{\vartheta}) = \frac{1}{n}\left[\sum_{t=2}^{T}\left[-\frac{1}{2}\ln(2\pi) - \frac{1}{2} lnc_t - \frac{1}{2}\frac{a_t^2}{c_t}\right] + ln\left[\frac{1}{\Gamma(r)\beta^r}\frac{1}{B(\underline{\omega})}\alpha_0^{r-1} e^{-\frac{\alpha_0}{\beta}} \prod_{i=1}^{3} \tau_i^{\omega_i - 1}\right]\right]$$

where $c_t = \alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 a_{t-1}^2$.The partial derivatives of $L^{0}(\underline{\vartheta})$ with respect to α_0, α_1 and β_1 are

$$L_{11}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{1}{c_t^2}-\frac{a_t^2}{c_t^3}\right)+\frac{1-r}{\alpha_0^2}\right]$$

$$L_{22}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-1}^4}{c_t^2}-\frac{2a_t^2a_{t-1}^4}{c_t^3}\right)+\frac{1-w_1}{\alpha_1^2}+\frac{1-w_3}{(1-\alpha_1-\beta_1)^2}\right]$$

$$L_{33}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-2}^4}{c_t^2}-\frac{2a_t^2\sigma_{t-1}^4}{c_t^3}\right)+\frac{1-w_2}{\beta_1^2}+\frac{1-w_3}{(1-\alpha_1-\beta_1)^2}\right]$$

$$L_{12}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-1}^2}{c_t^2}-\frac{a_t^2a_{t-1}^2}{c_t^3}\right)\right]\text{where } L_{12}^0=L_{21}^0$$

$$L_{13}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-2}^2}{c_t^2}-\frac{a_t^2\sigma_{t-1}^2}{c_t^3}\right)\right]\text{where } L_{13}^0=L_{31}^0$$

$$L_{23}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-1}^2a_{t-2}^2}{c_t^2}-\frac{a_t^2a_{t-1}^2\sigma_{t-1}^2}{c_t^3}\right)+\frac{2(1-w_3)}{(1-\alpha_1-\beta_1)^3}\right]\text{where } L_{23}^0=L_{32}^0$$

$$L_{33}^0=\frac{1}{n}\left[\sum_{t=2}^{T}\frac{1}{2}\left(\frac{a_{t-1}^2a_{t-2}^2}{c_t^2}-\frac{a_t^2a_{t-1}^2\sigma_{t-1}^2}{c_t^3}\right)+\frac{2(1-w_3)}{(1-\alpha_1-\beta_1)^3}\right]$$

$L^*(\underline{\vartheta})$ is given as,

$$L^*(\underline{\vartheta})=\frac{1}{n}\left[\sum_{t=2}^{T}\left[-\frac{1}{2}\ln(2\pi)-\frac{1}{2}lnc_t-\frac{1}{2}\frac{a_t^2}{c_t}\right]+ln\left[\frac{1}{\Gamma(r)\beta^r}\frac{1}{B(\underline{\omega})}\alpha_0^{r-1}e^{-\frac{\alpha_0}{\beta}}\prod_{i=1}^{3}\tau_i^{\omega_i-1}\right]+lnu(\underline{\vartheta})\right]$$

The partial derivatives of $L^*(\underline{\vartheta})$ with respect to α_0, α_1 and β_1 are

$$L_{11}^*=L_{11}^0+\frac{1}{n\alpha_0^2}, L_{22}^*=L_{22}^0+\frac{1}{n\alpha_1^2}, L_{33}^*=L_{33}^0+\frac{1}{n\beta_1^2}, L_{12}^*=L_{12}^0, L_{13}^*=L_{13}^0 and\, L_{23}^*=L_{23}^0$$

24.3 Illustration

The data are taken from the Istanbul Stock Exchange (ISE) which shows the every 5 min of ISE index for the time period from the opening time of the day 2 January 2003 to the closing time of the day 27 January 2003. Dickey-Fuller and Phillips-Perron unit root tests show that the data is not stationary. By calculating the return on the index data the series becomes stationary. The graphs of the original and the return for the series are shown in Fig. 24.1 (Table 24.1).

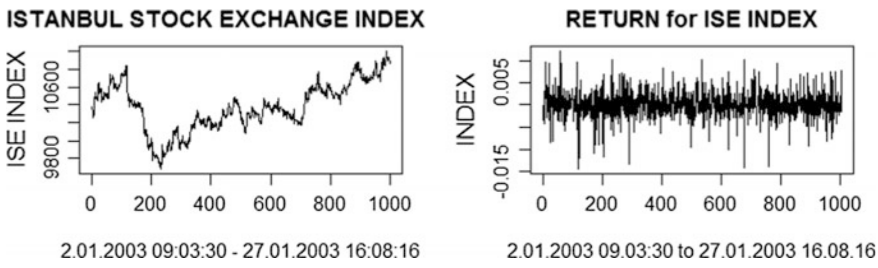


Fig. 24.1 The original and return on series of ISE index data

Table 24.1 Unit root tests for the original and return on series of ISE index data

	ISE index	Return on ISE index
Augmented Dickey-Fuller test	Dickey-Fuller = −1.8462 Lag order = 9 p-value = 0.6434	Dickey-Fuller = −10.737 Lag order = 9 p-value = 0.01
Phillips-Perron unit root test	Dickey-Fuller Z (alpha) = −8.6065 Truncation lag parameter = 7 p-value = 0.6296	Dickey-Fuller Z (alpha) = −853.75 Truncation lag parameter = 7 p-value = 0.01

The Lagrange Multiplier (LM) test for ARCH effects is performed and with Chi-squared = 30.313 and p-value = 0.002504 we can conclude that an GARCH model can be used to fit the data. For illustrative purposes an GARCH (1,1) model will be assumed with normal innovations. The ML and Bayes estimates, under SE loss function, of the parameters are computed. A vague prior is assumed for α_0 and Dirichlet prior is assumed for α_1 and β_1 where the hyperparameters of dirichlet distribution are assumed equal and unknown and are estimated using method of moments. So, $\omega_1 = \omega_2 = \omega_3 = 7.594982\text{e}{-07}$.

The estimates of the parameters of GARCH (1,1) is given in the Table 24.2. The parameters the 990 values of the return series will be used to estimate the parameters and then using the GARCH (1,1) model the next 10 values will be predicted. The estimated predicted values will be compared to the real ones by computing the ERs (Table 24.3).

Table 24.2 Parameter estimates for the GARCH (1,1)

Coefficients	MLEs	Bayes SE
α_0	3.3444e−06	5.2478e−06
α_1	0.1181	0.1175
β_1	0.5313	0.3019

Table 24.3 Expected risk of forecasts

SE loss function	
ML	Bayes
3.4629e−06	3.0916e−06

24.4 Simulation Results and Conclusions

The Bayesian and ML estimators of some distributions were compared by using expected risks (ERs) of Monte Carlo simulations (Nadar et al. 2015). The expected risk (ER) of θ under the SEL function is

$$ER(\theta) = \frac{1}{N}\sum_{n=1}^{N}\left(\hat{\theta}_n - \theta_n\right)^2$$

The simulation study is undertaken using a normal distribution for the innovations and different sample sizes. In particular the sample sizes are 200, 400, 600, 800 and 1000. The prior for α_0 is a gamma or an improper (vague) prior and for $(\alpha_{1,}\beta_1)$ Dirichlet function., The sample sizes and priors we obtain the ML and Bayes estimates of the parameters under a SE loss function. Table 24.4 presents the mean true value for each parameter and the average values of the ML and Bayesian estimates are reported. Furthermore, bold values, the expected risks are also

Table 24.4 Normal GARCH (1,1) model

Average values					
α_0 Gamma (3,1)	2.594948	2.832374	2.883744	3.102724	3.019853
α_1 Dirichlet $(1,2,3)$	0.331128	0.31891	0.325519	0.342709	0.338923
β_1 Dirichlet $(1,2,3)$	0.360123	0.352993	0.342554	0.340776	0.333716
		Sample	**Size**		
SE loss function α_0	**200**	**400**	**600**	**800**	**1000**
MLEs of α_0	2.901715	2.985848	3.07145	3.013091	2.917134
	0.539685	**0.26412**	**0.216391**	**0.123952**	**0.088867**
α_0 (vague)	2.859098	2.964992	3.059129	3.00491	2.910711
	0.511489	**0.245559**	**0.197727**	**0.122268**	**0.08816**
α_0 (Gamma)	2.860713	2.965373	3.05921	3.00504	2.910892
	0.488109	**0.234602**	**0.186901**	**0.122086**	**0.087983**
SE loss function α_1	**200**	**400**	**600**	**800**	**1000**

(continued)

Table 24.4 (continued)

Average values					
MLEs of α_1	0.245416	0.273668	0.279531	0.340164	0.33597
	0.025819	**0.017875**	**0.016318**	**0.012012**	**0.011084**
α_1 (Dirichlet), α_0 (vague)	0.254047	0.275202	0.28252	0.340988	0.336446
	0.024553	**0.017331**	**0.016077**	**0.011978**	**0.01107**
α_1 (Dirichlet), α_0 (Gamma)	0.253472	0.2751	0.282335	0.34091	0.336374
	0.02255	**0.016832**	**0.015885**	**0.011977**	**0.011033**
SE loss function $\boldsymbol{\beta}_1$	**200**	**400**	**600**	**800**	**1000**
MLEs of β_1	0.296622	0.342719	0.328933	0.380984	0.371603
	0.069724	**0.059263**	**0.056724**	**0.054637**	**0.054044**
β_1 (Dirichlet), α_0 (vague)	0.30998	0.347385	0.331934	0.382485	0.373312
	0.06868	**0.058232**	**0.056237**	**0.054602**	**0.053887**
β_1 (Dirichlet), α_0 (Gamma)	0.309437	0.34718	0.331835	0.382401	0.373238
	0.066549	**0.058026**	**0.055923**	**0.054602**	**0.053836**

reported. All the results are based on 1000 repetitions. The prior of α_0 is either a gamma with $r = 3$ and $\beta = 1$ or a vague prior and a Dirichlet prior for α_1 and β_1 with parameters $\omega_1 = 1, \omega_2 = 2$ and $\omega_3 = 3$.

It is observed that as the sample size increases the expected risks decrease. This should be expected since the MLEs are consistent. Also, as expected for all the estimates when the sample sizes increase the expected risks decrease. In all cases the expected risks when proper priors are used for the Bayes estimates are smaller than the ones corresponding when an improper prior is used for α_0 and to the MLE estimates. There is little difference between the MLEs and Bayes estimates when an improper prior for α_0 is utilized.

References

Ardia, D., & Hoogerheide, L. F. (2010). Bayesian estimation of the GARCH (1,1) model with student-t innovations in R. *The R Journal, 2*(2), 41–47.

Ari, Y. & Papadopoulos, S. A. (2016). Bayesian estimation of the parameters of the ARCH model with Normal Innovations using Lindley's approximation. *Journal of Economic Computation and Economic Cybernetics Studies and Research, 50*(4), 217–234.

Asai, M. (2006). Comparison of MCMC methods for estimating GARCH models. *Journal of the Japan Statistical Society, 36,* 199–212.

Bauwens, L., & Lubrano, M. (1998). Bayesian inference on GARCH models using the Gibbs sampler. *Econometrics Journal, 1,* 23–46.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307–327.

Bollerslev, T., Engle, R. F., & Nelson, D. B. (1994). ARCH models. In R. F. Engle & D. McFadden (Eds.), *Handbook of econometrics* (Vol. IV, pp. 2959–3038). North-Holland, Amsterdam.

Gilks, W. R., Best, N. G., & Tan, K. K. C. (1995). Adaptive rejection metropolis sampling within Gibbs sampling. *Journal of the Royal Statistical Society Series, C, 44,* 455–472.

Kim, S., Shephard, N., & Chib, S. (1998). Stochastic volatility: Likelihood inference and comparison with ARCH models. *Review of Economic Studies, 65,* 361–393.

Lee, S. W., & Hansen, B. E. (1994). Asymptotic theory for the GARCH(1, 1) quasi-maximum likelihood estimator. *Econometric Theory, 10,* 29–52.

Lindley, D. V. (1980). Approximate bayes methods. *Trabajos de Estadistica, 3,* 281–288.

Marín, J. M., Rodríguez-Bernal, M. T., & Romero, E. (2015). Data cloning estimation of GARCH and COGARCH models. *Journal of Statistical Computation and Simulation, 85*(9), 1818–1831.

Metropolis, N., Rosenbluthv, A. W., Rosenbluth, M. N., Teller, A. H., & Teller, E. (1953). Equation of State Calculations by Fast Computing Machines. *The Journal of Chemical Physics, 21,* 1087–1092.

Mitsui, H., & Watanabe, T. (2003). Bayesian analysis of GARCH option pricing models. *The Journal of the Japan Statistical Society (Japanese Issue), 33,* 307–324 (in Japanese).

Moore, D., & Papadopoulos, A. S. (2000). The Burr Type XII distribution as a failure model under various loss functions. *Microelectronics Reliability, 40,* 2117–2122.

Müller, P., & Pole, A. (1998). Monte Carlo posterior integration in GARCH models. *Sankhya, Series, B, 60,* 127–144.

Nadar, M., & Kızılaslan, F. (2015). Estimation and prediction of the Burr type XII distribution based on record values and inter-record times. *Journal of Statistical Computation and Simulation, 85*(16), 3297–3321.

Nakatsuma, T. (2000). Bayesian analysis of ARMA-GARCH models: A Markov Chain sampling approach. *Journal of Econometrics, 95,* 57–69.

Tierney, L., & Kadane, J. B. (1986). Accurate approximations for posterior moments and marginal densities. *Journal of American Statistical Association, 81,* 82–86.

Virbickaite, A., Ausin, M. C., & Galeano, P. (2015). Bayesian inference methods for univariate and multivariate GARCH models: A survey. *Journal of Economic Surveys, 29*(1), 76–79.

Chapter 25
The Potential Threat of Corporate Financial Distress in Switzerland

Tomáš Pražák

Abstract The financial performance and the financial health of companies is given through the ability to generate added value. For the resulting effect of creating added value, maximum activity is required. Otherwise, companies have significant payment difficulties that can be resolved by a radical change in its activities or structure. The aim of this paper is to indicate potential threat of the corporate financial distress in Switzerland. The financial health of companies is analyzed by Taffler's bankruptcy model. The construction of the predictive models and the bankruptcy models are based on actual data from companies which were threatened by bankruptcy in previous years. The Taffler's bankruptcy model is applied on the annual corporate financial results in Poland from 2006 to 2015. The results indicated that approximately 34% of companies during the reporting period were at risk of financial distress. Based on the development of the number of endangered businesses, it can be observed that during the recession, the number of companies in financial distress is rising. This hypothesis was confirmed by Pearson's correlation analysis.

Keywords Financial distress · Taffler's bankruptcy model · Switzerland
Pearson correlation coefficient

25.1 Introduction

The subject of the prediction of the corporate bankruptcy has been published in the economic literature since the 1960s and has been devoted to a number of scientific works. In order to predict the bankruptcy of a business or to properly classify a

T. Pražák (✉)
School of Business Administration in Karvina, Silesian University in Opava,
Univerzitní Nám, 1934/3, 73340 Karvina, Czech Republic
e-mail: prazak@opf.slu.cz

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_25

business according to its financial health, a variety of different methods have been used that differ in both their assumptions and complexities.

Predictive models are based on the hypothesis that the financial difficulty of an enterprise may be identified by certain signals that may be reflected in the ratios of financial ratios before it actually becomes apparent. The aim of the model is to give warning signals with sufficient time in advance. Already in 1966, William Beaver was looking for a relative financial ratio that better than others could have warned enough about the near-going decline of the business. He subsequently deduced several one-dimensional discriminatory models. On the contrary, Altman (1968) used a multidimensional discriminatory analysis to address the prediction of financial distress, which became the basis of the Z-score model and other established predictive and bankruptcy models.

Criterion of financial distress is often defined in the literature in a variety of ways, often based on time-lag lost, default dividends, bond defaults, large redundancies, capital restructuring, accumulated losses or negative cash flow (Balcaen and Ooghe 2006). Whether the company has a lack of capital, misinformation, or poor planning, it always come to the top management of the business when examining the causes of these shortcomings.

Financial distress also carries the so-called cost of financial distress, which is a natural accompaniment. These costs are in the form of both direct costs, which are various payments associated with dealing with financial distress such as court fees, lawyers' payments, or crisis managers. Indirect costs are primarily lost profits, for example, when an enterprise loses investor confidence and thus potential contracts.

However, it is important to noticed that the life of an enterprise is influenced by many external factors that cannot be affected by an enterprise, such as the development of macroeconomic indicators that can negatively affect the financial situation of an enterprise. These variations may be negated by appropriate management decisions, depending on the nature of the indicator.

The aim of this paper is to analyze the possible impact of selected macroeconomic indicators on the number of vulnerable financial distress companies in Switzerland. The financial distress of enterprises will be analyzed using the Taffler bankruptcy model at the national and sectoral level of Swiss enterprises between 2006 and 2015. Subsequently, using the econometric analyses of Pearson correlation coefficient and the use of granger causality, the potential impact of the development of macroeconomic indicators on the identified number of enterprises at risk of financial distress will be determined.

Switzerland reigns to most renowned charts, assessing the level of the economy, quality of life, business environment or freedom. In Switzerland, there is the highest average net wage in the world. At the same time, citizens can enjoy a beautiful environment and great public administration. To keep up the economy, there is an integrated specialized economy, top industry, production and distribution systems, and finance in the markets of Europe and around the world. The strength and foundation of the Swiss economy is in small and medium-sized companies, which account for over 90% of its GDP.

For the further development of each economy, the financial health of enterprises that are analyzed in bankruptcy models in this study is important. The use of bankruptcy models in previous studies and the study of the impact of macroeconomic factors on enterprises at risk of financial distress is set out in Sect. 25.1. In Sects. 25.2 and 25.3, selected macroeconomic variables based on literature review are characterized and the methodology used, which will be based on identifying enterprises at risk of financial distress of the resulting relationship. Section 25.4 lists the results of the methods used and the last part summarizes the findings.

25.2 Literature Review

Bankruptcy models serve to predict the company's financial problems or determine the degree of imminent threat to the company by bankruptcy. This type of model is based on actual data from a very wide range of companies. For the overall assessment of the financial situation of the company, it is also necessary to take into account the results of partial analyzes of individual business areas. For this reason, it is advisable to build up credit and bankruptcy models following financial analysis using absolute and ratio ratios.

Fundamental models for predicting financial distress and business bankruptcy based on financial indicators were originally analyzed by Beaver (1966) and Altman (1968) models. Predictive models are based on the hypothesis that the financial difficulty of an enterprise can be identified using the ratios of financial ratios before it actually becomes apparent. The construction of the predictive models and the bankruptcy models are based on actual data from companies which were threatened by bankruptcy in previous years.

On this bases, the Taffler's bankruptcy model was developed (1983). The first stage in constructing this model was to compute over 80 selected ratios from the accounts of all listed industrial firms failing between 1968 and 1976 and 46 randomly selected solvent industrial firms. The Taffler model's ratios and coefficients indicate the four key dimensions of the firm's financial profile that are being measured by the selected ratios. These dimensions, identified by factor analysis, are: profitability, working capital position, financial risk and liquidity. Afterwards, Agarwal and Taffler (2007) confirmed the predictive ability of the model over the years and also demonstrate the predictive ability of the published accounting numbers and associated financial ratios used in the z-score model calculation. In this paper, the Taffler model is shown to have clear predictive ability over this extended time period.

The high predictive value of the financial distress in the models, according to the study Liu (2004) or Goudie and Meeks (1991) have macroeconomic indicators.

According to Goudie and Meeks (1991), A macro-micro model is presented which is used to predict company failure. It bridges the gap between previous macroeconomic models and the microeconomic approach to company failure. A series of simulation exercises using this model quantifies the impact of variations in the exchange rate upon the failure rate.

Similarly, Liu (2004) deals with the macroeconomic determinants of corporate bankruptcy in the UK. Using a structured vector autoregressive model, it separates short and long-term effects. He empirically analyzed the relationship between corporate bankruptcy rates, interest rates, the aggregate volume of loans to the corporate sector and its profitability, the price level and the rate of start-up of new companies in the short and long term. From these macroeconomic variables empirically demonstrated the influence of interest rates on bankruptcy rates and pointed to the possibility of using interest rates as a means of reducing the number of failure companies in the economy. The macroeconomic model of business insolvency has been estimated also by Virolainen (2004), which empirically demonstrated the dependence of Finnish companies' bankruptcies on interest rates, gross domestic product, and their aggregate indebtedness for each sectors of the economy.

Bordo and Schwartz (2000) traced the changing nature of banking, currency, and debt crises from the last century to the present and their impact on business failures. They assess the impact of IMF loans on the macro performance of the recipients. A simple with-without comparison of countries receiving IMF assistance during crises in the period 1973–98 with countries in the same region not receiving assistance suggests that the real performance of the former group was possibly worse than the latter. The negative impact of the global crises on corporate sector, generally measured by development of GDP explained also Jakubík and Teplý (2008).

Borio (2007) analyzed the implications of financial revolution for the dynamics of financial distress and for policy. He argues that, despite the structural changes, some fundamental characteristics of the financial system have not changed and that these hold the key to the dynamics of financial instability. These characteristics relate to imperfect information in financial contracts, to risk perceptions and incentives, and to powerful feedback mechanisms operating both within the financial system and between that system and the macro-economy.

The determinants of mergers and bankruptcies using firm level data from Switzerland examined Buehler et al. (2006). They found considerable differences in the determinants of mergers and bankruptcies, in particular with respect to firm size, location and the impact of macroeconomic conditions. More specifically, large firms are more likely to grow further by merger than small firms.

Financial leverage, liquidity and financial health of companies in Switzerland was debatable issue of Drobetz and Fix (2003) or Drobetz and Grüninger (2007). Their results indicate that asset tangibility and firm size are both negatively related to corporate cash holdings, and that there is a non-linear relationship between the leverage ratio and liquidity. Financial leverage of firms is also closely related to tangibility of assets and the volatility of a firm's earnings.

25.3 Data and Methodology

25.3.1 Data Characteristics

The World Economic Forum's Global Competitiveness Report currently ranks Switzerland's economy as the most competitive in the world, while ranked by the

Table 25.1 Development of macroeconomic factors

	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP per capita	63,854	72,899	70,303	74,911	88,609	83,547	85,059	86,592	82,034
EUR/CHF	1.64	1.58	1.51	1.38	1.23	1.21	1.23	1.22	1.07
GDP growth	4.16	2.11	−2.31	3.04	1.64	1.01	1.88	2.45	1.22
Export/GDP	0.61	0.62	0.57	0.63	0.64	0.66	0.71	0.63	0.61

Source OECD (2018)

European Union as Europe's most innovative country. Switzerland has a stable, prosperous and high-tech economy. It has the world's nineteenth largest economy by nominal GDP and the thirty-sixth largest by purchasing power parity. It is the twentieth largest exporter, despite its small size. Switzerland has the highest European rating in the Index of Economic Freedom, while also providing large coverage through public services. The nominal per capita GDP, showed in Table 25.1, is higher than those of the larger Western and Central European economies and Japan.

According to the World Bank and IMF, Switzerland ranks 8th in the world in terms of GDP per capita. In 2017, average gross household income in Switzerland was 9946 francs per month, though 61% of the population made less than the average income.

The Swiss central bank in January 2015 surprisingly abolished the policy of keeping the euro exchange rate above the francs above 1.20 CHF introduced in September 2011 to protect the economy from the negative effects of strong domestic currency on exports. Frank then sharply strengthened by about 13%, which undermined export.

Switzerland does not have rudimentary resources; the economy is built on highly skilled workforce industry as one of the most advanced in the world. It is mainly the production of machine tools, power equipment, precision mechanics and optics of chemicals, electronics and selected foods. Significant revenues flow from the state from business and financial services, and the country is home of many international banks.

Switzerland is home to several large multinational corporations. The largest Swiss companies by revenue are Glencore, Gunvor, Nestlé, Novartis or Hoffmann-La Roche. Switzerland is ranked as having one of the most powerful economies in the world with the most important manufacturing sector. Manufacturing consists largely of the production of specialist chemicals, health and pharmaceutical goods, scientific and precision measuring instruments and musical instruments. According to IMF, the largest exported goods are chemicals (34% of exported goods), machines and electronics (20.9%), and precision instruments especially watches (16.9%). The service sector, especially banking and insurance,

Table 25.2 The basic activity of sectors of economy in Switzerland (in % of total)

Code	Nace Rev. 2, main section	Turnover	Employees	Value added
A	Agriculture, forestry and fishing	X	X	X
B	Mining and quarrying	0.11	0.16	0.22
C	Manufacturing	14.83	24.21	28.04
D	Electricity, gas, steam and air conditioning supply	1.87	1.06	2.35
E	Water supply; sewerage, waste management and remediation activities	0.26	0.49	0.58
F	Construction	3.48	11.82	8.27
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	65.44	21.57	25.36
H	Transportation and storage	3.16	7.61	7.11
I	Accommodation and food service activities	1.06	7.37	3.08
J	Information and communication	2.71	5.01	6.99
K	Financial and insurance activities	X	X	X
L	Real estate activities	0.58	1.42	2.03
M	Professional, scientific and technical activities	4.86	10.33	11.12
N	Administrative and support service activities	1.63	8.93	4.85
Q	Human health and social work activities	X	X	X
R	Arts, entertainment and recreation	X	X	X
S	Other service activities	X	X	X

Note The mark X denotes unavailability of data searched
Source Eurostat (2018)

tourism, and international organizations are another important industry for Switzerland.

Switzerland has also a low tax rates and overall taxation is one of the smallest of developed countries. Switzerland is a relatively easy place to do business, currently ranking 20th of 189 countries in the Ease of Doing Business Index.

The basic activity of sectors of economy in Switzerland is shown in Table 25.2. According to Eurostat database, the most active sectors are Wholesale and retail trade; repair of motor vehicles and motorcycles, Manufacturing and Professional, scientific and technical activities.

25.3.2 Methodology

In this paper, the financial health of companies is analyzed by Taffler's bankruptcy model (1983). As explained in Taffler (1983), the first stage in constructing this model was to compute more than 80 carefully selected ratios from the accounts of all listed industrial firms failing between 1968 and 1976 and 46 randomly selected solvent industrial firms and the correctness of the Taffler's model (25.1) provides the study of Agarwal and Taffler (2007).

Bankruptcy models indicate the financial condition of the company and its risk of potential bankruptcy. The models are based on real data from companies that have already gone bankrupt. Formulas are predicted to see if the company is going bankrupt or prospering. The forecast of bankruptcy can be detected several years before the actual bankruptcy.

Due to the availability of financial results in Amadeus database, the Taffler's bankruptcy model is applied on the annual financial results of 355 companies in Switzerland from 2006 to 2015.

$$TZ = 0.53R1 + 0.13R2 + 0.18R3 + 0.16R4 \tag{25.1}$$

R1 EBIT/short-term liabilities
R2 current assets/foreign capital
R3 short-term liabilities/total assets
R4 total sales/total assets

The resulting company qualification is made according to the following ranges:

TZ > 0.3—low probability of bankruptcy of the company
0.2 < TZ < 0.3—grey zone of unmatched results
TZ < 0.2—increasing probability of bankruptcy of the company

The impact of selected macroeconomic indicators on the number of firms threatened by financial distress will be examined through econometric analyzes in econometric software EViews. Selected methods for detecting possible relationship are Pearson correlation analysis and Granger causality test.

Based on the review of literature selected macroeconomic indicators are GDP per capita, GDP growth, interest rate and exchange rate. Bordo and Schwartz (2000), Liou and Smith (2007), Jakubík and Teplý (2008) concluded that the number of bankruptcies is increasing during the economic recession, while in the conjunction period their number decreases. The Pearson correlation coefficients (25.2) is used to confirm this hypothesis. Correlation coefficient measures the strength of linear dependence between two variables.

The calculation of the Pearson correlation coefficient (Brooks 2002) is then the following:

$$r_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} \tag{25.2}$$

where x and y are the sample means of X and Y, and sx and sy are the corrected sample standard deviations of X and Y. The Pearson correlation is +1 in the case of a perfect direct linear relationship, −1 in the case of a perfect inverse linear relationship, and some value in the open interval (−1, 1) in all other cases, indicating the degree of linear dependence between the variables. The closer the coefficient is to either −1 or 1, the stronger the correlation between the variables.

Finally, the Granger causality test to determine the direction of short-run dynamics i.e. interdependences between the number of corporates with potential financial distress and macroeconomic variables is used. The Granger test involves the estimation of the following equations (Brooks 2002):

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{q} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta X_{t-i} + \varepsilon_{1t} \tag{25.3}$$

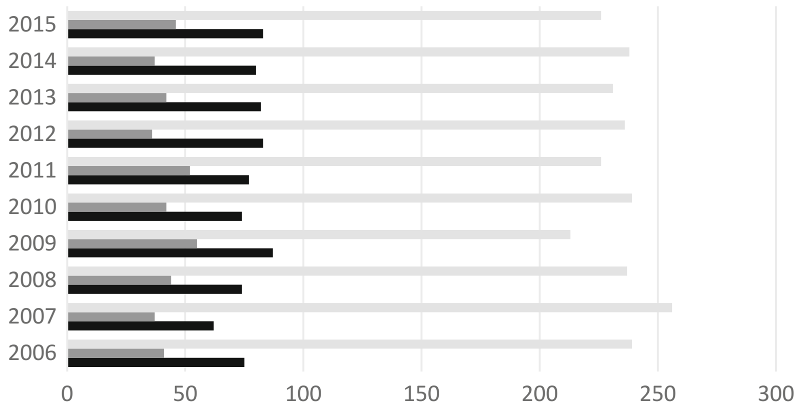
$$\Delta X_t = \varphi_0 + \sum_{i=1}^{r} \varphi_{1i} \Delta X_{t-i} + \sum_{i=1}^{r} \varphi_{2i} \Delta Y_{t-i} + \varepsilon_{2t} \tag{25.4}$$

in which Y_t and X_t represent corporates with potential financial distress and macroeconomic variables. ε_{1t} and ε_{2t} are uncorrelated stationary random processes, and t denotes the time period. Failing to reject the H_0: $\beta_{21} = \beta_{22} = \cdots = \beta_{2q} = 0$ implies that macroeconomic fundamentals do not Granger cause number of corporates with potential financial distress. Likewise, failing to reject H_0: $\varphi_{11} = \varphi_{12} = \cdots = \varphi_{1r} = 0$ suggest that number of corporates with potential financial distress do not Granger cause macroeconomic variables.

25.4 Results

Although Switzerland is one of the most competitive and performing economies, it is still important to monitor the financial situation of businesses in the economy. In this study, the potential financial distress of businesses is determined by using the Taffler bankruptcy model. Due to the availability of data in the Amadeus business database, a total of 355 enterprises were analyzed. From the results shown in Fig. 25.1, approximately 22% of enterprises (TZ < 0.2) were threatened by financial distress and possible bankruptcy, approximately 12% of firms were in the gray zone of potential financial distress (0.2 < TZ < 0.3) and 66% were located in the low-risk zone of financial distress (TZ > 0.3). Most businesses threatened by financial distress and bankruptcy were in 2009, 2011 and 2015, the years when the Swiss economy was affected by economic structural change. In 2009, the global economic crisis affected the number of companies in financial distress, the European debt crisis followed in 2011, and in 2015 the Swiss central bank unexpectedly dropped from the exchange rate commitment in the course of the past three years, holding a franc above CHF 1.20. This step had a negative impact on exports, which is a significant source of economic performance.

According to sector analysis of companies with Z-score TZ < 0.2 and 0.2 < TZ < 0.3 shown in Table 25.3, Transport and storage (H), Accommodation and food service activities (I) and other services (S) are sectors with the highest



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TZ>0,3	239	256	237	213	239	226	236	231	238	226
0,2<TZ<0,3	41	37	44	55	42	52	36	42	37	46
TZ<0,2	75	62	74	87	74	77	83	82	80	83

TZ>0,3 0,2<TZ<0,3 TZ<0,2

Fig. 25.1 Results of Taffler Model in Switzerland. *Source* Author's calculations

Table 25.3 Number of companies with potential threat of financial distress

Sector (NACE)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average in %
A (1)	0	0	0	0	0	0	0	0	0	0	0
C (11)	1	0	0	3	1	2	2	1	1	2	11.81
D (63)	29	23	23	27	19	25	20	25	27	33	39.84
E (6)	2	2	3	3	2	2	2	2	2	2	36.67
G (5)	0	0	0	0	0	0	0	0	0	0	0
H (67)	43	41	43	48	48	47	36	42	42	42	64.48
I (9)	4	6	4	6	5	7	8	7	7	6	66.67
J (8)	1	1	2	3	4	4	4	3	2	2	32.5
K (92)	14	10	23	26	19	23	27	20	16	18	21.3
L (7)	1	1	2	3	3	3	4	6	4	4	44.29
M (72)	12	9	11	15	9	11	12	12	9	13	15.69
N (5)	3	2	3	3	1	2	1	1	1	2	38
Q (2)	0	0	0	0	0	0	0	1	2	1	20
R (5)	4	3	3	3	4	2	2	2	2	2	54
S (2)	2	1	1	2	1	1	1	2	2	2	75

Source Author's calculations

Table 25.4 Pearson correlation analysis

Variable	GDP growth	GDP per capita	Exchange rate EUR/CHF	Interest rate
Correl	−0.8766*	0.3554	−0.3798	−0.4799
t-stat	−5.1537	1.0755	−1.1614	−1.5475
Prob	0.0009	0.3135	0.2790	0.1603

Source Author's calculations
* denotes statistical significance on 1%

number of companies with potential financial distress. On the contrary, the best performing sectors are the driving force of the Swiss economy with the largest share of economic activity, such as Manufacturing (C), Wholesale and Retail; (G), Financial and insurance activities (K) and Professional, scientific and technical activities (M). At the same time, it is clear from this sectoral analysis that structural changes have had a negative impact on the number of companies in financial distress.

Based on the results of the Taffler model, it can be assumed that macroeconomic developments have an impact on the number of businesses with a potential financial distress. This hypothesis can be confirmed on the basis of Pearson's correlation analysis, the results of which are shown in Table 25.4. The resulting correlation coefficients confirm claims by authors of similar publications, with the decline in economic activity characterized by GDP growth rising by the number of enterprises threatened by bankruptcy and financial distress. At the time of the economic growth, such enterprises are declining. Other macroeconomic indicators did not show a statistically significant dependence, although the interest rate indicator reaches negative middle strong impact.

To capture causal relationships, Granger's causality test of selected variables was used. The basic condition is the fulfillment of the stationarity of the analyzed data at the first difference. To fulfill this condition, the ADF unit root test was used. Subsequently, on these stationary data, the Granger causality test was carried out, the results of which are shown in Table 25.5. Based on the resulting probability of F statistics, it was possible to reject the zero hypothesis only for the interest rate indicator. Therefore, it can be argued that the interest rate for Granger caused a

Table 25.5 Granger causality analysis

Granger causality test	F-statistic	Probability
GDP_growth =/=> FDIS	1.3679	0.4223
FDIS =/=> GDP_growth	1.9715	0.3365
GDP_per_capita =/=> FDIS	0.4430	0.6930
FDIS =/=> GDP_per_capita	0.8853	0.5304
Exchange_rate =/=> FDIS	0.0671	0.9371
FDIS =/=> Exchange_rate	1.9191	0.3426
Interest_rate =/=> FDIS	11.2543***	0.0816
FDIS =/=> Interest_rate	19.4955**	0.0488

Source Author's calculations
, * denotes statistical significance on 5 % and 10%

number of companies with potential financial distress, but also the opposite relationship was found between these variables, when Granger caused a financial interest rate. These results corroborate Liu's claim (2004) that proper use of interest rates by the central bank is an appropriate tool to reduce the number of financially at risk corporations.

25.5 Conclusion

For the further development of each economy, the financial health of enterprises that are analyzed in bankruptcy models in this study is important. Bankruptcy models indicate the financial condition of the company and its risk of potential bankruptcy. The models are based on real data from companies that have already gone bankrupt. Formulas are predicted to see if the company is going bankrupt or prospering. The forecast of bankruptcy can be detected several years before the actual bankruptcy. These models are very useful for the investor when assessing the purchase of the company's shares or bonds. Bankruptcy models are used to predict the company's financial problems or determine the degree of potential threat to the company by bankruptcy.

The aim of this paper was to analyze the impact of the macroeconomic environment on the financial health of enterprises in Switzerland. Although Switzerland is one of the most competitive countries in the world, on the basis of Taffler's bankruptcy model, it was found that, on average, 34% of companies during the 2006–2015 reporting period were at risk of financial distress. An important result for the Swiss economy was the finding that the sectors with the greatest economic power had the lowest numbers of businesses at risk of financial distress. Based on the development of the number of endangered businesses, it can be observed that during the recession, the number of companies in financial distress is rising. This hypothesis was confirmed by Pearson's correlation analysis, where the correlation coefficient shows a statistically significant negative correlation between GDP growth and the number of enterprises in financial distress.

To determine the causal relationship between selected macroeconomic variables and the number of enterprises in financial distress, the Granger causal test was used. The resulting values of stationary data showed the appropriateness of using the interest rate as an element to reduce the number of companies in potential financial distress. The lower interest rate increases the demand of businesses after obtaining loans, which may increase their investment activity or reduce their liabilities.

Acknowledgments The research was financially supported by the Student Grant System of Silesian University in Opava within the "The effect of fundamental factors and corporate governance on stock prices" project. This support is greatly appreciated.

References

Agarwal, V., & Taffler, R. (2007). Twenty-five years of the Taffler z-score model: Does it really have predictive ability? *Accounting and Business Research, 37,* 285–300.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance, 23,* 589–609.

Balcaen, S., & Ooghe, H. (2006). 35 years of studies on business failure: An overview of the classic statistical methodologies and their related problems. *The British Accounting Review, 38,* 63–93.

Beaver, W. H. (1966). Financial ratios as predictors of failure. *Journal of Accounting Research, 4,* 71–111.

Bordo, M. D., & Schwartz, A. J. (2000). Measuring real economic effects of bailouts: Historical perspectives on how countries in financial distress have fared with and without bailouts. *Carnegie-Rochester Conference Series on Public Policy, 53,* 81–167.

Borio, C. E. V. (2007). Change and Constancy in the Financial System: Implications for financial distress and policy (SSRN Scholarly Paper No. ID 1022874). Social Science Research Network, Rochester, New York. 237, 1–27.

Brooks, Ch. (2002). *Introductory econometrics for finance*. Cambridge: Cambridge University Press. ISBN 0-52179367-X.

Buehler, S., Kaiser, C., & Jaeger, F. (2006). Merge or fail? The determinants of mergers and bankruptcies in Switzerland, 1995–2000. *Economics Letters, 90,* 88–95.

Drobetz, W., & Fix, R., (2003). What are the determinants of the capital structure? Some evidence for Switzerland. Working Paper in National Centre of Competence in Research Financial Valuation and Risk Management no. 88. Swiss National Science Foundation.

Drobetz, W., & Grüninger, M. C. (2007). Corporate cash holdings: Evidence from Switzerland. *Financial Markets and Portfolio Management, 21,* 293–324.

Eurostat. (2018). *Statistical classification of economic activities in the European Community* [Online]. Available from https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF.

Goudie, A. W., & Meeks, G. (1991). The exchange rate and company failure in a macro-micro model of the UK company sector. *Economic Journal, 101,* 444–457.

Jakubík, P., & Teplý, P. (2008). The prediction of corporate bankruptcy and Czech economy's financial stability through logit analysis. IES Working Paper 19/2008. IES FSV. Charles University.

Liu, J. (2004). Macroeconomic determinants of corporate failures: Evidence from the UK. *Applied Economics, 36,* 939–945.

Liou, D., & Smith, M. (2007). Macroeconomic variables and financial distress. *Journal of Accounting, Business and Management, 14,* 17–31.

OECD. (2018). *OECD Data Database* [Online]. Available from https://data.oecd.org/.

Taffler, R. (1983). The assessment of company solvency and performance using a statistical model. *Accounting and Business Research, 15*(52), 295–308.

Virolainen, K., (2004). *Macro stress testing with a macroeconomic credit risk model for Finland.* Helsinky, Bank of Finland, Discussion Paper, 18, 1–48.

Chapter 26
The Impact of Structure of Debt Funding Sources on Liquidity of Medium-Sized Companies in the Czech Republic

Markéta Šeligová

Abstract The aim of this paper is to determine the impact of structure of debt funding sources on liquidity of medium-sized companies in the Czech Republic from 2006 to 2015. With the purpose to fulfill the aim, we determine the impact of structure of debt funding sources including variables such as debt equity ratio, supplier loans, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities on liquidity of medium-sized companies in the Czech Republic. The relationship between structure of debt funding sources and liquidity of medium-sized companies is determined using a correlation analysis and panel regression analysis using generalized method of moments (GMM). The results confirm that there is negative impact of long-term bank loans on liquidity of medium-sized companies in the Czech Republic. The results also confirm the positive impact of other short-term liabilities on liquidity of medium-sized companies in the Czech Republic.

Keywords Debt funding sources · Liquidity of companies · Long-term bank loans Medium-sized companies

26.1 Introduction

Medium-sized companies are an important part of the economy of the state. One of the main competitive advantages of medium-sized companies compared to large companies is their flexibility, which enables them to react more quickly to changes in the market. Within the financing area, medium-sized companies are confronted with more

M. Šeligová (✉)
Department of Finance and Accounting, School of Business Administration, Silesian University, Univerzitní Nám. 1934/3, 733 40 Karviná, Czech Republic
e-mail: seligova@opf.slu.cz

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_26

limited access to debt funding sources than large and very large companies. The main source of financing for medium-sized companies is therefore self-financing. The most important debt funding sources are mainly bank loans and supplier loans. Medium-sized companies are perceived by banking institutions to be a relatively risky group of clients with relatively higher costs of providing lower credit.

Myers (2001) argues that agency effects of various kinds may create important reasons for holding liquid assets with the further implications of different patterns of corporate liquidity depending on capital structure or other firm characteristics. He believed that holding liquid assets will be important for companies facing growth opportunities and the expected return fluctuates over time. Given that the decision on liquidity associated with the debt structure of companies, each of them needs to monitor its liquidity relations following the decision of debt. Liquidity is a key financial indicator to measure whether the company is able to meet its debt obligations based on short-term debt ratio, long-term debt ratio and total debt ratio without causing undesirable losses. Stulz (1990) argues that firms with high leverage and losing their financial flexibility, may have difficulty in finding new funds to finance their projects. Šarlija and Harc (2012) suggest that liquidity is a characteristic of the company's assets that can be quickly converted to cash. Firms hold a certain amount of liquidity in during their activities to be able to meets its obligations on time. For this reason, Saleem and Rehman (2011) argues that liquidity management is very important for each company in order to maintain the ability to pay its obligations properly and on time.

The aim of this paper is to determine to determine the impact of structure of debt funding sources on liquidity of medium-sized companies in the Czech Republic from 2006 to 2015. With the purpose to fulfill the aim, we determine the impact of structure of debt funding sources including variables such as debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities on liquidity of medium-sized companies in the Czech Republic. In order to achieve the aim, the following research question will be identified and evaluated:

- What is the impact of structure of debt funding sources on liquidity of medium-sized companies in the Czech Republic?

The first part of this article will include a literature review. The second part of this article will focused on methodology and data. The third part of this article will contain results and discussion. Last part of this article will conclude results.

26.2 Literature Review

Williamson (1988), Schleifer and Vishny (2001), Anderson (2002) believe that more liquid companies are less costly to monitor and liquidate therefore higher liquidity growth leverage. On the contrary, De Jong et al. (2008), Lipson and Mortal (2009), Šarlija and Harc (2012) argue that more liquid companies are less indebted, because they could use the additional liquidity to internally finance their activities.

The aim of this paper is to determine to determine the impact of structure of debt funding sources on liquidity of medium-sized companies in the Czech Republic from 2006 to 2015. For this reason, it would be appropriate to mention a study focusing on the liquidity of companies in the Czech Republic. Unfortunately, there are few studies focusing on the liquidity of companies in the Czech Republic. For this reason, the literature review will be supplemented with additional relevant studies focusing on the liquidity of companies in other countries.

Anderson (2002) dealt with selected financial indicators related to the structure of own funding sources and debt funding sources. He examined the relationships among the firm's financial structure, its choice of liquid asset holdings and growth on UK and Belgian companies. Using regression analysis he examined the factors determining liquid asset holdings and the link between liquidity of companies and capital structure using the following variables: liquidity (dependent variable, sum of cash, bank balances, and investments in current assets divided by total assets) and independent variables such as cash flow (earnings before taxes and interest divided by total assets), long term debt, medium term debt, short term debt, R&D expenditures and market value to book value. The results revealed positive associations between leverage and liquid asset holding.

Selected financial indicators related to the structure of debt funding sources and liquidity of companies were dealt with by Šarlija and Harc (2012). They investigated the relationship between liquidity and the capital structure of Croatian companies. Pearson correlation coefficient was applied to the test on the relationship between liquidity ratios and debt ratios, the share of retained earnings to capital and liquidity ratios and the relationship between the structure of current assets and leverage. The results showed the existence of a statistically significant negative correlations between liquidity ratios and leverage ratios. The results showed that there are statistically significant correlations between leverage ratios and the structure of current assets. The relationship between liquidity ratios and the short-term leverage is stronger and negative than positive relationship between liquidity ratios and the long-term leverage. The more liquid assets firms have, the less they are leveraged. Long-term leveraged firms are more liquid. Increasing inventory levels leads to an increase in leverage. Furthermore, increasing the cash in current assets leads to a reduction in the short-term and the long-term leverage.

Trippner (2013) analyzed the relationship between liquidity (cash ratio, current ratio and quick ratio) and selected financial indicators related to the structure of own funding sources such as profitability (return on assets—ROA, return on equity—ROE) in the Polish companies from 2002 to 2012. Using correlation analysis it has been found that there is a positive and negative relation between liquidity and ROA and ROE.

Miloş (Milos 2015) analyzed the determinants of capital structure of the Romanian companies using panel data. He focused on selected financial indicators related to the structure of own funding sources and debt funding sources. He used variables including ratio between total debt and total liabilities, profitability (return on assets), liquidity (ratio between current assets and current liabilities), tangibility (ratio of tangible assets divided by the total assets) and size (natural logarithm of total sales). The results show that there is a negative connection between liquidity and leverage. The results suggest that less liquid companies obtain the necessary capital by borrowing. Companies often prefer and use a short-term loans when there is a lack of liquidity.

Růčková (2015) examined the relationship between liquidity, profitability and use of debt funding sources of companies in manufacturing industry in V4 countries. She examined the relationship between using debt sources (debt/equity ratio) and liquidity. The study results showed a positive relationship between liquidity and using debt sources in the Czech Republic. It can be stated that the increasing liquidity of companies is also increasing the using debt sources.

Based on the studies mentioned above and classification of debt funding sources, the following financial indicators will be selected: debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities. We will therefore examine the impact of these indicators on the liquidity of medium-sized companies in the Czech Republic.

26.3 Data and Methodology

Correlation analysis and panel regression analysis using generalized method of moments (GMM) will be used to determine the impact of the structure of debt funding sources on liquidity of medium-sized companies. All financial data is drawn from the Amadeus database. This database includes data from the annual reports of individual companies in the Czech Republic. The dataset cover the period 2006–2015. All data and time series are on annual frequency. The data are the basis for the application of correlation analysis and panel regression analysis, specifically generalized method of moments (GMM). A sample of companies includes 7087 medium-sized companies in the Czech Republic. According to the Amadeus database, medium-sized companies are characterized as follows:

- returns (operating revenue or turnover) more than 1 million EUR,
- total assets more than 2 million EUR,
- number of employees more than 15.

Correlation analysis and panel regression analysis using generalized method of moments will be used to determine the relationship between liquidity of medium-sized companies and structure of debt funding sources. According to Cohen (2014), the correlation analysis is a suitable method for the initial identification (estimation) of the functional relationship between an explained variable and explanatory variable.

For this reason, we first determine the relationship between liquidity of medium—sized companies and structure of debt funding sources using correlation analysis.

The correlation relationship can be expressed using the Pearson correlation coefficient, which may take the following form: The Pearson's correlation coefficient can be expressed using the following Eq. (26.1):

$$P = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \tag{26.1}$$

where X represents the mean value matrix of liquidity of companies, Y is the mean of the matrix of the values of the individual variables related to the structure of debt funding sources (explanatory variables) and n is the number of observations. Pearson's correlation coefficient is based on the calculation by entering the covariance of the variables X and Y into the numerator and then by the denominator product of the standard deviations of the variables X and Y, which are defined as the root of the variance of the random variables X and Y. Covariance describes the degree of mutual variability of the two variables X and Y. If the variables X and Y are in no relation, the covariance is zero.

Pearson's correlation coefficient values range from −1 to 1, Values close to 1 suggest a positive dependence between the dependent variable and the independent variable, the values approaching −1 have a completely opposite negative relationship. Values approaching 0 show the mutual independence of the variables, where it is not possible to determine unequivocally the dependence between the analyzed variables (there is no linear dependence confirmed here, but it can be a non-linear dependence between the analyzed variables). The variables are uncorrelated in this case. The statistical significance of the correlation coefficient, which can be tested at 1, 5 and 10% significance, plays an important role in determining the relationship between variables.

Correlation and correlation coefficients can be used to determine the relationship between the variables, including the resulting effect, i.e. whether it is a positive, negative or neutral relationship. However, we are not able to determine how strong the dependence between these variables is, and how is a causal relationship or link between them, when we examine the relationship between the cause and its consequences within the variables analyzed by us.

For this reason, the generalized method of moments (GMM) will be used to determine the impact of the structure of debt funding sources on liquidity of medium-sized companies.

The generalized method of moments (GMM) is used in econometrics and statistics. The generalized method of moments (GMM) is a generic method for estimating parameters in statistical models. It is applied in the context of semi-parametric models, where the parameter of interest is finite-dimensional, whereas the full shape of the distribution function of the data may not be known, and therefore maximum likelihood estimation is not applicable. The meth-od requires that a certain number of moment conditions were specified for the model. These moment conditions are functions of the model parameters and the data, such that their expectation is zero at the true values of the parameters. The GMM method then minimizes a certain norm of the sample averages of the moment conditions. The GMM estimators are known to be consistent, asymptotically normal, and efficient in the class of all estimators that do not use any extra information aside from that contained in the moment conditions. (Hansen 1982).

Based on Haas and Lelyveld (2010), the following model will be estimated. The relationship between liquidity of companies and structure of debt funding sources will be estimated using the following equations in general form (26.2):

$$L_{it} = \alpha_1 + \beta_1 * \Delta L_{it-1} + \beta_2 * X_{1it} + \beta_3 * X_{2it} + \cdots + \beta_n * X_{nit} + \varepsilon_{it} \tag{26.2}$$

The dependent variable L_{it} is an indicator of current liquidity (L3), quick liquidity (L2) and cash liquidity (L1) of medium-sized companies in the Czech Republic at time t, L_{it-1} is delayed dependent variable, X_{nit} are other factors that represent structure of debt funding sources and which may affect the liquidity of medium-sized companies in the Czech Republic. These factors include debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities, β_0 and ε_t is model constant and the residual component in the model.

Table 26.1 includes description of explained and explanatory variables. Dependent variables are represented through three liquidity ratios such as current liquidity (L3), quick ratio (L2) and cash ratio (L1). The structure of debt funding sources is presented through variables such as debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities and other short-term liabilities. All variables are used to determine the relationship between liquidity of medium-sized companies and structure of debt funding sources. The choice of variables is based on the above studies.

The liquidity ratio is very important indicator because liquid company only is able to pay its payables. If the company has a sufficient amount of funds for

Table 26.1 Description of used variables

Variables	Calculation	Expected relationship
Current liquidity (L3) Quick liquidity (L2) Cash liquidity (L1) Debt equity ratio (DER) Supplier loan (SL) Long-term bank loans (LBL) Short-term bank loans (SBL) Other long-term liabilities (OLL)	Current assets/current liabilities (Current assets—inventory)/current liabilities Financial assets or cash/current liabilities Debt/equity Turnover time of receivables—turnover time of liabilities Long-term bank loans/balance sheet total Short-term bank loans/balance sheet total Other long-term liabilities/balance sheet total	Dependent variable Dependent variable Dependent variable
Other short-term liabilities (OSL)	Other short-term liabilities/balance sheet total	

payment of its current liabilities, the company will be liquid. An excessively high value of liquidity is usually accompanied by lower values of equity (return on equity) that is associated with a conservative approach. On the other hand, companies that have too low levels of liquidity typically use debt sources for financing their activities.

Debt equity ratio (leverage) measures debt sources to equity. The higher value of the debt equity ratio, the higher ratio of debt sources to equity. This fact can indicate a higher risk for creditors. The value of debt equity ratio 1 indicates that equity and debt sources are involved in the financing of companies in the same amount. Higher debt represents a higher level of risk of companies. On the other hand, higher debt may mean a larger volume of funding sources because the costs of external funding tend to be cheaper than costs of equity. Companies that have too low levels of liquidity typically use debt sources for financing their activities. For this reason, we can expect a negative relationship between liquidity of companies and debt equity ratio. This fact is consistent with study Miloś (2015) who found negative relationship between liquidity and debt equity ratio.

The causal link can also be found in the context of the representative conflict. The increased debt ratio will not be allowed by managers due to the increased threat of bankruptcy, because the possibility of consuming the benefits of a managerial position is diminishing with the growth of the threat of bankruptcy. This leads to a very consistent use of debt financing and collateral. However, this is reversed to the fact that companies with a smaller volume of assets that can be used to secure debt will consider a lower debt ratio from the point of view of the representative conflict because the lack of appropriate assets increases the cost of debt and thus reduces the level of managers' benefits. The existence of fixed assets in the context of capital structure management is still linked to the existence of a non-debt tax shield. It expresses the savings that an enterprise earns by depreciating costs and reducing the tax base. It can be said that a non-debt tax shield has a substitution effect in relation to the interest tax shield for the management of the capital structure.

Companies with higher earnings and less volatility in earnings are the ones that have greater indebtedness, due to the increased credibility in front of potential creditors. Moreover, they have more income to shield from taxes. On the other hand, more profitable companies are the ones that can use their retained earnings in order to finance their investment projects.

26.4 Results and Discussion

This part focuses on the results of correlation analysis, generalized method of moments and their comments.

Then, we can determine the relationship between liquidity of medium-sized companies and structure of debt funding sources using correlation analysis. Table 26.2 presents results of the correlation analysis using the Pearson's correlation coefficient.

Table 26.2 Correlation between liquidity of medium-sized companies and structure of debt funding sources

Variables	DER	SL	LBL	SBL	OLL	OSL
L1	−0.0026	0.0020	−0.0316*	−0.0096*	−0.0141*	0.01955 **
L2	−0.0036	0.0026	−0.0416*	0.0142*	−0.0127*	0.0737*
L3	−0.0026	0.0028	−0.0450*	0.0198*	−0.0130*	0.0820*

Source Authors' calculations
Note * denotes significance at 1% level, ** denotes significance at 5% level, *** denotes significance at 10% level

Table 26.2 presents correlative relationship between liquidity of medium-sized companies (dependent variable) and structure of debt funding sources (independent variables) such as debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities

Correlation has shown a neutral link with a tendency towards a negative relationship between long-term bank loans and cash liquidity, quick liquidity and current liquidity. The results suggest that the use of long-term bank loans will reduce to a small extent the liquidity of medium-sized businesses. Table 26.2 indicates a very weak neutral link between short-term bank loans and cash liquidity, quick liquidity and current liquidity. The relationship has been demonstrated at a level of 1% of statistical significance.

On the other hand, the correlation coefficient between short-term bank loans and quick liquidity and current liquidity confirms a neutral relationship, but with a negligible tendency towards positive correlation. A statistically significant but neutral link has been established between cash liquidity, quick liquidity, current liquidity and other short and long-term liabilities. It can be said that the increasing volume of other liabilities will not have a significant effect on the development of medium-sized companies' liquidity. Other variables and links between them have been shown to be statistically insignificant.

Using a correlation analysis, the link between variables was not confirmed unambiguously. For this reason, the Generalized Method of Moments (GMM) method will be used to determine the resulting relationship between structure of debt funding sources and liquidity of medium-sized companies in the Czech Republic.

We used econometrics software EViews 9. Table 26.3 presents the resulting relationship between liquidity of medium-sized companies (dependent variables) and structure of debt funding sources (independent variables).

In line with Table 26.3, statistically significant relationships between the structure of debt funding sources and the liquidity of medium-sized companies operating in the Czech Republic were demonstrated in three models. On the other hand, the Sargan/Hansen test (J-statistic) shows the robustness of the one model (J-statistic 44.0784).

The first model showed a statistically significant positive effect of the cash liquidity (L1) of the previous period on the cash liquidity of the current year. This

Table 26.3 Estimation results between liquidity of medium-sized companies and structure of debt funding sources

Variables	Delayed variable	LBL	OSL	J-statistic
L1	0.3455*	−1.18*	5.60**	**44.0784**
L2	0.4216*	−3.3 A*	2.98**	63.6946
L3	0.3729*	−4.29*	3.87**	74.0269

Source Authors' calculations
Note * denotes significance at 1% level, ** denotes significance at 5% level, *** denotes significance at 10% level

means that the cash liquidity of the past years strengthens the cash liquidity of the current period.

Furthermore, the negative impact of long-term bank loans on cash liquidity was found. The long-term bank loans have been shown to reduce the cash liquidity of medium-sized companies. This relationship is in line with the results of the correlation analysis, where the neutral relationship was demonstrated, but with a tendency toward negative correlation. If companies use long-term bank loans to finance their activities or to meet their obligations, there will be a decrease or threat to the solvency of medium-sized businesses through cash liquidity.

Medium-sized companies, due to their low financial strength, rely on their own funding sources to finance their activities. If medium-sized companies do not have enough money, they use short-term bank loans to finance their activities. These bank loans are not linked to collateral that would be difficult for medium-sized companies. Due to the low financial strength of medium-sized companies, greater use of short-term loans may jeopardize their solvency.

The results of the GMM method confirmed the positive effect on the significance level of 5% of other short-term liabilities on cash liquidity of medium-sized companies. The growth of short-term liabilities will lead to a rise in the cash liquidity of medium-sized companies. Short-term liabilities include, for example, liabilities to employees, liabilities to suppliers (trade liabilities), etc. Growth of these liabilities due to their subsequent repayment will contribute to the growth of cash liquidity at that moment.

26.5 Conclusion

Medium-sized companies are an important part of the economy of the state. One of the main competitive advantages of medium-sized companies compared to large companies is their flexibility, which enables them to react more quickly to changes in the market. Within the financing area, medium-sized companies are confronted with more limited access to debt funding sources than large and very large companies. The main source of financing for medium-sized companies is therefore self-financing.

The aim of this paper was to determine to determine the impact of structure of debt funding sources on liquidity of medium-sized companies in the Czech Republic from 2006 to 2015. With the purpose to fulfill the aim, we determined the impact of structure of debt funding sources including variables such as debt equity ratio, supplier loan, long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities on liquidity of medium-sized companies in the Czech Republic.

Correlation analysis and subsequently generalized method of moments were used to determine the impact of the structure of debt funding sources on the liquidity of medium-sized companies. In the context of the correlation analysis, indicators such as long-term bank loans, short-term bank loans, other long-term liabilities, other short-term liabilities have been found to have an impact on the liquidity of medium-sized companies.

On the other hand, the results of the generalized method of moments have shown the impact of indicators such as long-term bank loans and other short-term liabilities on liquidity of medium-sized companies. All resulting relationships were tested at a statistical significance level of 1, 5 and 10%. The resulting relationships were confirmed using the Sargan/Hansen test (J-statistic), which demonstrates the robustness of the model.

Impact of other variables on liquidity of medium-sized companies in the Czech Republic was not statistical significant, thus we are not able to confirm the impact of other variables on liquidity of medium-sized companies in the Czech Republic.

Acknowledgements This paper ensued thanks to the support of the grant SGS/7/2018 "Analysis of the influence of selected aspects on the financial structure of companies in the conditions of Central and Eastern European countries".

References

Anderson, R. W. (2002). Capital structure, firm liquidity and growth. Working papers-research series. National Bank of Belgium [online]. Available at: www.nbb.be/doc/ts/publications/wp/WP27en.pdf. Accessed 1 Jan 2017.

Cohen, J., & Cohen, P. (2014). *Applied multiple regression/correlation analysis for the behavioral sciences*. 2nd. Psychology Press. ISBN 0-89859-268-2.

De Jong, A., Kabir, R., & Nguyen T. T. (2008). Capital structure around the world: The roles of firm and country-specific determinants. *Journal of Banking and Finance*, *32*, 1954–1969.

Haas, R., & Lelyveld, I. (2010). Internal capital markets and lending by multinational bank subsidiaries. *Journal of Financial Intermediation, 19*, 1–25, [online], [vid. 2017-03-01]. Available at: www.sciencedirect.com/science/article/B6WJD-4VJ07JK1/2/49949562160fbe5ed0a1dae3c3f1ee93.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica, 50*(4), 1029–1054. ISSN 1468-0262.

Lipson, M. L., & Mortal, S. (2009). Liquidity and capital structure. *Journal of Financial Markets, 12*(4), 611–644. ISSN 1386-4181.

Miloş, M. C. (2015). Capital structure determinants. Evidence from the Romanian listed companies. *Analele Universitatii 'Eftimie Murgu' Resita. Fascicola II. Studii Economice*, 129–134. ISSN: 2344-6315.

Myers, S. C. (2001). Capital structure. *The Journal of Economic Perspectives, 15*(2), 81–102.

Růčková, P. (2015). Impact of liquidity and profitability on use of debt finance sources of companies in manufacturing industry in V4 countries. *Acta Academica Karviniensia*. *15*(3), 69–79. ISSN 1212-415X.

Saleem, Q., & Rehman, R. U. (2011). Impacts of liquidity ratios on profitability. *Interdisciplinary Journal of Research in Business*, *1*(7), 95–98. ISSN 2249-4588.

Schleifer, A., & Vishny, W. R. (2001). Stock market driven acquisitions. *Journal of Financial Economics* [online]. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=278563. Accessed 28 Feb 2017.

Stulz, R. (1990). Managerial discretion and optimal financing policies. *Journal of financial Economics*, *26*(1), 3–27. ISSN 0304-405X.

Šarlija, N., & Harc, M. (2012). The impact of liquidity on the capital structure: A case study of Croatian firms. *Business Systems Research, 3*(1), 30–36.

Trippner, P. (2013). Analysis of financial liquidity management in the enterprise and its impact on the profitability. *International Conference on Finance & Banking*, 494–501 (8p).

Williamson, O. E. (1988). Corporate finance and corporate governance. *Journal of Finance*, *43*(3), 567–591. ISSN 1540-6261.

Chapter 27
Banking Flows and Credit Risk in Southern European Countries

Mafalda Venâncio de Vasconcelos

Abstract In this paper, we use data from the first trimester of 2004 through the last trimester of 2014 to assess the impact of an increase in the credit risk of southern European banks—namely, in Portugal, Spain, and Italy—on bank transactions between these countries and German banks. Our analysis adds new evidence for the role of bank credit risk as a driver of foreign bank flows. Our main finding is that the bank's credit risk has an important role in explaining German bank flows, although this impact is relatively small, namely that an increase in the bank credit risk in southern European countries, increases the German bank flows to these countries. We also find that a bank's credit risk has become a more significant determinant of German bank flows since the financial crisis.

Keywords Banking flows · Credit risk · Financial crisis

JEL Classification E00 · F21 · F34 · G15 · G21

27.1 Introduction

The increase in financial globalization over the last decades has brought with it new risks and increased the odds of an adverse shock in a large financial system spreading to other countries. This was, in fact, what occurred after the outbreak of the American subprime crisis. The financial crisis led to an increased level of credit risk for banks and caused the collapse of innumerous financial institutions around the world.

Growing mistrust surrounding counterparty credibility, combined with the need to backup liquidity, led international banks (and other financial institutions) to become less willing to issue loans to each other. Consequently, there was a drop in

M. V. de Vasconcelos (✉)
University of Turin, Turin, Italy
e-mail: avenanci@unito.it; amvasconcelos@netcabo.pt

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_27

gross capital flows. Having peaked in the first quarter of 2008, cross-border bank flows (especially intergroup) fell sharply, particularly since Lehman's failure.

Unlike other periods of sharp reversals in capital flows, the recent fall in flows to (and from) banks has affected developed economies. According to the Bank for International Settlements (BIS), for reporting resident banking systems, cross-border claims, and liabilities (adjusted for exchange rate variations) fell by $4.4 trillion and $4.5 trillion respectively—8% of annual world GDP—between March 2008 and the end of 2009.

Since 2008, trends in the earnings of Italian, Spanish, and Portuguese banks have been determined by the cost of risk, which has reflected the materialization of credit risk in the three southern European countries. Here we highlight the importance of German banks in shaping the perception of the risk in banks located in the Southern European countries.

According to the BIS, German banks seem to be particularly exposed to peripheral European countries, and were especially during the period before the financial crisis. For example, and according to the BIS, in 2012, German lenders had the highest exposure in Europe to Spain, at $139.9 billion, of which $45.9 billion alone was bank exposure. Since the German banking sector is, in absolute terms, the largest in the monetary union, the financial relations between German banks and southern European banks are an important field of study that must be explored.

Given the importance of Germany and southern European countries in shaping the future of the European Union and the consequences that developments in these countries can have on the world economy, this paper will analyze the impact of an increase in southern European bank credit risk on German bank flows to those countries. The paper is structured as follows: first, we give a brief overview of previous related works; second, we describe the methodology and data used in this work; third, we present descriptive statistics; fourth, we present our results; fifth, we present the extensions; sixth, we present the robustness checks; and seventh, we present our final conclusions.

27.2 Literature Review

Several authors have analyzed the drivers of international bank flows for different time periods and in both advanced and emergent economies. The sharp contraction of international bank flows—especially in advanced economies—during the recent financial crisis awakened the interest of researchers in what the drivers of international bank flows during this period could be. Our literature review will cover the works of those authors we consider most relevant to our present study.

Calvo et al. (1993) was one of the first studies to analyze global and country-specific factors as determinants of international capital flows. They found that, although domestic factors were important drivers of investment flows to Latin America in the early 1990s, the considerable co-movement between the real exchange rate and foreign reserve flows suggested the influence of external variables. Following this work, several other authors have analyzed the influence of external and domestic factors in explaining international bank flows and reached different conclusions regarding the relative importance of those factors.

Regarding domestic factors, Hernandez and Rudolph (1995) examined total private capital flows (FDI, portfolio, and loans) and found that domestic investment, saving rates, and export growth were important for explaining the flows to 22 developing countries during 1986–1993. Chuhan et al. (1993) also looked at portfolio flows—bond and equity—and found that domestic and external factors were equally important in explaining flows to Latin America, but that domestic factors tended to be much more important in explaining flows to Asia. On the other hand, concerning external factors, Herrmann and Mihaljek (2010) studied the nature of spillover effects in banking flows from advanced to emerging market economies and found that global as well as country specific factors are significant determinants of cross-border bank flows. They found that global risk aversion and expected financial market volatility seem to have been the most important factors contributing to the decrease in cross-border bank flows during the crisis of 2007–2008. The importance of external factors is also demonstrated by Forbes and Warnock (2012), who indicate that global movements in international capital flows are significantly associated with global risk. Cerutti et al. (2014) also analyzed the determinants of global liquidity using cross-border bank flows data. They identify not only the global factors driving cross-border bank flows, but also country-specific factors. Their study confirms the explanatory power of US financial conditions, with flows increasing with bank leverage, growth in domestic credit, and M2, and decreasing with market volatility (VIX) and term premia. Moreover, they found that recipient country characteristics affect not only the level of country-specific flows, but also the cyclical impact of global liquidity, with sensitivities to bank flows decreasing with stronger macroeconomic frameworks and better bank regulation, but less so for flows to non-financial firms.

The importance of global and regional common factors is highlighted by Shirota (2015), who found that the aforementioned factors explain about 40–50% of the volatility in cross-border banking flows to seventy countries. Relatedly, Fratzscher (2011) found that common shocks, such as key crisis events and changes to global liquidity and risk, have exerted a large effect on capital flows during both the recent financial crisis and its recovery. The author found that these effects were quite heterogeneous across countries, with a large part of this heterogeneity being explained by differences in institutional quality, country risk and the strength of macroeconomic fundamentals. The paper also shows that common factors were the main overall drivers of capital flows during the crisis, while country-specific determinants were dominant in accounting for the dynamic of global capital flows in 2009 and 2010, especially for emerging markets.

Other studies have analyzed issues related to global banking networks. For example, Cihák et al. (2011) analyzes the stability of a country's banking system as it becomes more linked to the global banking network. The author finds evidence that, for banking sectors that are not very connected to the global banking network, increases in interconnectedness are associated with a reduced probability of a banking crisis. However, once interconnectedness reaches a certain value, a further increase in interconnectedness can increase the probability of a banking crisis.

Niepmann (2016) find that banks are more likely to operate in countries that have larger markets, less efficient banking systems, and are more open to foreign entry. A related study by Haselmann (2006) concerning issues of foreign bank operations found that foreign banks compete in the same markets as domestic banks. Furthermore, they found that foreign banks tend to follow long-term strategies that contribute to credit markets. This study also showed that foreign banking behavior is independent of macroeconomic conditions that reign in the foreign bank's country of origin. Another related study, Herrero and Martinez (2007), analyzed the cross-country determinants and financial stability implications of the mix of international banks' foreign claims. The authors distinguish between local claims (extended by host country affiliates) and cross-border claims (originating from outside the receiving country), finding that the share of local claims is driven by restrictions on banking sector openness and by business opportunities in the local economy. Moreover, this study shows that the impact of limits on property rights, entry requirements, and start-up and informational costs are less robust and that foreign claim volatility is lower in countries with a larger share of local claims.

The impact of risk aversion, information costs, and entry barriers on international bank flows is also a popular line of inquiry. For example, Milesi-Ferreti and Tille (2011) find that the retrenchment of international capital flows during the financial crisis has been related to creditors' rising risk aversion. On the other hand, Buch (2003) provides evidence of the importance of the impact of information costs and regulatory barriers on a bank's cross-border activities. The role of institutional quality—political risk—in driving foreign bank capital is also approached by Papaioannou (2009), who finds that institutional underdevelopment is a key driving explanatory factor for the lack of foreign financing in the developing and underdeveloped world. The author suggests that poorly-performing institutions, such as weak property right protections, legal inefficiency, and a high risk of expropriation are major impediments to foreign bank capital. Another relevant study, by Heid et al. (2004), analyzes German bank lending during the Asian and Russian crises, finding that German banks mainly reacted to the Asian crisis by reallocating their portfolios among emerging markets.

27.3 Methodology and Data

We begin this section with a description of the dataset used in this work, followed by a discussion of the methodology applied to the analysis of the effect of a bank's credit risk on German bank flows.

27.3.1 Methodology

The econometric work is carried out using a random effects model with clustered standard errors and according to the following specification:

$$\begin{aligned}Y_{i,t} = {} & \beta_0 + \beta_1 X_{1\,i,t-1} + \beta_2 X_{2\,i,t-1} + \beta_3 X_{3\,i,t-1} + \beta_4 X_{4\,i,t-1} + \beta_5 X_{5\,i,t-1} + \beta_6 X_{6\,i,t-1} \\ & + \beta_7 X_{7\,t} + \alpha_i + \alpha_t + e_{i,t}\end{aligned}$$

where $Y_{i,t}$ is the growth rate of foreign claims reported by German banks to Italy, Spain, and Portugal; $X_{1\,i,t-1}$ is the bank credit risk; $X_{2\,i,t-1}$ is the political risk in a country; $X_{3\,i,t-1}$ is the current account balance (as a percentage of GDP); $X_{4i,t-1}$ is the fiscal balance (as a percentage of GDP); $X_{5\,i,t-1}$ is the trade openness (as a percentage of GDP) in a country; $X_{6\,i,t-1}$ is the economic risk rating; and $log\, X_{7\,t}$ is the logarithm of the closing price of the S&P 500 volatility index. Moreover, α_i represents the fixed effects that account for time-invariant country characteristics in country i, and α_t represents time-fixed effects.

We argue that the random effect estimates are typically more efficient, since they use information both "between" and "within" panels. Their consistency, however, crucially relies on individual effects not being correlated with the disturbances. In the aforementioned model, we use the variables that measure the bank's credit risk, political risk rating, current account balance (as a percentage of GDP), fiscal balance (as a percentage of GDP), trade openness (as a percentage of GDP), and economic risk rating for the previous quarter to alleviate endogeneity issues. Controlling for time-fixed effects enables us to capture the influence of aggregate (time-series) trends.

27.3.2 Data

First, in order to analyze international bank flows, we use data taken from the Consolidated Banking Statistics (CBS) of the Bank for International Settlements (BIS) for the period of 2004q4–2014q4. According to BIS requirements, the consolidated data captures the "position of bank's worldwide offices, including the position of [the] bank's foreign subsidiaries and branches but excluding inter-office activity. Central banks and other official authorities collect data from individual consolidated banks headquartered in their jurisdiction, and then provide to the BIS aggregated data from their national banking system" (www.bis.org/statistics/bankstatsguide_repreqcons.pdf).

We use the data on foreign claims from CBS because it is a comprehensive measure of international borrowing that includes both cross-border lending by the head office and local lending by foreign subsidiaries. The designation "foreign claims" includes: cross-border claims originating from banking offices outside the counterparty country; local claims originating from banking offices inside the counterparty country in foreign currency; and local claims originating from banking offices inside the counterparty country in local currency. Furthermore, the counterparty sector includes the official sector (including central banks), banks (excluding central banks), non-bank private sector, non-bank financial institutions, non-financial private sector, non-financial corporations, and households.

Considering that we want to analyze the relationship between lending by German banks to peripheral southern European countries, our dependent variable is the growth rate of foreign claims reported by German banks to Italy, Spain, and Portugal.

Second, in order to analyze the effect of a bank's credit risk, we first use the principal component of senior credit default swaps (maturing in 5 years) of Italian, Spanish, and Portuguese banks. The central idea of using the principal component is that it can be employed to study the commonalities between a set of correlated variables. The central idea of a principal component analysis is to reduce the dimensionality of a set of correlated variables by converting them into a set of linearly uncorrelated variables that are called principal components. The resulting principal components will account for most of the variance in the correlated variables. It will reveal common patterns in the data and identify the main direction in which the data varies. A principal component analysis is often found to be useful as it can reveal relationships between variables that would not appear in an ordinarily analysis. In Figs. 27.1, 27.2 and 27.3 in Appendix, we present the credit default swaps (5 years maturity) of Italian, Spanish and Portuguese banks for the period from 2004 until 2013. In the same picture we plot the corresponding credit default swaps based on the first principal component. Here we can observe the close association between the evolutions of risk for the aforementioned measures that follow the same pattern in each country for the period in analysis.

Third, choosing the set of control variables is problematic because the literature suggests a large number of variables as potential determinants of foreign bank flows. With respect to the control variables in the regression, we chose the most common variables following other researchers:

- Bank credit risk: Captures the probability of a bank defaulting on a loan to measure a bank's credit risk. We use the first principal component of senior credit default swaps (maturing in 5 years of Italian, Spanish and Portuguese banks).
- Political risk rating: Measures the political risk in a country. The greater the value attributed to the political risk rating, the lower the level of political risk is attributed to each country. So, when we mention the word "rating", we are referring to the value attribute to the corresponding variable, when we do not mention this word, it means that we are referring to the level of risk attributed to that variable.
- Current account balance (as a percentage of GDP): An indicator of the economy's health. A positive coefficient in this variable is seen as a measure of the strength of the country's macro fundamentals by lenders, therefore, more financing is likely to be made available to a country with a higher current account balance.

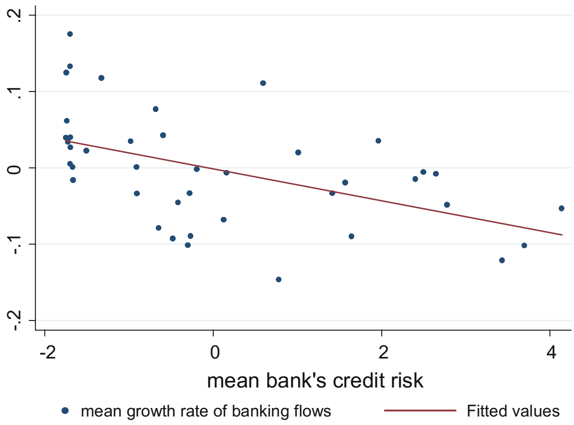
- Fiscal balance (as a percentage of GDP): This variable is used as a measure of the strength of macroeconomic policies since it measures the government revenue net of exposures. For instance, a higher fiscal balance is expected to correlate with a country's lower probability of default.
- Trade Openness (as a percentage of GDP): This measure quantifies trade restrictions. Other works have found that higher barriers to trade increase transaction costs (Asiedu 2002) and therefore they are an impediment to capital flows. We argue that it is possible higher barriers to trade also affect German bank flows.
- Economic risk rating: This variable aims to capture the macroeconomic developments in a given country. The macroeconomic conditions of a country are important determinants for international bank flows since countries not seen as safe investment opportunities (and therefore more likely to suffer a capital flow turnaround) are not attractive to foreign investors. Here, it is important to note that the greater the values attributed to the economic risk rating, the lower the level of economic risk is attributed to each country.
- S&P 500 volatility index: measures the expected short-term uncertainty in global financial markets. We use the natural logarithm of this variable. The expected sign of this coefficient is negative since greater uncertainty in the global environment is expected to lower international bank flows.

In the appendix, we also present the definition of the variables and a detailed description of the source of our data.

27.4 Descriptive Statistics and Other Evidence

In this section, we present the descriptive statistics and the correlation matrix for the variables used in this study. Table 27.1, presents the descriptive statistics and Table 27.2 presents the correlation matrix. In this last table, we present the correlations of the independent variables in the $t - 1$ period (except the logarithm of the S&P 500 volatility index that is presented in the contemporaneous period) and the dependent variable in the t period, due to the fact that, in our model, we analyze the impact of the independent variables in the $t - 1$ period (except the logarithm of the S&P 500 volatility index that is presented in the t period) and the dependent variable in the contemporaneous period.

Analysis of the descriptive statistics shows us that the growth rate of banking flows varies greatly, with a minimum of −0.164 and a maximum of 0.2598. The mean of this variable (−0.00243) indicates that the mean growth rate of foreign claims reported by German banks to Portugal, Spain, and Italy is, on average, negative during the period under analysis. Furthermore, the growth rate of banking flows reported by German banks is negative (−0.0054178) in what it concerns to Italy and Portugal (−0.0062897) while it is positive in what it related to Spain (0.0044206) where German banks are more exposed. Table 27.2 in the appendix presents the variable correlation matrix where, as mentioned, the dependent variable is presented in period t and the independent variables in period $t - 1$, except the logarithm of the S&P 500 volatility index that is presented in the t period. Upon analysis of this matrix, we see that there is, in fact, a strong negative (−0.2879) association between the growth rate of banking flows and bank credit risk. This last value express the intuition behind the fact that German banks rely less in countries that have a higher bank credit risk. In the figure below, we plot the mean growth rate of foreign claims reported by German banks versus the bank's mean credit risk.



Mean growth rate of banking flows versus bank's mean credit risk

Here, we can clearly see the negative relationship between these variables and verify that German banks lessen their exposure to Portugal, Spain, and Italy when the credit risk of banks in those countries increases. The correlation matrix also suggests a notable association between the growth rate of bank flows with political risk rating (0.2436), economic risk rating (0.4284), fiscal balance (as a percentage of GDP) (0.3397), and the log of the S&P 500 volatility index (−0.4213). The association between our dependent variable with current account balance (as a percentage of GDP) (−0.1148) and with trade openness (as a percentage of GDP) (−0.0669) is not as strong but, and as we have already mentioned, we think it is important to include them in our analysis. The strong correlation between the growth rate of banking flows and economic risk rating (0.4284) should also be highlighted. The variable that reports the growth rate of foreign claims includes not only cross-border lending by the head office, but also local loans by foreign subsidiaries. Despite their foreign ownership, local subsidiaries are still more exposed to the host country environment where their loans and deposits are located. This could justify the elevated association between our dependent variable and those variables that measure, in a certain way, a country's risk—e.g. the credit risk of national banks (as previously mentioned, our focus is on the credit risk of Portuguese, Spanish, and Italian banks), political risk rating, and economic risk rating.

27.5 Results

27.5.1 Main Results

In this section, we present the analysis of the estimated results shown in Table 27.3. First, we analyze the impact of bank credit risk on transactions between German banks and the aforementioned peripheral European nations, while at the same time controlling for political and macroeconomic conditions in the host country. Second, we add our variable measuring global uncertainty (that is, the logarithm of the S&P 500 volatility index).

In Model 1 of the same table, we analyze the impact of bank credit risk on the growth rate of German bank flows to the aforementioned three countries, as well as when controlling for political risk rating, current account balance (as a percentage of GDP), fiscal balance (as a percentage GDP), trade openness (as a percentage of GDP), and economic risk rating—and therefore, we first analyze the impact of local factors on the growth rate of banking flows. The estimates obtained suggested that an increase in bank credit risk has a positive effect on German bank transaction volume with southern European countries, when we control for the previously mentioned variables. The magnitude of the bank credit risk coefficient (0.00659) is relatively small, although it is statistically significant at the 5% level. This positive coefficient suggests that German banks are more likely to operate in countries with less banking efficiency, as is the case with the three countries that make up our sample and that have a demonstrated weakness, especially after the financial crisis of 2008. This is in line with Niepmann (2016), who found that foreign banks are more likely to operate in countries with lower banking efficiency. Considering that a bank's credit risk is associated with its efficiency—that is, for a bank to be considered higher risk, in principle it must be less efficient in its operations, making it more sensitive to the surrounding climate—it is probable that, with an increase in bank credit risk, German banks will be more likely to operate in these countries with less efficient banking systems. The results estimated in Model 1 suggest that a 10 point increase in bank credit risk in southern European countries increases the growth rate of German bank transactions by almost 0.066 points.

Moreover, empirical evidence suggests that higher political risk in the host country is likely to increase German banking in those politically riskier countries. An example of this evidence could be a change in regulations (that results in higher political risk in the country) that would prejudice local banks but benefit foreign subsidiaries operating in the local market. The impact of political risk on the growth rate of foreign assets is, however, relatively small. Nevertheless, we should be somewhat careful in our interpretation of the relationship between the two aforementioned variables, considering that the coefficient for political risk rating (-0.00149) is relatively small in magnitude and statistically significant at the 10% level.

Analysis of the estimated results also suggests other interesting findings. Trade openness seems to have a positive, strong and statistically significant (at the 1% level) effect on German bank flows and when we control for bank credit risk, political risk rating, current account balance (as a percentage of GDP), fiscal balance (as a percentage of GDP), and economic risk rating. The coefficient for this variable is in fact the greatest in magnitude appearing on the regression. This coefficient (0.275) suggests an increase in trade openness by 10 point, changes the growth rate of German bank flows by 2.75 points.

In fact, lower trade barriers decrease transaction costs, making international transactions more likely to occur. Furthermore, countries that are better able to meet their financing needs and ensure good management of public finances are attractive locations for German foreign investors. According to model estimates, fiscal balance (as a percentage of GDP) has a close and significant association (at a 1% level) with German bank flows—a 10 point increase in the fiscal balance (as a percentage of GDP) increases the growth rate of German bank flows by 1.97 points. In fact, countries that implement stronger and more successful macroeconomic policies and whose governments are able to sustain their fiscal accounts are more likely to see their economies grow; therefore, there is a greater probability that foreign banks will be operating in these locations (Niepmann 2016). According to model estimates, macroeconomic developments are closely related to German bank flows. The coefficient for economic risk rating is relatively small but statistically significant at the 1% level and predicts that an increase of 10 points in the economic risk rating (which means better macroeconomic considerations and developments in a country) increases the growth rate of German bank flows by 0.118 points.

Finally, our estimated results suggest that current account balance (as a percentage of GDP) is of secondary importance for explaining German bank transactions with southern European countries, considering that the coefficient for this variable is not statistically significant at any level.

Model 2 presents the results obtained when we add in global factors that may influence the decision of German banks to invest or not in southern European countries to the previous model. In fact, when we account for the impact of the global environment on the willingness of German investors to invest in southern European countries, the results do not seem to change with respect to the previous model. Moreover, the coefficient for the logarithm of the S&P 500 volatility index is not statistically significant, suggesting that this variable is not important for explaining the volume of transactions between German banks and southern European countries.

To summarize, our estimates suggest that a higher bank credit risk increases the growth rate of German bank flows to southern European countries. However, the impact is relatively small when conditioned by the domestic and global factors considered in this study.

Table 27.2 Correlation matrix

Variables	Growth rate of banking flows	Lag bank credit risk	Lag political risk rating	Lag economic risk	Lag current account balance (% GDP)	Lag fiscal balance (% GDP)	Log S&P 500 volatility index	Lag trade openness (% GDP)
Growth rate of banking flows	1							
Lag bank credit risk	−0.2879	1						
Lag political risk rating	0.2436	−0.7456	1					
Lag economic risk rating	0.4284	−0.5617	0.4556	1				
Lag current account balance (% GDP)	−0.1148	0.4222	−0.7242	−0.1748	1			
Lag fiscal balance (% GDP)	0.3397	−0.4012	0.3743	0.6911	−0.0966	1		
Log S&P 500 volatility index	−0.4213	0.0742	0.0556	−0.1469	−0.1957	−0.1623	1	
Lag trade openness (%GDP)	−0.0669	0.2625	−0.0498	−0.4178	−0.286	−0.1798	−0.0072	1

27.6 Extensions

An analysis of the impact of bank credit risk before and after the financial crisis.

The devastating financial crisis that rocked the world in the middle of 2007 was preceded by a sharp decline in international bank flows after years of growing financial globalization. We suggest that this event may have shaped the importance of bank credit risk in driving German bank flows. Therefore, and as an extension to our present study, in this section we will divide our analysis into two parts—before and after the financial crisis—comparing the impact of bank credit risk on the volume of foreign claims reported by German banks to Portugal, Spain, and Italy during both of those periods.

In Models 3 and 4 we present the estimation results before (2004q4–2007q4) and after (2008q1–2014q4) the financial crisis, respectively. Although the number of observations is relatively small when we restrict our sample to before and after the financial crisis—48 observations in the period before and 60 observations in the period after—the coefficients are more precisely estimated if we want to analyze how the financial crisis shaped the perception of bank credit risk by German bank investors.

The results suggest that the bank credit risk is of secondary importance for explaining German bank flows before the financial crisis. The results also suggest that trade openness (as a percentage of GDP), economic risk rating, and the logarithm of the S&P 500 volatility index seem to be important in the model. In fact, the trade openness (as a percentage of GDP) coefficient (0.490) is positive and statistically significant at the 10% level, indicating that greater trade openness (i.e. lower barriers to entry) has a positive impact on German bank flows. On the other hand, the economic risk rating coefficient (0.0181) is statistically significant at the 1% level and indicates that a lower economic risk has a positive impact on German bank flows and therefore German banks perceive macroeconomic condition as an important issue when they decide whether or not to invest in a country. The variable that measures global uncertainty also appears to be important for German bank investors' decisions with a coefficient that is negative and statistically significant at the 1% level, indicating that the higher the expected short-term uncertainty in global financial markets, the lower the growth rate of German bank flows.

The coefficient of this variable suggests that a 100% increase in global financial market uncertainty decreases the growth rate of German bank flows to southern European countries by 0.358.

Empirical evidence suggests that, since the financial crisis, bank credit risk has become an important driver of German bank flows. The coefficient of this variable was not statistically significant before this event, but since the financial crisis, it has become positive and statistically significant at the 1% level, although the impact is relatively low. It is estimated that, after the crisis, a 10 point increase in a bank's credit risk increases the growth rate of German bank flows by 0.0725 points. Although it seems to be a small impact, the financial crisis had an impact on banks' credit risk, and that impact was perceived by German banks. Furthermore, the results suggest that political risk became a significant determinant of German bank flows since the global crisis. The coefficient of this variable was not statistically significant before the crisis, but it became positive and statistically significant at the 1% level after the financial crisis. The estimates suggest that an increase of 10 points in political risk (which mean lower political risk in a country) increases the growth rate of German bank flows by 0.0266 points—although this result is significant, it has a very small absolute value.

We found that, since the financial crisis, current account balance (as a percentage of GDP) became an important driver of German bank flows. Our estimates suggest that a 10 point increase in current account balance (as a percentage of GDP) increases the growth of German bank flows by 3.41 points. Current account balance is seen by German banks as a measure of the strength of a country's macro fundamentals; therefore, a higher current account balance (as a percentage of GDP) is associated with higher stability, increasing the likelihood of more financing being made available. Interestingly, our results suggest that higher fiscal balance (as a percentage of GDP) is associated with lower growth rate of German bank flows, with a coefficient (−2.20) that is negative and statistically significant at the 1% level. This result suggests that, since the financial crisis, German banks are not willing to invest in countries that have a lower probability of default. According to our model estimates, trade openness became a more important driver of German bank flows only after the financial crisis. Our estimates suggest that a 10 point increase in trade openness (that is, lower barriers to entry) predicts an increase of 11.81 points in the growth rate of German bank flows. Moreover, empirical evidence suggests that a decrease in economic risk is associated with a higher growth rate German bank flows, although the impact is relatively small. The coefficient of this variable suggests that a 10 point increase in economic risk rating increases the growth rate of German bank flows by 0.0870 points. Furthermore, the evidence suggests that uncertainty in global financial markets is an important driver of German bank flows. The coefficient (−0.244) is negative and statistically significant at the 1% level. Our estimates suggest that a 100% increase in the S&P 500 volatility index would change German bank flows by −0.244, thus confirming the importance of global uncertainty in shaping the decisions of foreign investors, since the financial crisis.

27.7 Robustness Checks

As a robustness check, we created a model with country and time fixed effects. The goal of using this model as a robustness check is that it allows us to eliminate the effects of unobservable variables that do not change over time (such as social norms, culture, and religion) and that may be correlated with our explanatory variables. Controlling for time fixed effects enables us to capture the influence of aggregate (time series) trends. Thus, in Table 27.4, we present the results of the model using the variables in the $t - 1$ period (except the logarithm of the S&P 500 volatility index that is presented in the contemporaneous period) and under different specifications. First, we added the variable that reflects bank credit risk. Second, we

Fig. 27.1 Bank credit default swaps—Italy

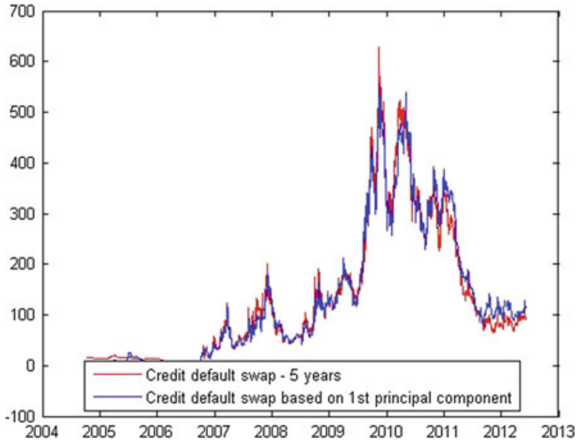
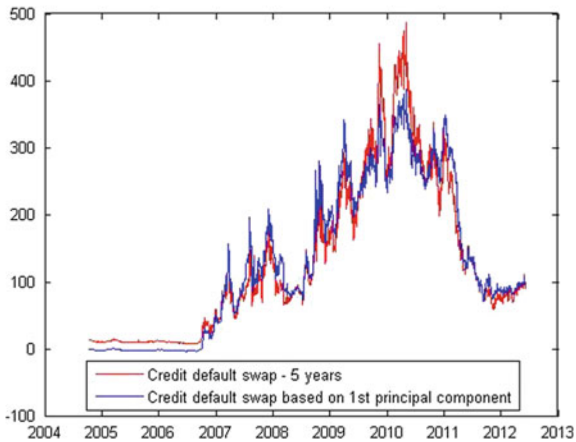


Fig. 27.2 Bank credit default swaps—Spain



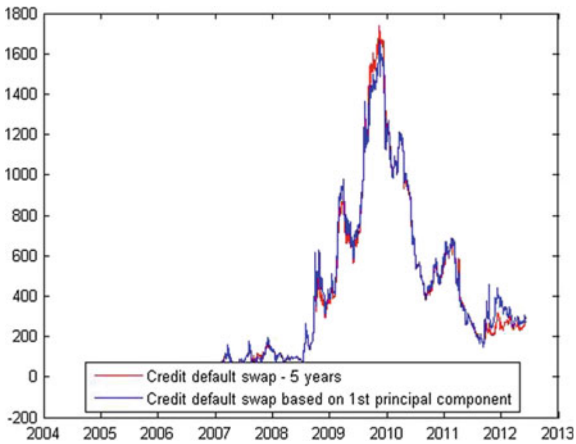


Fig. 27.3 Bank credit default swaps—Portugal

Table 27.1 Descriptive statistics

Variables	N	Mean	Std. dev.	Min.	Max.
Growth rate of banking flows	123	−0.00243	0.081	−0.164	0.2598
Bank credit risk	123	0.06328	1.83	−2.123	5.678
Political risk rating	111	76.8513	4.853	67.5	84.5
Economic risk rating	111	35.0901	3.049	28.5	40
Current account balance (% GDP)	116	−0.04831	0.04178	−0.1304	0.0221
Fiscal balance (% GDP)	123	−0.04921	0.038	−0.16	0.0425
Log S&P 500 volatility index	123	2.906	0.3789	2.433	3.787
Trade openness (% GDP)	114	0.6225	0.0828	0.467	0.811

Notes N is the number of observations. All the variables relate to period *t*

added the variables that reflect the macroeconomic and political conditions of a country (political risk rating, current account balance (as a percentage of GDP), fiscal balance (as a percentage of GDP), trade openness (as a percentage of GDP), and economic risk rating). Third and finally, we added the variable that measures global uncertainty (log of the S&P 500 volatility index).

The results estimated in Models 1 through 4 of the aforementioned table suggest that, when we control for country and time fixed effects, bank credit risk seems to be of secondary importance for explaining the growth rate of German bank flows. However, the results suggest that our model fits well for the period after the financial crisis. The bank credit risk coefficient (0.00958) is positive and statistically significant at the 5% level and confirms our results. In fact, the increased credit risk of Portuguese, Italian, and Spanish banks seems to positively impact foreign claims reported by German banks to Portugal, Italy, and Spain, as well as being a relevant factor when considering the investment decisions of German banks regarding southern Europe.

27.8 Conclusions

In this paper, we analyzed the effect of an increase in the credit risk of southern European banks on the growth rate of German bank flows to those countries during the last quarter of 2004 through the last quarter of 2014.

Our main finding is that an increase in the bank credit risk has a positive impact on German bank flows to these countries. However, this impact is relatively small, and trade openness (as a percentage of GDP) and fiscal balance (as a percentage of GDP) are more important drivers of German bank flows.

Before the financial crisis, bank credit risk was of secondary importance in explaining German bank flows. We find that bank credit risk became an important driver of German bank flows since this event, although its impact is still relatively small. We find that higher trade openness (i.e., lower barriers to entry) is an important driver increasing German bank flows since the financial crisis. Lower political risk, higher current account balance (as a percentage of GDP), lower economic risk, and uncertainty in global financial markets are expected to—albeit not greatly—increase German bank flows after the financial crisis. On the other hand, higher fiscal balance (as a percentage of GDP)—decreases German bank flows after the financial crisis.

Appendix

See Figs. 27.1, 27.2, 27.3 and Tables 27.1, 27.2, 27.3, 27.4.

Definitions and Source of Data

a. *Definition of banking flow data*

- **Growth rate of banking flows**: This variable measures the growth rate of foreign claims reported by German banks to Portugal, Spain, and Italy. The data was retrieved from the Bank for International Settlements—Consolidated Banking Statistics (immediate borrower basis). Foreign claims are financial claims on residents of countries other than the reporting country, i.e., claims on non-residents of the reporting country. In consolidated banking statistics, foreign claims are calculated as the sum of cross-border claims and local claims (in all currencies) of the reporting bank's foreign affiliates or, equivalently, of international claims and local claims denominated in local currencies. Furthermore, we use the data available on an "immediate borrower basis," given their suitability for the analysis. This source of data measures borrowing by all residents, regardless of ownership. Therefore, use of the immediate borrower basis is warranted

Table 27.3 Regression results

Variables	Model 1	Model 2	Model 3	Model 4
Lag bank credit risk	0.00659**	0.00659**	0.00151	0.00725***
	(0.00332)	(0.00332)	(0.0202)	(0.00242)
Lag political risk rating	−0.00149*	−0.00149*	4.62e−05	0.00266***
	(0.000789)	(0.000789)	(0.00161)	(0.000369)
Lag current account balance (% GDP)	0.0371	0.0371	0.235	0.341**
	(0.151)	(0.151)	(0.525)	(0.145)
Lag fiscal balance (% GDP)	0.197***	0.197***	0.329	−0.220***
	(0.0343)	(0.0343)	(0.484)	(0.0509)
Lag trade openness (% GDP)	0.275***	0.275***	0.490*	1.181**
	(0.0842)	(0.0842)	(0.254)	(0.0849)
Lag economic risk rating	0.0118***	0.0118***	0.0181***	0.00870***
	(0.00285)	(0.00285)	(0.00419)	(0.00302)
Log S&P 500 volatility index		1.241	−0.358***	−0.244***
		(2.288)	(0.0919)	(0.0537)
Constant	−0.464**	−3.740	0	0
	(0.196)	(5.948)	(0)	(0)
Observations	108	108	48	60
R-squared	0.8159	0.8159	0.7313	0.8643
Number of countries	3	3	3	3
Country RE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Financial crisis			BEFORE	AFTER

Notes The dependent variable is the growth rate of foreign claims reported by German banks to Italy, Spain, and Portugal in period *t*. Robust standard errors in parentheses (***$p < 0.01$, **$p < 0.05$, *$p < 0.1$)

because, despite their foreign ownership, local subsidiaries are still more exposed to the host country environment where their loans and deposits are located. Furthermore, their access to credit would be largely driven by the host country risk characteristics, thus, by taking this approach, one can better control for country-specific macro conditions.

b. *Definition of data on bank credit risk*

- **Bank credit risk**: This variable measures the credit risk of Portuguese, Spanish, and Italian banks. We used the first principal component of senior credit default swaps (maturing in 5 years/senior debt) of ten banks in Italy, Spain, and Portugal. The data was obtained from Bloomberg and covers the following banks:
- *Italy*: Intesa SanPaolo; Unicredit S.p.A.; Mediobanca; Banco Popolare Società Cooperativa; Banca Monte dei Paschi di Siena.

Table 27.4 Robustness Checks—Regression results with country- and time-fixed effects (using all independent variables in the *t-1* period—except the log of the S&P 500 volatility index—in period *t*)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Lag bank credit risk	0.00106	0.00963	0.00963	−0.0259	0.00958**
	(0.00683)	(0.00424)	(0.00424)	(0.142)	(0.00172)
Lag political risk rating		0.00327	0.00327	−0.00434	0.00656
		(0.00243)	(0.00243)	(0.0202)	(0.00340)
Lag current account balance (% GDP)		0.102	0.102	0.427	0.149
		(0.259)	(0.259)	(2.312)	(0.171)
Lag fiscal balance (% GDP)		0.0550	0.0550	0.427	−0.133
		(0.0238)	(0.0238)	(0.403)	(0.0554)
Lag trade openness (% GDP)		0.789	0.789	−0.0776	0.833**
		(0.284)	(0.284)	(2.367)	(0.176)
Lag economic risk rating		0.00956**	0.00956**	0.0195*	0.00732*
		(0.00185)	(0.00185)	(0.00623)	(0.00230)
Log S&P 500 volatility index			−0.0751	0.000636	−0.0283
			(0.0474)	(0.479)	(0.0247)
Constant	0.00696	−1.050	−0.852	−0.361	−1.240*
	(0.0588)	(0.426)	(0.511)	(1.557)	(0.352)
Observations	120	108	108	48	60
R-squared	0.780	0.823	0.823	0.733	0.876
Number of countries	3	3	3	3	3
Country FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Financial crisis				BEFORE	AFTER

Notes The dependent variable is the growth rate of foreign claims reported by German banks to Italy, Spain, and Portugal in period *t*. Robust standard errors in parentheses (***$p < 0.01$, **$p < 0.05$, *$p < 0.1$)

- *Spain*: Banco Santander, S.A.; Banco Bilbao Vizcaya Argentaria; Banco Popular Español.
- *Portugal*: Banco Comercial Português; Novo Banco, S.A.

c. *Definition of control variables*

(c1) *Political risk and risk characteristics data*

The risk variables used in this analysis were taken from the International Country Risk Guide database. This database comprises 22 variables in three subcategories of risk: political, economic and financial. It has been produced by Political Risk Services (PRS) on a monthly basis since 1983. The ICRG staff compiles political, economic, and financial information which is then converted into risk points for each individual risk component on the basis of a consistent pattern of evaluation. The political risk assessments are based on subjective analysis of the available information, while the economic and financial risk assessments are based solely on objective data. After a risk assessment (rating) has been assigned to each of the 22 risk components, the components within each category of risk are added together to provide a risk rating for each risk category (political, economic or financial). The following interpretations of risk categories are based on the definitions provided by the ICRG.

Political risk rating: Political risk is ranked on a scale *ranging from 0, denoting minimum level of institutional quality, to 100, indicating a total absence of political risk. The PRS suggests that "...the aim of the political risk rating is to provide a means of assessing the political stability of the countries covered by ICRG on a comparable basis."* The political risk rating includes 12 variables that cover both political and social attributes. The sequence component points (maximum) are presented in parentheses (1): Government Stability (includes government unity, legislative strength, and popular support) (12 points). (2): Socioeconomic Conditions (includes unemployment, consumer confidence, and poverty) (12 points). (3): Investment Profile, (includes assessment in contract viability/expropriation, profits repatriation, and payment delays) (12 points). (4): Internal Conflict (includes civil war, terrorism/political violence, and civil disorder) (12 points). (5): External Conflict (includes war, cross-border conflict, and foreign pressures) (12 points). (6): Corruption (6 points). (7): Military in Politics (6 points). (8): Religion in politics (6 points). (9): Law and Order (6 points). (10): Ethnic Tensions (6 points). (11): Democratic Accountability (6 points). (12): Bureaucracy Quality (4 points).

Economic risk rating: Economic risk is ranked on a scale *ranging from 0, denoting the highest possible risk level, to 50, indicating an elimination of economic risk. Its purpose is "... to provide a means of assessing a country's current economic strengths and weaknesses."* (PRS). The Economic Risk Rating includes 5 weighted variables that cover macroeconomic developments, according to: (1): GDP per Head of Population. (2): Real Annual GDP Growth. (3): Annual Inflation Rate. (4): Budget Balance as a Percentage of GDP. (5): Current Account Balance as a Percentage of GDP.

(c2) *Other controls*

Current account balance (as a percentage of GDP): This variable measures the ability of a country to finance its needs. The current account provides information about the transactions of a country with the rest of the world. It covers all transactions (other than financial) of goods, services, primary income, and secondary income that occur between resident and non-resident units. In our work we use the current account as a share of gross domestic product. Data source: OECD.

Fiscal balance (as a percentage of GDP): The fiscal balance measures the strength of the macroeconomic foundations of a country. General government net lending/borrowing (% of GDP): net lending (+)/borrowing (−) is calculated as revenue minus total expenditure. It measures the extent to which the government is making its financial resources available to other sectors of the economy and not residents (net lending) or if it is using its financial resources generated by other sectors of the economy and not residents (net borrowing).

The variable used in our work measures the fiscal balance as a share of gross domestic product. This data was seasonally adjusted with ARIMA 13. Data source: Eurostat.

Trade Openness (as a percentage of GDP): This variable measures the trade openness of a country. It is the sum of the exports and imports of goods and services measured as a share of gross domestic product. Data source: Eurostat.

S&P 500 volatility index: This variable measures global uncertainty. We used the closing price of the S&P 500 volatility index of the Chicago Board Options Exchange. Furthermore, we use the natural logarithm of this variable.

References

Asiedu, E. (2002). On the determinants of foreign direct investment to developing countries: Is Africa different? *World Development, 30*(1), 107–119.

Bank for International Settlements Monetary and Economic Department. (1983). The International interbank market: A descriptive study. In *Bank for International Settlements*. BIS Paper No. 8.

Bank for International Settlements, Monetary and Economic Department. (2009). Guide to International financial statistics. In *Bank for International Settlements*. BIS Paper No. 14, July 2009.

Buch, C. M. (2003). Information or regulation: what is driving the international activities of commercial banks? *Journal of Money, Credit and Banking, 36*(6–1), 851–870.

Calvo, G., Leiderman, L., & Reinhart, C. (1993). Capital inflows and real exchange rate appreciation in Latin America: The role of external factors. *IMF Staff Papers, 40*(1), 108–151.

Cerutti, E., Claessens, S., & Ratnovski, L. (2014). *Global liquidity and drivers of cross-border bank flows*. IMF Working Paper No. 14/69, 2014.

Chuhan, P., Claessens S., & Mamingi, N. (1993). *Equity and bond flows to Asia and Latin America. The role of global and country factors*. The World Bank Working Paper No. 1160, July 1993.

Cihák, M., Muñoz, S., & Scuzzarella, R. (2011). *The bright and the dark side of cross-border banking linkages*. IMF Working Paper No. 11/86.

Forbes, K. J., & Warnock, F. E. (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal International Economics, 88,* 235–251.

Fratzscher, M. (2011). *Capital flows, push versus pull factors and the global financial crisis*. Working Paper No. 17357. European Central Bank.

Haselmann, R. (2006). Strategies of foreign banks in transition economies. *Emerging Markets Review, 7,* 283–299.

Heid, F., Nestmann, T., Weder di Mauro, B., & von Westernhagen, N. (2004). *German bank lending during emerging market crisis: A bank level analysis*. Deutsche Bundesbank, Discussion Paper No. 4.

Hernandez, L., & Rudolph, H. (1995). *Sustainability of private capital flows to developing countries. Is general reversal likely? Policy research and external affairs*. Working Paper No. 158. The World Bank.

Herrero, A., & Martinez, M. (2007). The mix of International banks' foreign claims: Determinants and implications. *Journal of Banking & Finance, 31*(6), 1613–1631.

Herrmann, S., & Mihaljek, D. (2010). *The determinants of cross-border banking flows to emerging markets: New empirical evidence on the spread of financial crises*. Bank for International Settlements Working Papers No 315.

Milesi-Ferretti, G.-M., & Tille, C. (2011). *The great retrenchment: International capital flows during the global financial crisis*. Hong Kong Institute for Monetary Research, Working Paper No. 38, December 2011.

Niepmann, F. (2016). *Banking across borders with heterogeneous banks*. International Finance Discussion Paper No. 1177.

Papaioannou, E. (2009). What drives international financial flows? Politics, institutions and other determinants. *Journal of Development Economics, 88*(2), 269–281. March 2009.

Shirota, T. (2015). What are the major determinants of cross-border banking flows? *Journal of International Money and Finance, 53,* 137–147.

Chapter 28
Special Agricultural Safeguards in the International Trade of Meat Analysis and Impacts on the Brazilian Economy

Cinthia Cabral da Costa, Heloisa Lee Burnquist and Joaquim J. M. Guilhoto

Abstract This study identified the impact of special agricultural safeguards (SSG) for the global market of meat and for the Brazilian economy. The tariff lines (TLs) subject to SSG were selected and the period of analysis was 1995 (when the rules about the SSGs were established) to 2015 (more recent period for which there are notifications). The value of additional tariff was calculated for each of the most important TLs in Brazilian export value and together with the price elasticities for imports, was used to estimate the impacts on imports. Finally, the effect of an increase in Brazilian exports of meat without SSG taxes was calculated as well as its impact in the country's economy by using an input-output matrix for Brazil. The most important markets that applied SSGs to Brazilian exports were the US for beef and European Union for poultry. However, the additional tariffs could be estimated in only two of the sixteen years that the US applied SSGs on beef imports, suggesting that its use has been enforced when the average annual price has been lower than the trigger price level. Therefore, with the additional tariffs that could be estimated, the results indicated that the impact of the value of the meat that could not be exported to both markets EU and US, due to SSGs was equivalent to BRL 3.7 billion of the economy's production value (at 2015 prices) and almost BRL 2 billion of the Brazilian GDP.

The content of this publication expresses the views of this author and does not necessarily represent the views of the OECD or its member countries.

C. C. da Costa (✉)
Embrapa Instrumentation, São Carlos, Brazil
e-mail: cinthia.cabral.da.costa@gmail.com

H. L. Burnquist
ESALQ/USP, Piracicaba, Brazil
e-mail: hlburnqu@usp.br

J. J. M. Guilhoto
Organisation for Economic Co-operation and Development (OECD), Paris, France
e-mail: guilhoto@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_28

Keywords Beef · Poultry meat · SSG tariff · Input-output matrix
Brazil

28.1 Introduction

The Uruguay Round Agreement on Agriculture (URAA), concluded in 1995, is an important benchmark in international trade. In the case of agricultural trade, which presents a protectionism level much higher than for other products defined as "non-agricultural", one of the most significant results of the URAA was eliminating quantitative barriers, the so-called import "quotas", which were the most protectionist mechanisms used by developed countries against agricultural imports. In its place emerged the tariff quotas (defined by the TRQ acronym, from the English name "*tariff rate quota*"), where the same product has two different tariffs: one that is lower, applicable up to a certain level of imports (in-quota) and another higher tariff, applicable when the imported volume exceeds the quota limit (extra-quota). However, very high extra-quota tariffs may also be prohibitive for trade and, hence, work in the same manner of the quantitative quotas that existed before 1995. In addition, another mechanism was implemented along with the tariff quotas, which did not previously exist and was intended to be transient, the so-called special safeguards, known by the SSG acronym (from the English name "special safeguards").

The SSG consists in an additional tariff applied to the extra-quota tariff, which works in the same way of the extra-quota tariff. However, unlike the extra-quota tariff, the additional SSG tariff is not a fixed value or percentage, but rather depends on certain conditions. There are two conditions in which it may occur: (i) when the import price is lower than a certain value (price trigger) or (ii) when the import volume is larger than a certain quantity (volume trigger).

In the case of the price-based SSG, the additional tariff becomes higher as the difference between the import price and the trigger price becomes higher. The countries that impose the additional SSG tariff should notify its use, indicating the product and year used for the calculation, but they don't report the value of the additional tariff. However, with the calculation formula presented in the Agriculture Agreement and an average import price of the product, it is possible to estimate that value.

As for the volume-based SSG, there is even less information about the additional tariff value attributed to the products. Similarly, the countries only notify what was applied, showing that the volume imported in the year exceeded the trigger limits described in the Agriculture Agreement, but don't describe the additional value applied. The only information in this case refers to the max limit of the additional tariff, which should be 33% of the applied tariff's value (Harris 2008).

During the Doha Development round between 2002 and 2006, the SSG mechanism did not receive any formal proposal for elimination or change. On the contrary, instead of eliminating or reforming this mechanism, what was proposed in that occasion and resumed in the discussions in the WTO Ministerial Meeting in Nairobi, in 2015, was a similar mechanism, which would be adopted by the developing countries, called SSM (acronym for the English name "Special Safeguard Mechanisms"). Some studies about the SSG action carried out in a way to subsidize analysis for building the SSM are: Pal and Wadhwa (2006), Aznal (2007), Harris (2008), Finger (2009), Wolf (2009) and Hertel et al. (2010).

Among the studies developed with this purpose, only Harris (2008) made an in-depth analysis of the SSG. This author showed that the SSG, which should have been applied only during the implementation period of the Uruguay Round reforms, continued in use as a permanent mechanism. By analyzing the notifications of SSG in the period of 1995 to 2002 or 2007, depending on the existence of the notifications, this author verified that the most affected products were meat, dairy and sugar. The countries with highest use of such instrument for these products were the European Union (EU) and the United States (US), and they used the price-based mechanism (price SSG). Japan also presents a high application of the latter, but to a larger set of products and making use mainly of volume-based SSG. Harris (2008) also includes in his study some criticism to the values indicated for the triggers, in particular related to the reference price. These triggers were fixed by the average values observed in the period 1986–88 and never updated. At that period the level of agriculture prices was relatively high. He adds that it would be of no use to cut the extra quota tariffs if this mechanism was not reviewed, since the additional SSG tariff could become more prominent and restrict trade in the same fashion.

The main difference that distinguishes the special agriculture safeguards (SSG and the SSM proposal) of the general safeguards is the fact that the former is automatic, while imposing the latter depends on proof of the damage. As they are automatic and, therefore, exempt from any damage-proving criterion, the agriculture safeguards produce the following distortions in the international market: (i) intensifying the international price downfall process, since they change the demand for imports, especially if many countries apply, at the same time, safeguards to a same product or if applied by a major importer; (ii) directly harming consumers of importing countries that apply the safeguard and maintain domestic prices at higher levels than global prices; (iii) transferring the excess supply resulting from the imposition of the safeguards to the countries that do not impose such mechanism, thus reducing the product price and negatively affecting local producers. This last factor directly affects Brazil as an agricultural producer.

Specifically with regard to the SSM proposal, indicated for developing countries, there is also a risk of increasing the protection level. In the Uruguay Round, only the products that were subject to tariffication can entitled to the SSGs. In the case of the SSM, proposals presented during the Doha Round negotiations suggest a large flexibility in product selection. If no eligibility criterion is defined, the PEDs will tend to ensure the right of use on all products. The PDs in turn will seek to maintain the right of use of the SSGs in parallel to the imposition of SSMs by part of the PEDs.

A specific analysis of the SSG impact was carried out by Costa et al. (2015). These authors estimated that the impact of their use in the period from 1995 to 2013 over sugar exports in the US and EU was equivalent to a reduction in Brazilian sugar exports in 8 million tons of sugar (approximately 7 million that was not imported by the EU and 1 million to the US) The authors also estimated that, if these exports had occurred, Brazil could have gained, in that period, approximately BRL 42 billion in production value for the entire economy, considering the direct, indirect and income effect impacts. As alerted by Harris (2008), the price triggers for sugar (average values observed in the period 1986–88) presented very high price levels, causing a practically constant application of the mechanism.

This study has the objective of a similar analysis to that made by Costa et al. (2015) but adjusted to another important group of agriculture products: meats. The next section (Sect. 28.2) shows the behavior of international meat trade and the importance of Brazil in this market. Section 28.3 describes the methods and data used with the objective of identifying the impact of the additional SSG tariff and, in Sect. 28.4, the empirical estimates of its usage impacts in the meat markets were analyzed. Finally, Sect. 28.5 concludes the analyses and results presented.

28.2 The International Trade of Meat

According to OECD-FAO data (2015) on all global meat consumption, the participation of beef, pork and poultry represent 22, 38 and 35%, respectively. In that same report, there is a growth prediction of 12% in the consumption of beef and pork and 24% in poultry consumption. Regarding trade, according to FAO data (2018b), the global meat trade value registered in recent years (2010–13), represents 5% of the global agriculture imports. Of this total, 40% is of beef, 32% of poultry, and 26% of pork. This section has the objective of identifying the top players in this market, in a way to stress the significance of this study's topic for the Brazilian economy, as well as identifying the importance of the countries that use special safeguard for meat products.

Figure 28.1 shows the major frozen beef exporters and importers for the most recent years. Figures 28.2 and 28.3 show this same profile, but for poultry and pork, respectively. As may be observed in these figures, Brazil stands out as the largest global exporter of beef and poultry, and one of the top in pork. It is verified in Fig. 28.1b that the US, China,[1] Russia and Japan are the top beef importers. Due to geographic proximity, the North-American market should be the most important for Brazil. However, according to USITC (2018), in the entire period analyzed, the United States imported 49% of beef from Australia and 36% from New Zealand and no imports originating from Brazil. That distortion further stresses the importance of protectionist barriers applied in that market and the potential damage for Brazilian exports.

[1]The data from China correspond to the sum of the values of Hong Kong, Continental China, Macao and Taiwan.

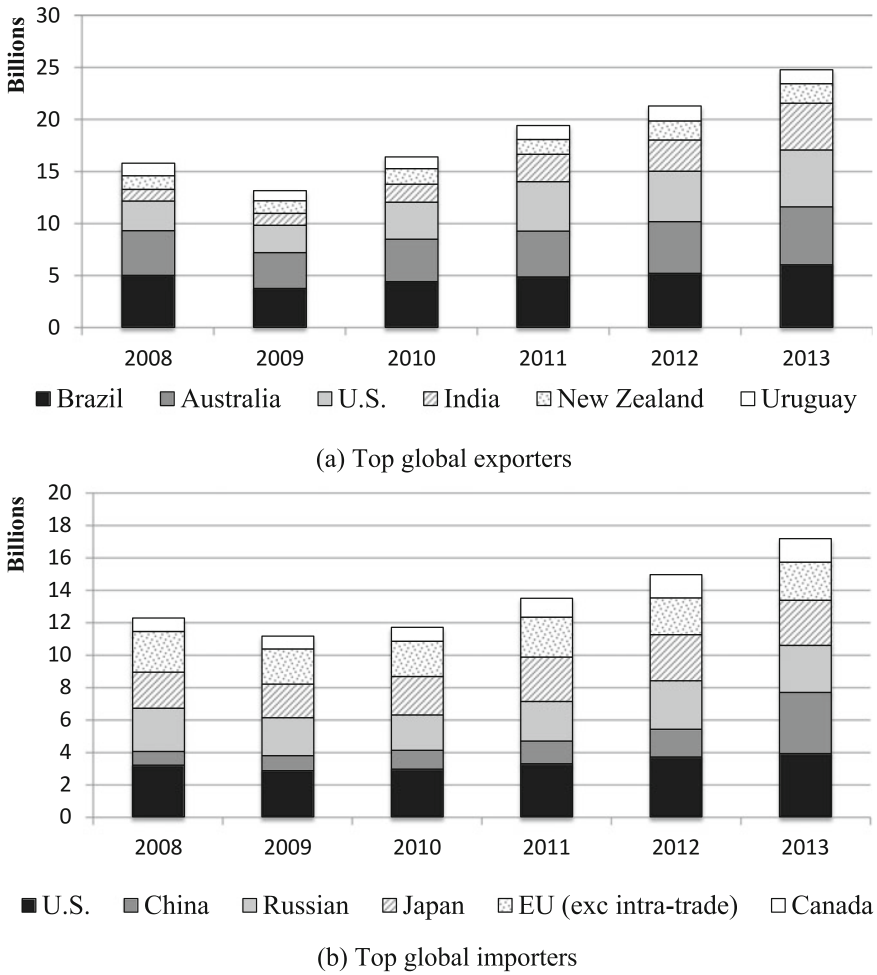
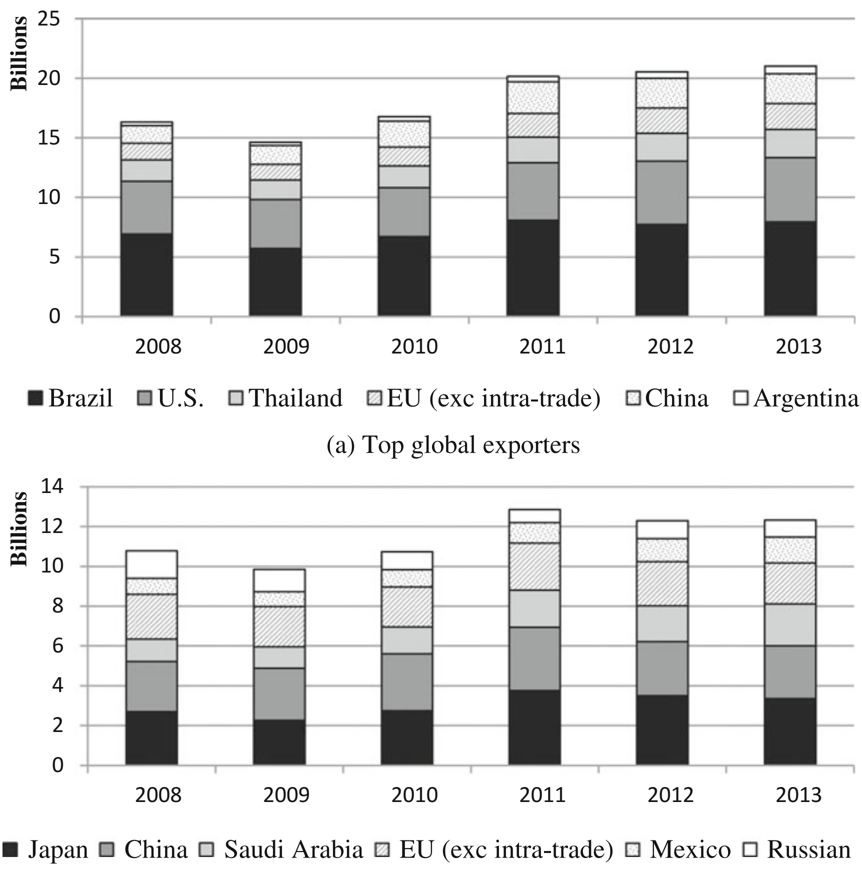


Fig. 28.1 Values, in USD, exported by the top global exporters and importers of frozen beef in the period between 2011 and 2013. *Source* Prepared by the authors, based on FAO (2018b)

With regard to the global poultry market, where Brazil equally stands out as a global exporter (Fig. 28.2a), the top importers, described in Fig. 28.2b, are Japan, China, Saudi Arabia, and the extra-block imports by the European Union. As for the pork market, the European Union (EU), US and Canada detain a higher share than Brazil in global export value (Fig. 28.3a). Among the top importers are Japan, China, Russia and the US (Fig. 28.3b). This picture of these meats' global trade, which are the most commercialized and consumed in the world, demonstrates not only the importance of Brazilian exports but also the importance of importing countries that adopt trade barriers. Table 28.1 describes the products and the top importing markets, indicating which of them used tariff quotas (TRQ) and applied



(b) Top global importers

Fig. 28.2 Values of poultry trade by the top global exporters and importers, in USD, for the period between 2011 and 2013. *Source* Prepared by the authors, based on FAO (2018b)

additional tariffs from the special safeguards mechanism (SSG) on their imports during the period of 1995, when these mechanisms were introduced, up to the latest notifications, which refer to 2015. The most relevant markets, in their majority, apply tariff quotas and are entitled to the application of the additional SSG tariff. They are: European Union, United States, Japan and Canada. Russia is another large importing market in expansion and also has tariff quotas, although not entitled to SSG application and, therefore, did not use them.

China, another market that has been prominent in imports of some of these products, especially pork and poultry, does not apply TRQ or SSG for these products. However, China Taipei has a TRQ and right of use of SSG for these products. Despite the meat TRQ in this country being as a simple tariff, since the intra and extra quota tariffs are the same, there have been notifications of SSG use in these

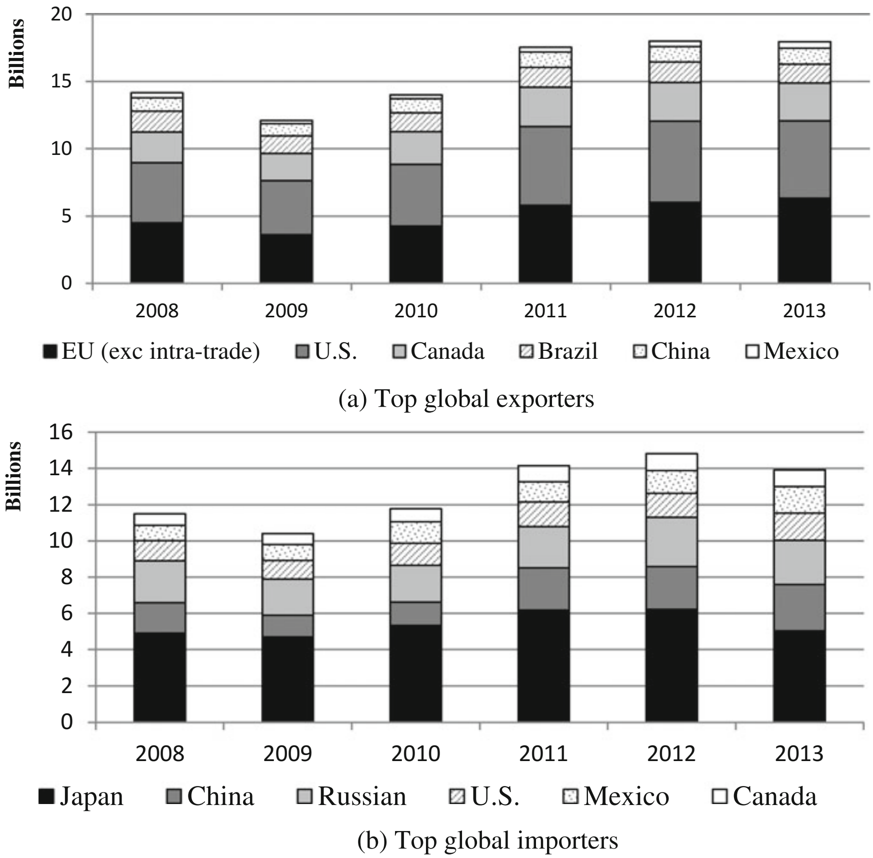


Fig. 28.3 Values of frozen pork trade by the top global exporters and importers, in USD, for the period between 2011 and 2013. *Source* Prepared by the authors, based on FAO (2018b). *Source* Prepared by the authors, based on FAO (2018b)

Table 28.1 Use of tariff quota mechanisms (TRQ) and special safeguards (SSG) in the main meat importing markets, in the period of 1995–2015

	European Union	United States	Japan	Canada	Russia
Beef	TRQ	TRQ/SSG	–	TRQ	TRQ
Poultry	TRQ/SSG	–	–	TRQ	TRQ
Pork	TRQ	–	–	–	TRQ

Source WTO (2018a, b)

products for several years. As it is not possible to distinguish the imports of China from those of China Taipei, according to the data available in United (2018), it is worth noting that in this market as well there are high levels of protectionist barriers from these mechanisms that could have been put into practice.

The SSG is still a protectionist mechanism that lacks analyses in terms of its impact. Given the relevance of the meat market for Brazil and the use of this protection mechanism in markets of major relevance in their imports, this study sought to evaluate the impact of additional SSG tariff use in the main meat importing markets. The entire period that this mechanism has been in place was analyzed, since 1996 until the latest notifications registered with the World Trade Organization (WTO), in 2015. The analyses carried out in this study, therefore, focused on the countries and products described in Table 28.1 that applied the additional tariff from the SSG and estimated their impacts, by means of the export level that would have been achieved if they had not been applied. The following section describes the methods and data used in this analysis.

28.3 Method and Data

This section presents the theory and method used to estimate the impact of the additional SSG mechanism applied on trade. Considering that the application of the additional SSG tariff should be obligatorily notified in a document with the WTO, the first stage consisted in identifying their application in this database (WTO 2018a). The notifications indicate the tariff line affected and the year for each country. In parallel, the main tariff lines (LT) used on meat imports in the markets analyzed were identified for United States and European Union in the period (1995–2015). This data was obtained from Eurostat (2018) and USITC (2018). The SSG notification does not present the additional tariff value. Therefore, at second stage of the study an estimate of the additional tariff value is obtained.

The additional tariff depends on the nature of the SSG applied, i.e. if it was on volume or price. In the case of meat exports, the price-based SSG was the most important. As previously described, for the volume-based SSG, the additional tariff could be any value up to 33% of the tariff applied. For the price-based SSG there is a rule that was used to obtain estimates in this study. The rule is that if the import price reaches below a certain limit, defined as a price trigger, in a value less than or equal to 10% of that trigger, no additional tariff is imposed; if the difference is within 10 and 40% of the trigger price, the additional tariff is 30% of the amount at which the difference has exceeded the 10% of the trigger price; if the difference is within 40 to 60% of the trigger price, the previous account is summed with an additional tariff of 50% of the amount at which the difference exceeds the 40% of the trigger price; if the difference is within 60–75% of the trigger price, the additional tariff is 70% of the amount at which the difference exceeds the 60% of the trigger price, summed to the increments described in previous intervals. Finally, if the mentioned differed is beyond 75% of the trigger price, the additional tax will be 90% of the amount at which the difference has exceeded the 75% of the trigger price, plus the integral increments corresponding to the previous intervals (FAO 2002).

Therefore, it is verified that for these calculations, the import prices should also be identified. An average import unit value of the country in the year of application was used as a proxy, obtained by dividing the value and volume of imports of each tariff line, using data was obtained from the sources: Eurostat (2018) and USITC (2018). Nonetheless, when there is a notification of SSG use and the identified price is not below 10% of the trigger price, we adopted a reference price from other major global importers, obtained from United (2018).

Once the values of the additional tariffs were estimated for each year in which their use was notified, we use an economic formula to estimate the trade gain deriving from the price change. This formula is described in Eq. 28.1.

$$\Delta M = \eta^M * \Delta P * M_{BASE} \tag{28.1}$$

where M is the imported volume; P is the price paid by domestic consumers; η^M is the import price elasticity; and Δ represents a percentage variation. Thus, $\Delta P = \left(P_f - P_i\right)/P_i$. M_{BASE} is the quantum imported, considering the initial price (P_i), i.e. the price paid by the consumer before a change in the import tariff, which directly impacts that price.

Considering that the variation is caused by the change in the country's import tariff, (1) can be rewritten as described in Eq. 28.2. Since it is necessary to use all tariffs imposed on the product, extra-quota tariffs were also considered in addition to the additional tariff. Thus, T_i is the initial import tariff, which represents the extra-quota tariff plus the additional SSG tariff and T_f is the extra-quota tariff without the additional SSG.

$$\Delta M = \eta^M * \frac{\left(T_f - T_i\right)}{(1 + T_i)} * M_{BASE} \tag{28.2}$$

The import tariff is given in percentage terms of the price of the imported product. In the case that the tariff is specific or mixed, the tariff equivalent was annually estimated, considering the same import price used to estimate the SSG for each year, or the country's annual average import price.

The value of the import price elasticity (η^M), in turn, depends on the product's domestic demand $\left(\eta^d\right)$ and supply (η^s) elasticities, as well as the ratio of the volume consumed (D) and produced (S) with the imported quantum (M). Equation (28.3) describes the formula to obtain the import demand price elasticity.[2]

$$\eta^M = \eta^d * \frac{D}{M} - \eta^s * \frac{S}{M} \tag{28.3}$$

The elasticity data was obtained from Fapri (2018) and the domestic consumption and production data from FAO (2018a).

By knowing the volume that was not imported due to the application of the SSG in each year, a part of this volume was adopted as potentially being supplied by

[2]The derivative of this eq. can be found in Orcutt (1950).

Brazil. The percentage used to calculate the exports that Brazil ended up not sending to that country was based on the percentage that Brazilian exports (X_{BR}) of that product group had within global exports (X_W), in each year of the analysis. By multiplying the volume that the country ended up not exporting by the basic price (received by the producer—P_b) we obtain for each year an estimate of the value of the country's exports losses (y). Equation (28.4) describes this calculation. It can also be verified in this equation that, despite the variations in imports and Brazil's participation have been estimated year by year, the value that was not exported was calculated for the entire period analyzed (the subscribed "t" indicates the year analyzed). This was done so this value could be placed as a total impact to estimate other effects on the Brazilian economy, which is described below.

$$\sum_{t=1996}^{2015}\left[\Delta M*\left(\frac{X_{BR}}{X_W}\right)\right]_t * P_b = y \tag{28.4}$$

The value of y was then used as a demand shock (demand that did not occur) on the input-output matrix of the country. This relationship between demand shock and the impact on the economy can be obtained from Eq. (28.5), as described by Miller and Blair (2009). In this equation, the variable Y represents a demand matrix, where the value of exports that did not occur is entered[3]; X is the matrix that describes the impact of that demand on the production value of the entire economy and matrix (A) represents the technical relation in the intermediary demand.

$$X = (I - A)^{-1}Y \tag{28.5}$$

The impacts (X) estimated in this manner indicate the direct and indirect effects on the economy, also called type I multipliers. Type II multipliers were also obtained as type I plus the effect of a consumer income variation caused by the direct and indirect effects. In order to obtain type II multipliers, the matrix A of technical coefficients includes "families" as if it was another sector of the economy. The new matrix is described as $\bar{A}$.

In addition to the impacts on the production value, the impacts on the value of remunerations (Z_R), of imports (Z_M), of the number of jobs (Z_E) and of the Gross Domestic Product (Z_{GDP}) were also estimated. For such, the result obtained from Eq. (28.5) was used to obtain the estimates described in Eq. (28.6).

$$Z_{(nx1),k} = \left[diagonalized\left(C_{(nx1),k}\right)\right]_{(nxn),k} * X_{nx1} \tag{28.6}$$

[3]The difference between y and Y is a value and Y is a vector-type matrix where, in the line corresponding to the meats sector that was not exported by the country, the value y found is included.

where $k = R$ (remunerations value), M (imports value), GDP (GDP value) and E (number of people employed). The C_k coefficients were obtained at the actual input-output matrix.

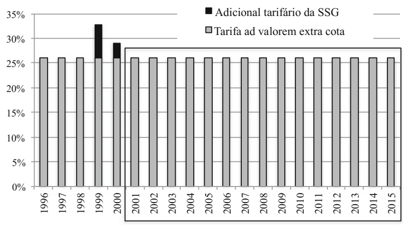
The input-output matrix used in this study was estimated based on the data from the Brazilian National Accounts (Brazil 2018) as described by Guilhoto and Sesso (2010). The productive structure, in terms of the value and the coefficients used, which were the structures required to obtain the results, refer to that observed in the country on 2013.

28.4 Results: Empirical Estimate of the Impact from the Main SSGs Applied to Meat Trade in the United States and the European Union

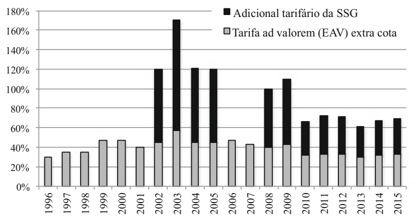
As described in Sect. 28.2, the analysis made in this study focused on the countries and products described in Table 28.1, which made use of the SSG in the meat market. They are: US in the imports of beef and EU in imports of poultry. The additional SSG tariff is applied over the extra-quota tariff value. The extra-quota tariff applied in the US on beef is 26.4%. In the case of EU, there are mixed tariffs. In order to estimate an equivalent *ad valorem* value (EAV) of the mixed tariffs, it should be taken into account that their EAV changes depending on the import price reference. Figure 28.4 shows the EAVs calculated for the poultry extra-quota tariff in the EU for each year, using the average import price of each one of them. It may be observed in Fig. 28.4 how the tariff equivalents change their protection level while changing the product price reference. In that sense, it is verified that a higher level of tariff protection is observed for lower price levels, which means increasing the protection in periods of global excess supply, which in turn also contributes to the even higher increase in this excess, causing a snowball-type effect. The same rationale applies to the impact of special price safeguards, whose additional tariff increases as the product import price decreases.

In order to make a comparison between the products' protection level, we therefore consider that in the EU, depending on the import price used, the EAV remained between: 50–70% for poultry; 70–90% for beef; and 25–30% for pork.

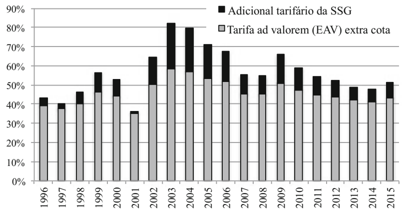
Despite indicating only one tariff for an entire product group, we actually have several tariff lines (LT), often with different tariffs, for each type of meat. The tariff described and used in this study in each group represents the most relevant LT in the country's imports. Likewise, for each of those products, in each country, we have some LTs where the SSG was applied. For the products analyzed, it was observed that the price SSGs were the most active and that there were nine tariff lines that stood out when observing their application: one LT in the US (tariff line 02023010 and 02023080—beef, frozen, intra and extra quota, respectively) and eight poultry LTs in the EU (they are: 02071290—whole frozen chicken; 02071410—boneless chicken, frozen; 02071450—chicken breast, with bones, frozen;



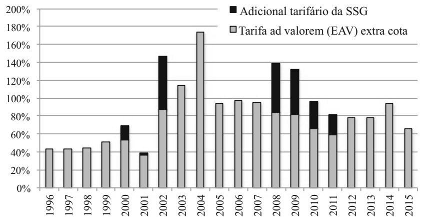
(a) Frozen beef, in the U.S.



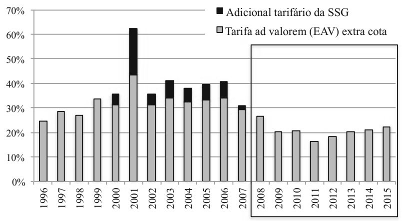
(e) Chicken legs, with bones, frozen, in the EU



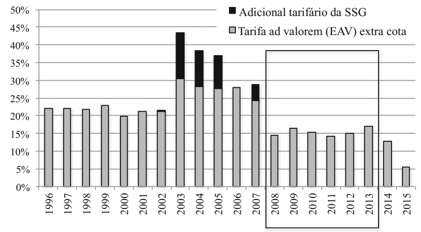
(b) Boneless chicken, frozen, in the EU



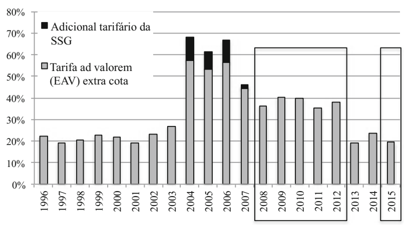
(f) Other chicken parts, with bones, frozen, in the EU



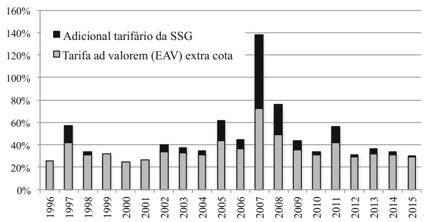
(c) Whole chicken, frozen, in the EU



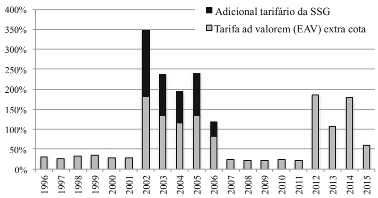
(g) Whole turkey, frozen, in the EU



(d) Chicken breast with bones, frozen, in the EU



(h) Turkey cuts, frozen, in the EU



(i) Duck or goose meat, frozen, in the EU

Fig. 28.4 *Ad valorem* equivalent (EAV) estimated for the extra quota tariff and additional tariff estimate from the use of price SSGs for the tariff lines analyzed, using the average annual price data for imports in the period 1996–2015. *Source* Prepared by the authors based on data from the WTO (2018a, b), USITC (2018), United (2018) and Eurostat (2018)

02071460—chicken legs, with bones, frozen; 02071470—other chicken parts, with bones, frozen; 02072510—whole turkey, frozen; 02072710—turkey cuts, frozen and; 02073615—duck or goose meat, frozen).[4] This was the universe analyzed in this study.[5]

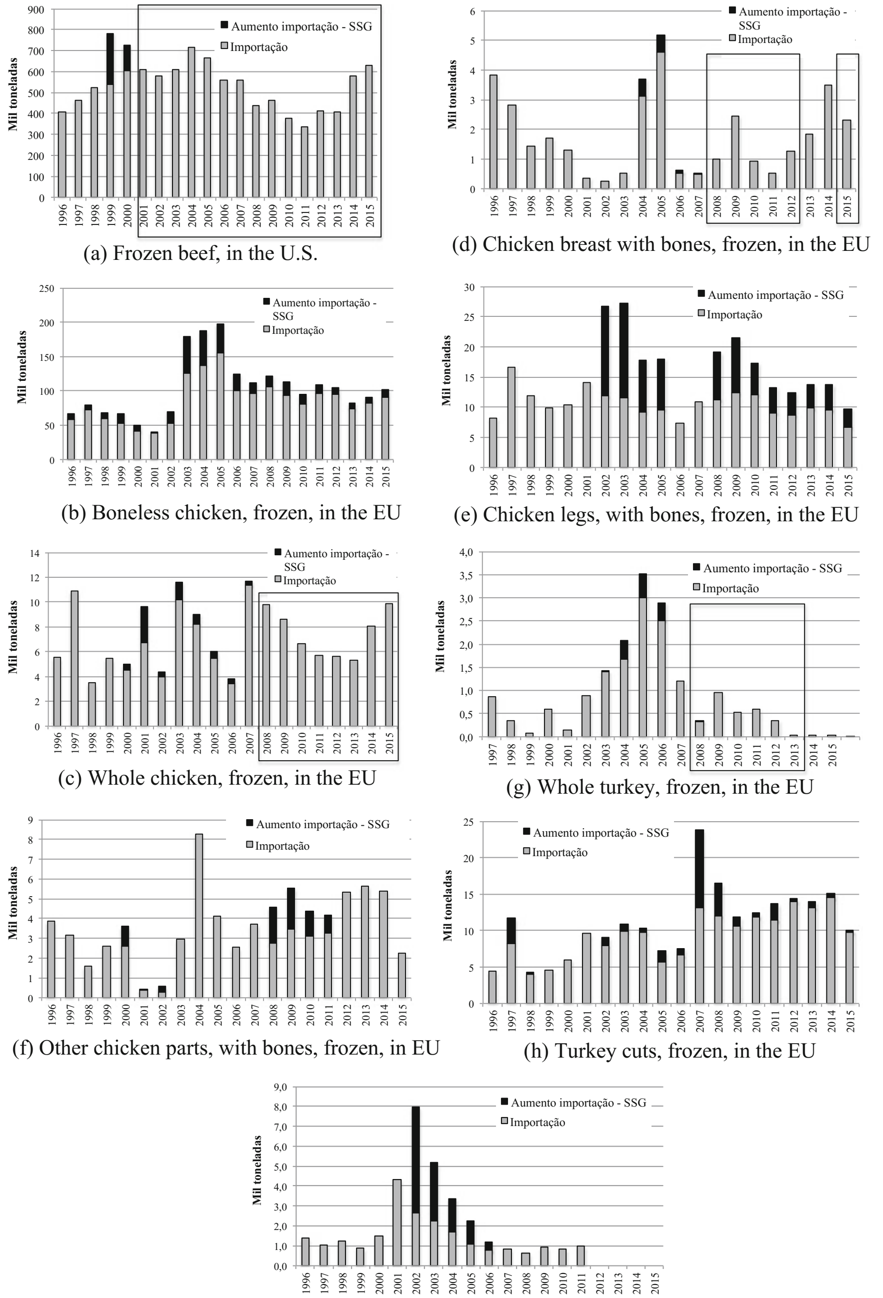
Figure 28.4 shows the estimated values of the additional price-based SSG tariffs for this set of nine LTs that used this mechanism, along with the extra quota tariff applied at each year, for the period of 1996–2015. Since the price SSG is applied per ship and there is no way to identify the cargo's import price on which it was applied, the analyses were performed with average annual prices. The average extra quota import price was used (only the US indicates the intra and extra quota imports separately), for it is on the extra quota imports that the SSG incurs. However, in the cases where the country declared use of SSG and the import price identified was not below the trigger price, a global import price was used for this estimate, as described in Sect. 28.3. For some LTs, however, it was observed that even using this resource for several years, despite the country having notified the use of price SSG, import price levels low enough to warrant an SSG activation were not found. All years where there was a notification of SSG activation and the price observed did not corroborate with their use were marked in Fig. 28.4 charts with a square. A larger price variation can occur during some year and justify the use of an SSG, since this study used an annual average price. But if that was the case, as during most of the period analyzed, the use of a safeguard instrument wouldn't be expected.

In those cases, since the import price is above the trigger price, as well as the global prices, it was not possible to estimate the corresponding additional tariffs. It is verified that this was more severe for beef in the US. This observation, which did not occur in an isolated manner, but persistently within the application of more significant special safeguards on the global meat trade, raises doubts whether the SSGs are really being applied within import price conditions below the trigger, and not only considering normal annual price variations. In that case, even reforms to this mechanism could fail to be effective to reduce the protection levels.

As previously mentioned, it is also verified in Fig. 28.4 that the extra quota tariff EAV values change throughout the years, since different price levels are observed each year. As expected, the estimated volume which was not imported due to the SSG is directly proportional to the scale of the additional tariff estimated and described in Fig. 28.4. However, the basic imported volume, which is the volume imported in the year of the SSG application is also important for this estimate, and

[4]In the period analyzed (1995–2015) these tariff lines underwent some transformations. Therefore: the LT 02071210 was 02072110; the LT 02071290 was 02072190; the LT 02071410 was 02074110; the LT 02071450 was 02074151; the LT 02071460 was 02074171; the LT 02071470 was 02074171; the tariff line 02072510 was 02072210; the LT 02072710 was 02073931 and; the LT 02073615 was 02074515 and also 02074315.

[5]Japan, despite not having a tariff quota for pork meat, submitted a volume SSG usage notification for this product in 1997. This data was not estimated and stands as a mere observation in this study.



(a) Frozen beef, in the U.S.

(d) Chicken breast with bones, frozen, in the EU

(b) Boneless chicken, frozen, in the EU

(e) Chicken legs, with bones, frozen, in the EU

(c) Whole chicken, frozen, in the EU

(g) Whole turkey, frozen, in the EU

(f) Other chicken parts, with bones, frozen, in EU

(h) Turkey cuts, frozen, in the EU

(i) Duck or eat, frozen, in the EU

Fig. 28.5 Import volume observed and estimate of what was not imported due to the application of an additional special safeguard tariff, applied by the U.S. and EU in the meats market, period 1996–2015. *Source* Prepared by the authors based on data from the WTO (2018a, b), USITC (2018), United (2018) and Eurostat (2018) the magnitude of the values, which can be observed in the axes of the charts in Fig. 28.5, draws attention to this fact. The magnitude of the impact on the imported volume is observed in Figs. 28.5a and 28.3b as quite superior to the others, indicating their greater significance for trade. Figure 28.5a, which has the greatest import magnitude among the tariff lines analyzed, represents the SSG impact on beef imports in the US.

And, as presented above, this effect could only be estimated for the years 1999 and 2000, despite the US having notified the use of SSG in all years up to 2015. Since this is a very large market, the magnitude of the impacts that could not be estimated, therefore, could be important for the global meats market. If we consider the impacts of beef and poultry reduction in the years of 1999 and 2000 due to the SSG estimated in this study, this value represents approximately 2.5 and 1.5% of the global trade of these meats, respectively, in the years 1999 and 2000. As for the other years, where only the impacts on poultry were measured, the participation of these impacts in the global poultry market varied from 1.6% in 2003 to 0.1% in 2001, with an average of 0.5% for the period (except the years 1999 and 2000). These results depend of the price elasticities considering. The values of those elasticities are described in Fig. 28.6.

Applying Brazil's participation in global exports of beef and chicken on each of the years studied for the estimated volumes that were not imported due to SSG application, we obtain an estimate of Brazilian exports that did not occur. Brazil's participation in beef trade varied from less than 10% before 2000 and reaching 20% from the mid 2000s decade. As for the poultry market, Brazilian participation was of 15% until the decade of 2000, and reached the threshold of approximately 35% from then on. By multiplying them by the basic prices of these products, which were obtained in Brazil's Input-Output Matrix of 2013, we obtain the demand shock values estimated for the Brazilian economy. The values of these shocks were approximately BRL 517 million for poultry and BRL 287 million for beef. Table 28.2 shows the results obtained from the impact of these values on the Brazilian economy.

The first observation about the results refers to the relatively low impact found in this study of the meat market when compared to those obtained for the sugar market (Costa et al. 2015). In the latter, the impact in the period of 1995–2013 was approximately BRL 42 billion in gross production value (VBP) of the Brazilian economy and in the former, for a period with an additional two years, from 1995 to 2015, the impact was less than BRL 4 billion in the VBP. Nonetheless, the trigger prices to activate SSG in sugar were quite high in regard to the prices practiced in the period, resulting in high levels of an additional tariff applied and, consequently, in the high impacts observed by Costa et al. (2015). In the case of meat, the trigger price was clearly higher only for one of the tariff lines analyzed (Boneless chicken, frozen, in the EU). As may be observed in the charts in Figs. 28.4 and 28.5, most of the impacts could not be estimated due to prices observed above the trigger price. But in face of the fact that SSG applications were notified for those products and years, much of the impact certainly could not have been estimated in this study.

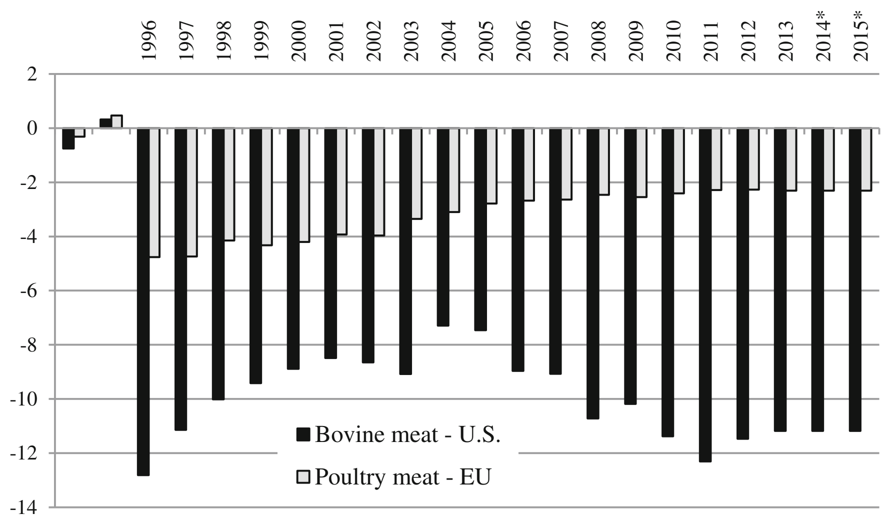


Fig. 28.6 Values of the price elasticity of demand for imports (η^M) of beef in the U.S. and poultry in the EU. *Note* *The same value of the last year was considered due to the lack of data; η^d is the demand price elasticity and η^s the price elasticity of supply, both domestic, used as a basis to estimate the demand for imports. *Source* Fapri (2018), FAO (2018a)

Table 28.2 Estimated impact on the Brazilian economy of a demand shock in Brazilian meat exports: BRL 517 million for poultry and BRL 287 million for beef. Values in BRL million, at 2015 prices (for the "Job" variable, the results indicate number of people)

	Gross production value (GPV)	Number of people employed	GDP	Remuneration	Importation
Type I[a]					
Beef	817	9,721	344	120	31
Poultry	1,472	17,511	620	216	56
Type II[a]					
Beef	1,339	15,139	653	226	58
Poultry	2,411	27,272	1,176	407	104

Note [a]Type I corresponds to the direct and indirect impacts and Type II to the impacts, besides those, also of the income effect
Source Research results

This observation could be more important in this study than the impacts estimated to show the relevance of minding the use of this mechanism.

The type I estimated impacts—which correspond to the direct and indirect effects of a demand shock, in addition to the actual sector that received the shock—were higher in the following sectors presented in decreasing order of impact: Other food products; Livestock and; Trade. These sectors were the most impacted by the direct and indirect effects in all variables analyzed: production, GDP, remuneration, employment and importation. However, as may be observed in Table 28.2, the impact of a growth in imports was quite small. This is a good result for the country's economy, for it is verified that the shock does not demand much from sectors highly dependent on imported products in the country.

It is verified that the impact with only the income effect, which is the difference between Type II and Type I impacts, represents an important portion of the total impact, corresponding to approximately 36% for GPV variables and number of jobs, and 47% for the remaining variables. Thus, while separating the income effect of the type II impact, we observe that the sectors most affected by this effect are different depending on the variable analyzed. Considering the gross production value (GPV), in addition to the actual sector that received the shock, the most impacted sectors in order of significance were: Trade; Real estate activities; Oil refining; Other food products; Food and; Agriculture. In turn, considering the income effect of the impact on the GDP, the Real estate sector's activities were superior to those of Trade, followed by the sectors of: Foods and; Agriculture. However, observing the impacts on employment, few sectors were relevant, with the following sectors standing out in this order: Trade; Livestock; Foods; and Agriculture Despite having a much lower impact than on those sectors, but still quite superior to the average of the country's sectors, and due to the income effect of the country's meat exports growth, the following sectors stood out in job creation: Associative organizations and personal services; Private education and; Private health care.

28.5 Conclusion

The results illustrate how a trade protection mechanism, such as SSG—for which there are few analysis and that should have been eliminated for having a transient character when adopted—presents expressive impacts on international meat trade and for the economy of a country that exports such products, as Brazil.

The use of special safeguards (SSG) for agricultural products has been an instrument with a high potential to enable increases in the consolidated tariffs at the WTO by member countries. Thus, it gains importance, mainly in periods of high relative supply of products and reduced prices in the international market. In fact, when the prices of the international market are reduced, that increases the imported product's competitiveness in the importer country markets. With the reaction of these importers in the form of higher tariffs by the percentage provided in the agreements, there is a reduction in imports that increases an excess of the global supply, particularly when the countries that react are significant importers. As a result, prices could end up even lower in the international market. This characterizes a perverse effect associated to the deployment of SSGs, reinforcing the importance of measuring and analyzing its effects, as presented in this study.

It is worth noting that the transparency of the measurements for their evaluation could be improved, since the countries don't need to inform the value of the imposed tariff when notifying its application. Today, importers are only required to notify that they are using the SSG measure. Another aspect involves the fact that the price-based SSG is applied per ship, which also makes it difficult to obtain the actual cargo import price on which it was applied. An approximation consists in employing average annual prices for the commodity. Given such procedure cannot provide the exact value, there are cases in which the country declares the use of SSG and the actual import price calculated is not lower than the trigger price. Therefore, the results obtained can be underestimated, and it is important to analyze the results obtained with that reservation. This was identified, for example, in the case of the US meats market. In that market, this effect could only be estimated for the years 1999 and 2000, despite the US having notified the use of SSGs in all years up to 2015. Since it is a very large market, the magnitude of the impacts could not be estimated, therefore, they could be important for the global meats market and were not collected.

Despite these reservations, the results obtained in this study can subsidize future trade negotiations at the WTO. In addition, the study offers an analytic instrument that may be updated in a relatively simple manner, providing a way to monitor the changes throughout different periods of time.

References

Aznal, M. (2007). Special products and special safeguard mechanism in WTO agriculture negotiation. Briefing Paper, 1.

Brazil. (2018). Instituto Brasileiro de Geografia e Estatística—IBGE. Available at: https://ww2.ibge.gov.br/home/. Download. Statistics. National Accounts Accessed in: 2018.

Costa, C. C., Burnquist, H. L., & Guilhoto, J. J. M. (2015). Special safeguard tariff impacts on the Brazilian sugar exports. *Journal of International Trade Law and Policy, 14*(2), 70–85.

Eurostat—European Commission. (2018). International Trade. Data. Database. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/international_trade/data/database. Access: 2018.

FAO—Food and Agriculture Organization of the United Nations. (2002). FAO papers on selected issues relating to the WTO negotiations on agriculture. Rome.

FAO—Food and Agriculture Organization of the United Nations. (2018a). FAOSTAT. Available at: http://www.fao.org/home/en. Statistics. Databases. Data. Food Balance. Commodity balances—livestock and fish primary equivalent.

FAO—Food and Agriculture Organization of the United Nations. (2018b). FAOSTAT. Available at: http://www.fao.org/home/en. Statistics. Databases. Data. Trade. Crops and livestock products.

FAPRI—Food and Agriculture Policy Research Institute. (2018). Tools. Elasticities database. Available at: http://www.fapri.iastate.edu/. Access: January 20, 2018.

Finger, J. M. (2009). A special safeguard mechanism for agricultural imports and the management of reform. World Bank: Policy Research Working Paper, n. 4927.

Guilhoto, J. J. M., & Sesso Filho, U. A. (2010). Estimation of the input-output matrix using preliminary data from national accounts: application and analysis of economic indicators for Brazil in 2005. Economy & Technology UFPR/TECPAR. Year 6 (Vol. 23) October/December.

Harris, D. (2008). Special safeguards and agricultural trade liberalization. Rural Industries Research and Development Corporation: Australian Government. Publication no. 08/125.

Hertel, T. W., Martin, W., Leister, A. M. (2010). Potential implications of a special safeguard mechanism in the World Trade Organization: The case of wheat. *World Bank Economic Review*, 1–30.

Miller, R. E., & Blair, P. D. (2009). *Input-output analysis: Foundations and extensions* (2nd ed.). Cambridge: Cambridge University Press.

OECD-FAO. (2015). Agricultural outlook 2015–2024. Available at: http://www.fao.org/3/a-i4738e.pdf. Access: 2015.

Orcutt, G. H. (1950). Measurement of price elasticities in international trade. *The Review of Economics and Statistics, 32*(2), 117–132.

Pal, P., & Wadhwa, D. (2006). An analysis of the special safeguard mechanisms in the Doha Round of Negotiations. ICRIER Indian Council for Research on International Economic Relations. Working Paper, n. 189.

United Nations. (2018). Comtrade Database. Available at: https://comtrade.un.org/. Get Data. Extract data. Accessed in: 2018.

USITC—United States International Trade Commission. (2018). Trade DataWeb. Available at: http://dataweb.usitc.gov. Access: 2018.

Wolfe, R. (2009). The special safeguard fiasco in the WTO: The perils of inadequate analysis and negotiation. *World Trade Review, 8*(4), 517–544.

WTO—World Trade Organization. (2018a). Available at: https://www.wto.org/ Document, data and resources. Documents Online search facility. Accessed in: 2018a.

WTO—World Trade Organization. (2018b). Available at: https://www.wto.org/ Document, data and resources. Statistics. Tariffs. Tariff Analysis Online Access in: 2018b.

Chapter 29
Long-Term International Trade Analysis Measuring Spatial Extension of Globalization: Kuznets or Hysteresis Paradigm?

Bruno G. Rüttimann

Abstract How is trade globalizing? And how can globalization of trade be modeled? Based on a new spatial inequality metric applied to WTO cross table of world trade figures from 2000 to 2016, the spatial evolution of globalization extension is measured and can be interpreted according to the globalization types model. The result shows that after a sustained globalization tendency in the time period 2003–2012, since 2013 the international trade system is again de-globalizing. These are indications that for trade globalization may apply the inverse Kuznets paradigm. The differentiated regional globalization evolution can be explained with the globalization types respectively for the globalization expansion by Heckscher-Ohlin and Stolper-Samuelson trade models and for the ongoing de-globalization period by Linder's trade model.

Keywords Globalization · Types · Metric · Inequality · Model
Kuznets · Hysteresis

29.1 Introduction

The present paper belongs to a long-term study regarding evolution of trade globalization. Globalization is here not intended as increasing absolute trade figures but intended as increasing interweavement of trade flows of different geographic and economic regions, reflecting the spatial distribution of physical merchandise and goods flows. The present paper is the latest version including 2016 international trade figures, embracing now for the first time also the period from 2000 to 2002 of the long-term study regarding trade globalization. The results of precedent papers are summarized in (Rüttimann 2017 to be published), to which we will refer to in this paper. The ongoing heuristic study based on phenotypic aspects of the globalization

B. G. Rüttimann (✉)
Inspire AG/ETH, Zürich, Switzerland
e-mail: brunoruettimann@bluewin.ch; bruno.ruettimann@inspire.ethz.ch

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_29

phenomenon has so far leading to formalize and validate a new trade theory, where the underlying logic bases on different globalization types and enouncing the trade globalization postulates (Rüttimann 2017). The trade globalization patterns (commodity globalization type 1a, specialty globalization type 1b, cost-advantage globalization type 1c) are described and modeled for the first time in (Rüttimann 2007) and applied and interpreted, so far, in final form in (Rüttimann 2017) to which we refer or (Rüttimann 2016).

29.2 Theoretical Background and Methodological Approach

In the following, we will apply the new entropy-based inequality risk metric according to (Rüttimann 2007, 2010, 2011) to foreign trade flows to measure the globalization degree of the trade system. In brief: from the paradigmatic interpretation of thermodynamic entropy we can define risk as a dualistic view of order in an economic system, therefore the more order (i.e. inequality) that exists in an economic system the more risky the economic system (or vice versa, the more equality a system shows the less risk it presents). The greater the inequality compared to the riskless state with equality $\psi_{XY} = 1$, the larger the risk for an economic agent, i.e. here an economic region. Whereas in the here presented context inequality refers rather to a single element of a system, the concept of risk can be aggregated to a subsystem or to the entire system.

To analyze the trade flows, i.e. the material flows of type 1 globalization, dealing with commodities (type 1a), specialties (type 1b), and standard goods (type 1c), by applying the inequality metric to which country X (origin) exports to which countries Y (destination) imports, corresponding to the trade matrix $T^{\alpha} = [t^{\alpha}_{XY}]$ representing the interweavement of flows. Concentration of flows results in low entropy, i.e. high order (or low disorder), or in our interpretation high risk of high inequality according to the CAPM of portfolio theory of assets, or high disorder (even distribution would result in high entropy or low risk) of the system. Therefore, this new metric represents a paradigmatic approach of Boltzmann entropy of a thermodynamic system leading to the statistical entropy measure of a system; indeed, the risk is defined as the second momentum but where the pole is not the mean but the status of equality. The interpretation of this metric as risk of an economic trade system is valid because a highly diversified portfolio of export destinations corresponds to expanding the business activity to new geographic regions reducing the risk of the portfolio, becoming less vulnerable.

The metric is applied to yearly WTO cross trade tables (Appendix Table 29.1 for data of 2016) and then the evolution is monitored—in this paper from 2000 to 2016. The former results have been published in various papers and summarized in (Rüttimann 2017).

29.3 Analyzing Trade Globalization Patterns Between 2000 and 2016

The world trade flows on an aggregated basis, according to WTO figures, have rapidly increased from 6185 b$ in 2000 to 17,816 b$ in 2011 showing a deep set-back in 2009 due to the repercussion of the financial crises. Also having been raised by WTO itself concerns about the consistency of the data, it is the only long-term data available regarding trade interchange (Degain et Maurer 2010). After the economy had recovered, from 2012 onward, trade flows experienced a reduced dynamic by flattening, attending the highest trade level in 2014 with 18,146 b$ and since 2014 onwards a contraction of international trade is observable (Fig. 29.1). From Fig. 29.1 it is also observable that all regions have been touched by the financial crisis, but with higher sensitivity for the regions with predominant type 1a globalization (commodities type), i.e. Middle East, Central and South America, CIS, and Africa; sensitivity is different for various regions (Rüttimann 2017, 2016).

Figure 29.1 shows an apparent high correlation among the evolution of the various regional trade flows. Therefore, if we put the values in a correlation matrix plot (Fig. 29.2) we find evidence how much the economies are correlated among themselves and the total world trade volume. All the p-values are zero and show obvious statistical significance (figures not annexed). We will see a different picture when comparing the globalization tendencies of the various geographical economic regions.

The evolution of the associated regional and world risk of the trade system, i.e. the globalization degree seen as interweavement of trade flows, is shown in Fig. 29.3. It emerges that globalization has steadily increased (diminishing risk)

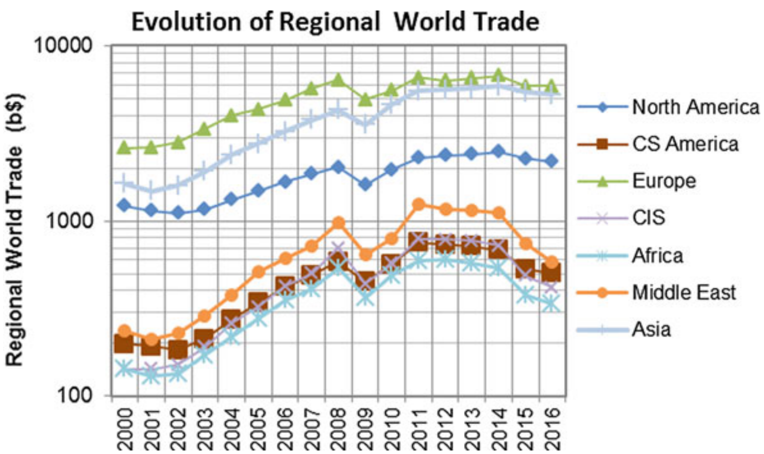


Fig. 29.1 Regional evolution of world trade of different macro-economic geographic regions (figures contain also domestic trade)

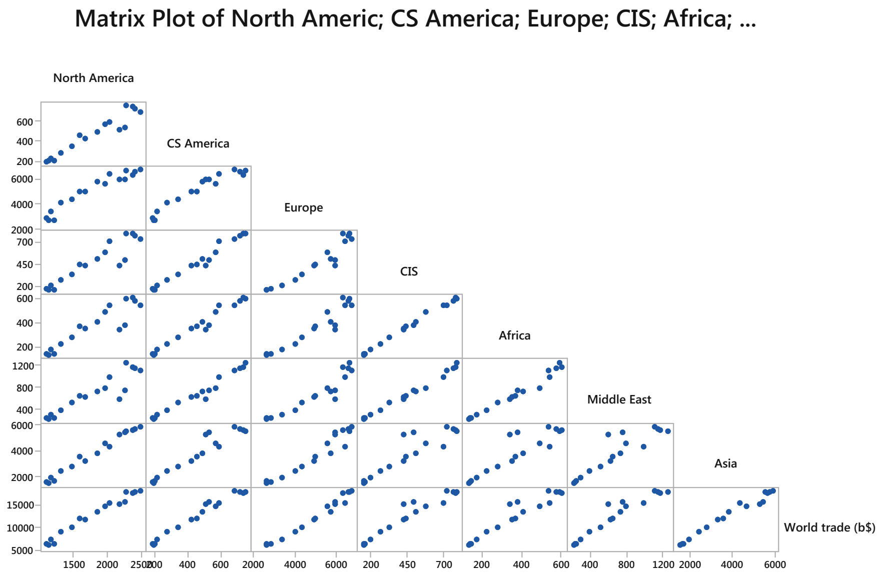


Fig. 29.2 Correlation matrix of regional and world trade flow scatterplots (data period 2000–2016, figures contain also domestic trade)

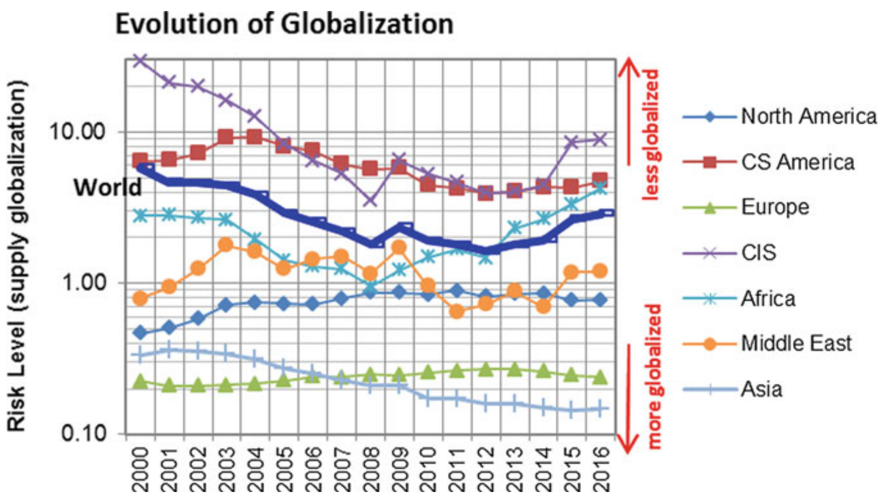


Fig. 29.3 Regional risk of different macro-economic geographic regions revealing heterogeneous evolution

since the beginning of the availability of time series in 2000 with a global risk value of 5.79 reaching the value of 1.80 in 2008. The financial crisis meant a concentration of trade flows to preferential trade destinations entailing a temporal de-globalization. Then, globalization phenomenon resumed again reaching the highest observable globalization extension with a risk value of 1.62 in 2012. From 2013 onward, we can observe a de-globalization tendency on aggregated level, but also in most geographic regions giving first signs for an inverse Kuznets curve. Interesting, Europe experienced a constant de-globalization until 2013 and is now slightly globalizing again. Also interesting to observe, Asia has constantly globalized reducing the risk level until 2015 to a value of 0.14 (the highest globalization degree of all economic regions) but has experienced in 2016 an increase to 0.15; this shows a first sign of difficulties to sustain the spatial expansion strategy, given mainly by Chinese exports.

If we analyze the corresponding Fig. 29.2 applied to data of Fig. 29.3 with the correlation matrix plot of regional and global risk (Fig. 29.4) we get a quit different picture: globalization of the various geographic economic regions have performed differently. Statistically significant positive correlation between regional and world risk show SC America, CIS, and Asia, and at the limit also Africa; statistically significant negative correlations show NA and Europe. Middle East is not showing a clear correlation (Fig. 29.5). The associated Pearson correlation has to be taken only as indication being, in certain cases, in presence of non-linear behavior. Generally, we can conclude that emerging economies have been showing a positive correlation between regional risk and world risk, whereas mature economies have shown a negative correlation during the analyzed time frame (Fig. 29.4 and 29.5). This result gives further evidence for the validity of the eclectic globalization model already presented in (Rüttimann 2016, and especially updated in 2017). Due to the

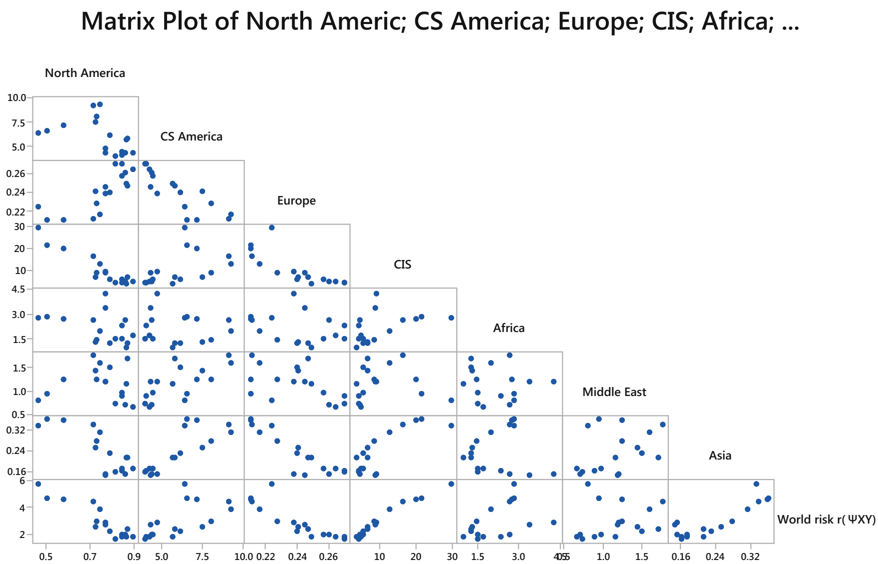


Fig. 29.4 Correlation matrix of globalization scatter plots (regional and global risk data of the time period 2000–2016)

Correlations

	North America	CS America	Europe	CIS	Africa	Middle East	Asia
CS America	-0.463						
	0.061						
Europe	0.769	-0.829					
	0	0					
CIS	-0.94	0.476	-0.78				
	0	0.053	0				
Africa	-0.404	-0.108	-0.303	0.457			
	0.108	0.679	0.237	0.065			
Middle East	-0.007	0.7	-0.523	0.043	-0.145		
	0.98	0.002	0.031	0.869	0.578		
Asia	-0.806	0.824	-0.899	0.81	0.036	0.369	
	0	0	0	0	0.892	0.145	
World risk r(ΨXY)	-0.919	0.618	-0.872	0.981	0.455	0.204	0.863
	0	0.008	0	0	0.067	0.433	0

Fig. 29.5 Figure 29.4 associated Pearson correlations of globalization and *p*-values (regional and global risk data of the time period 2000–2016)

fact that economics is not an exact science such as physics—indeed, the rational "homo oeconomicus" is a fiction—we may see exceptions in data. Now, Europe after a long de-globalization period shows again globalization tendencies, at least for the last three years, against the world de-globalization tendency. What is the reason? De-globalization means concentration of flows to preferential economies—but also these economic relations may saturize. At the same time emerging economies are progressing, needing new specialty goods to evolve, so that mature economies diversify again their portfolio of destinations, spreading their activities to these new growing economic regions. We can see here typical signs of complementary economies remembering the Ricardian school, or better the H-O (Heckscher-Ohlin) trade theory, entailing the tendency of globalization. The general cost advantage of emerging economies entails also the tendency for globalization reflecting the thoughts of Stolper-Samuelson. On the other hand, the initial tendency for globalization can then alternating with Linder's trade theory, i.e. this trade theory sais, that similar advanced economies are rather doing business together than complementary economies (entailing tendency of de-globalization).

The scatterplot of trade volume versus risk value for the years 2000–2016 shows during the period 2003–2013 a perfect regression model (Fig. 29.6). The new added data of 2000–2002 do not fit the model; the recent years 2014–2016 deviate as well from the model. The globalization regression model seems to fit well during trade expansion showing that globalization (new markets) is made with additional trade. Economic recession let concentrate on large mature economies; indeed, the emerging economies are mostly commodity-based, economies which suffer first (high sensitivity) economic recession (Rüttimann 2017). Although it is too early to state, we see here also a first sign of a hysteresis pattern, i.e. trade expansion and trade concentration present different trade-volume/risk-value during economic growth and economic recession (Fig. 29.6). The 2010 data, economic recession due

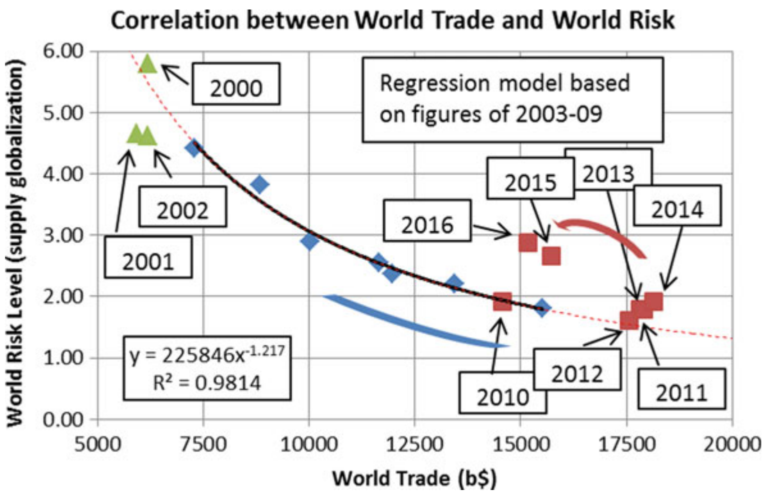


Fig. 29.6 Modeling globalization on aggregate level with an L-model

to the repercussion of the world finance crisis, may be an exception. Indeed, the whole world was affected at the same time so that trade reduced equally in all economic regions. The macro-economic behavior of globalization began to reveal an inverse Kuznets curve which might only emerge presently (Fig. 29.3), but the ongoing trade evolution may lead to alternating cycles of globalization/de-globalization as soon as different economic regions develop leading to a hysteresis pattern (Fig. 29.6). Indeed, we have now 3 consecutive years that Europe, as well as NA, is again globalizing. The further evolution of trade will confirm or reject the hysteresis hypothesis.

If we look at disaggregated data, i.e. at the evolution of regional risk, we get Fig. 29.7 showing a scatterplot of the regional trade volume-risk. Each single economy, with the exception of NA and Europe, show a decreasing risk with increasing trade volume. Indeed, whereas most regions are increasing global interweavement (diminishing their risk) with growing trade volumes (such as SCA, CIS, ME, Asia), it is observable that Europe and NA have decreased the trade interweavement (increasing risk) with growing trade volume. We can therefore not generally state—and that is important—that increasing trade volume is increasing global interweavement, but different economies are evolving differently regarding globalization (postulate 2 and 6, Rüttimann 2016, 2017). As soon as economies are reaching a certain maturity, preferential trade destinations will establish, which reduces interweavement, increasing the risk indicator giving evidence for the Kuznets curve. N.B.: despite China is showing the largest export trade of the world, from a continental geographic region point of view, Europe is still the largest economic region (domestic and export). To model the explicit volume-risk globalization on these disaggregated data might not be correct, each region experiencing for its own potentially an L-shaped curve according to its enterprise's economic

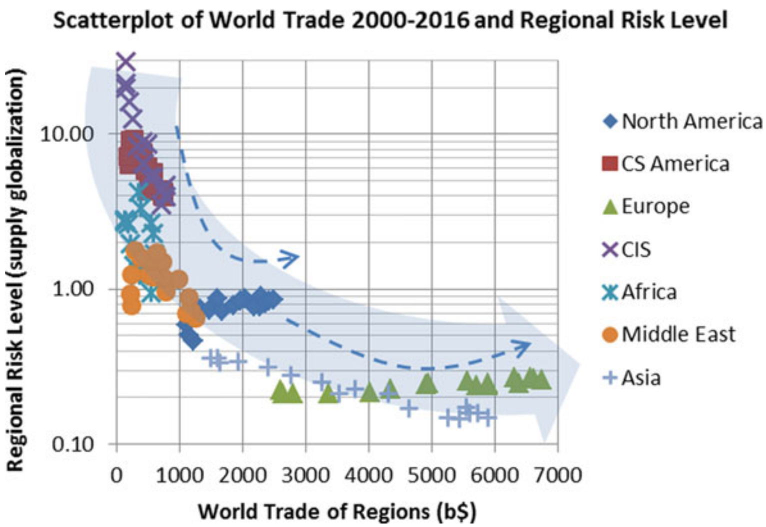


Fig. 29.7 Regional volume-risk pattern on disaggregated level

possibilities (postulate 1); nevertheless, also the enveloping curve shows an L-shaped curve.

The sensitivity analysis of different economic regions related to conjunctural evolution of economy is not performed at this time; for that we refer to a previously carried out analysis (Rüttimann 2017).

29.4 Unifying Trade Globalization Theory with an Eclectic Globalization Model

The lack of a scholastic theory which models globalization—either specifically or comprehensively, descriptive or analytically—leads naturally to the intention to close this deficiency. Indeed, the complexity of trade globalization can hardly be modeled by an omnipotent equation; an eclectic model might be necessary to explain the different behaviors of regional and world trade flows. At the base of that is to substitute the generic economic word "goods" with "specific products", because the product categories (commodities, specialties, intermediates) have a different logic of pricing and transaction leading to different globalization types. Indeed, the present analysis gives further insights into globalization behavior of trade deriving from differentiating the entity "goods". From Fig. 29.7 we can derive the following model (Fig. 29.8) which has been presented in (Rüttimann 2017) which concludes that certain specific trade theories applies best to certain specific geographic regions. In fact, the different patterns of evolution of trade globalization are mainly determined by two different causes:

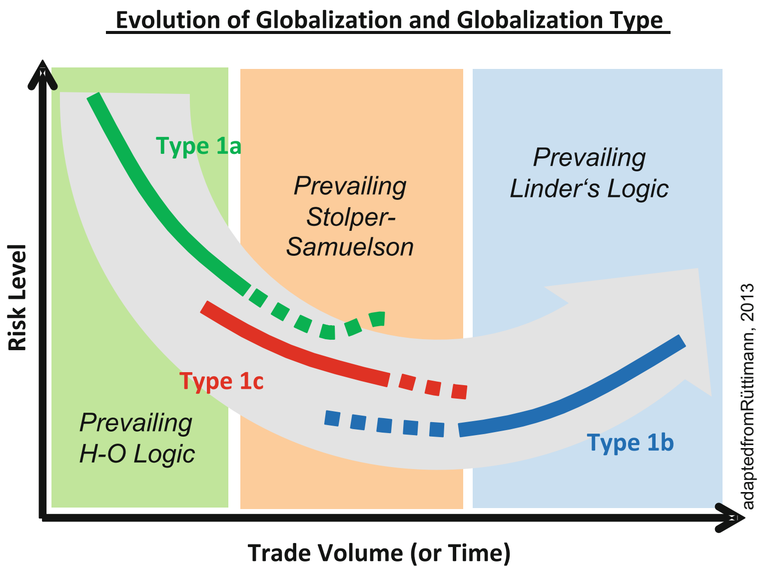


Fig. 29.8 The eclectic globalization model of trade

– The maturity degree of the different economic regions
– The characteristic of traded goods and relative globalization types.

For economic regions such as SC America, CIS, Africa, and Middle East, which are emerging economies presenting clear type 1a globalization pattern of commodities, the Heckscher-Ohlin trade theory applies best. For Asia, presently represented mainly by China, which is still an emerging economy and following for the time being still a low cost-based globalization logic (type 1c), the Stolper-Samuelson trade theory applies best. Mature economies such as NA and Europe, which trade consists mainly of specialty products, Linder's trade theory applies best. This differentiated reality shows that it is hardly possible to describe trade theory by only one basic trade theory logic, but we have to construct an eclectic globalization trade model to explain the evolution of globalization (Rüttimann 2017).

29.5 Conclusions

The present paper is an ongoing long-term analysis on trade globalization with the aim to find evidence for an omnipotent eclectic law of globalization to be used for scholastic and business modeling explaining what type of trade is how globalizing. Indeed, present mainstream models are not sufficient to explain the differentiated trade globalization phenomenon. The present results are encouraging bringing insights into this complex phenomenon called globalization which lead crystalizing such an eclectic trade globalization model. Nevertheless, the applicability of the various trade theories still have to be further investigated. If we are for trade globalization in presence of a Kuznets phenomenon or hysteresis pattern cannot yet be determined, needing additional future trade data. The analysis is to be continued.

Acknowledgements My very special thank goes to WTO, especially to Christoph Degain, providing me with the latest available trade data as well as with the data from the beginning of WTO cross trade tabulation gathering, encouraging this research.

Appendix

See Table 29.1.

Table 29.1 Cross trades and inequalities for the year 2016

2016 **t_{XY}**	North Am A	SC Am B	Europe C	CIS D	Africa E	Middle E F	Asia G	Supply	p_X
A	**1105.00**	**156.00**	**356.00**	**10.00**	**26.00**	**72.00**	**462.00**	2187.00	0.14
B	**119.00**	**115.00**	**89.00**	**6.00**	**14.00**	**15.00**	**146.00**	504.00	0.03
C	**529.00**	**93.00**	**4106.00**	**133.00**	**173.00**	**200.00**	**654.00**	5888.00	0.39
D	**17.00**	**3.00**	**207.00**	**77.00**	**15.00**	**14.00**	**83.00**	416.00	0.03
E	**28.00**	**8.00**	**133.00**	**2.00**	**68.00**	**17.00**	**82.00**	338.00	0.02
F	**56.00**	**5.00**	**99.00**	**4.00**	**24.00**	**86.00**	**314.00**	588.00	0.04
G	**1028.00**	**137.00**	**846.00**	**87.00**	**160.00**	**238.00**	**2745.00**	5241.00	0.35
Demand	2882.00	517.00	5836.00	319.00	480.00	642.00	4486.00	**15,162.00**	1.00
p_Y	0.19	0.03	0.38	0.02	0.03	0.04	0.30	1.00	1598

$p_{XY\infty}$	A	B	C	D	E	F	G		p_X
A	0.38	0.30	0.06	0.03	0.05	0.11	0.10		0.14
B	0.04	0.22	0.02	0.02	0.03	0.02	0.03		0.03
C	0.18	0.18	0.70	0.42	0.36	0.31	0.15		0.39
D	0.01	0.01	0.04	0.24	0.03	0.02	0.02		0.03
E	0.01	0.02	0.02	0.01	0.14	0.03	0.02		0.02
F	0.02	0.01	0.02	0.01	0.05	0.13	0.07		0.04
G	0.36	0.26	0.14	0.27	0.33	0.37	0.61		0.35
	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00

Ψ_{XY}	A	B	C	D	E	F	G		**$r_X(\Psi_{XY})$**
A	2.66	2.09	0.42	0.22	0.38	0.78	0.71		**0.77**
B	1.24	6.69	0.46	0.57	0.88	0.70	0.98		**4.72**
C	0.47	0.46	1.81	1.07	0.93	0.80	0.38		**0.24**
D	0.21	0.21	1.29	8.80	1.14	0.79	0.67		**8.90**

(continued)

Table 29.1 (continued)

Ψ_{XY}	A	B	C	D	E	F	G		$r_X(\Psi_{XY})$
E	0.44	0.69	1.02	0.28	6.35	1.19	0.82		**4.24**
F	0.50	0.25	0.44	0.32	1.29	3.45	1.80		**1.19**
G	1.03	0.77	0.42	0.79	0.96	1.07	1.77		**0.15**
									2.89
$r_Y(\Psi_{XY})$	**0.61**	**5.03**	**0.29**	**8.95**	**4.17**	**0.90**	**0.26**	**2.89**	**$r(\Psi_{XY})$**

Network of world merchandise trade by region
Source WTO International Trade Statistics, Table i04
The bold figures in the table represent the trade data and the inequalities

References

Degain, C., & Maurer, A. (2010). Globalization and trade flows: What you see is not what you get, WTO working paper.

Rüttimann, B. (2007). *Modeling economic globalization—A post-neoclassic view on foreign trade and competition*. Münster, Germany: MV-Wissenschaft. ISBN 978-3-86582-447-9.

Rüttimann, B. (2010). Measuring economic globalization: Entropy—based inequality risk metric. *Europa Regionum, XIII*, 7–23 (University of Stettin, Poland).

Ruettimann, B. (2011). An entropy-based inequality risk metric to measure economic globalization. In *Proceedings of 1st Conference on Spatial Statistics.* Procedia Environmental Sciences (Vol. 3, pp. 38–43). Elsevier.

Rüttimann, B. (2016). *Evolution of trade globalization from 2003–2014: Weakening dynamics of world trade confirms globalization postulates*. Paper presented at ICOAE 2016. Proceedings of the 2016 International Conference on Applied Economics (ICOAE), July 7–9, 2016. Nicosia, Cyprus: Advances in Applied Economic Research.

Rüttimann, B. (2017 presented). *Evidence for the globalization types model integrating different trade theories*. Paper to be published in International Journal of Computational Economics and Econometrics (IJCEE).

Chapter 30
Empirical Analysis of Copper Co-movement, Volatility and Hedge Ratios with Top Producing Countries

Corlise L. Le Roux

Abstract An empirical analysis of copper and a selection of currencies and indices of the countries that produce the largest amount of copper is done in the study to evaluate co-movement, volatility effects and static hedge ratios. The countries that are included are Chile, Peru, China, Australia, Congo, Zambia, Mexico, Indonesia, Canada, Russia, Poland, Kazakhstan, Brazil, South Africa and India. An index for Congo was not available, but the currency was included. To evaluate the overall effect on copper to emerging markets, the MSCI Emerging Market 50 Index was also included as part of the variables. The data will be evaluated by means of number of financial econometric models. The methodology includes correlation, VAR, Johansen Cointegration, Granger Causality, the generalised autoregressive conditional heteroscedastic (GARCH) model, Glosten-Jagannathan-Runkle generalised autoregressive conditional heteroscedastic (GJR-GARCH) model, and the exponential GARCH (EGARCH) model. The final part of the analysis includes the graphical representation of dynamic conditional correlations and four static hedge ratios which are the OLS methodology, ECM methodology, VECM methodology and finally the ECM-GARCH methodology. The models will be based on daily data from 1 August 2011 to 9 April 2018. The Granger Causality results suggest that relationships exist between all the variables except for seven currencies and one index, namely, the currencies for Australia, Brazil, Canada, Kazakhstan, Peru, Poland and Congo. The Index that does not show any relationship is the Zambian Lusaka All share Index. Volatility is present in the data and therefore the models mentioned will be compared in order to identify which model is the best fitting model for the selected commodities, currencies and index. Overall, GJR-GARCH was the best fitting model for copper spot and future, in addition, leverage effects exist which imply that negative shocks have a greater effect than positive shocks. The static hedge ratio analysis showed that Russian RPS Index and copper future provided the largest value, followed by the Brazilian Bovespa Index and the Peruvian S&P/BVL General Index. On the negative values, the largest negative value was obtained for the South African FTSE/JSE All Share Index.

C. L. Le Roux (✉)
University of Johannesburg, Johannesburg, South Africa
e-mail: corlisel@uj.ac.za

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_30

Keywords Co-movement · Copper · Hedge ratio · Volatility

30.1 Introduction

Copper, recognised as one of the metals that was extracted and used by humans has evolved into a vital metal used today. Copper is used in a number of manners, most notably in building construction and electrical and electronics. Even though copper is a metal that is utilised significantly around the world, it is highly recyclable and obtains a recyclable value of up to 95% of the newly mined price (Copper Development Association Inc 2017). Considering the importance of copper in modern day society, the linkages of the copper price to the countries that produce copper to their currency and main index will be investigated in the paper.

By understanding the co-movement of copper with the currency and index of the top countries producing copper, the relationships between then can be used for investment management, risk management and policy decision purposes. This paper only shows the foundational analysis between the variables, however further analysis can be done to better understand the co-movement relationship and the extent thereof. Since volatility is present within the market and individual financial assets a volatility analysis will be included as that can also be used as a method of forecasting time series data. These relationships and characteristics present within the included variables are important to understand as copper is a base metal which will still be used for many years in commercial and industrial applications and could therefore be used in future investment decisions.

This paper evaluates the co-movement and volatility behaviour present in 32 variables consisting of commodities, currencies and indices. The commodity is only focused on copper, however the currency and index are selected for 15 countries. The countries are Australia, Brazil, Canada, Chile, China, Congo, India, Indonesia, Kazakhstan, Mexico, Peru, Poland, Russia, South Africa and Zambia. These countries are listed as top copper producing countries. One country has been removed from the list, namely the United States.

The empirical data analysis of the study will include correlation, Johansen cointegration test and three GARCH family models, the generalised autoregressive conditional heteroscedastic (GARCH) model (Bollerslev 1986), Threshold GARCH (TGARCH) model also known as the Glosten-Jagannathan-Runkle generalised autoregressive conditional heteroscedastic (GJR-GARCH) model (Glosten et al. 1993), and the exponential GARCH (EGARCH) model (Nelson 1991). In addition, the conditional correlation will be shown to show a dynamic correlation movement. Lastly a comparison of four static hedge ratio measures will be done.

The remainder of the paper is structured as follows; Section 30.2 provides a brief review of current literature. Section 30.3 discusses the methodology and explanation of the data. Section 30.4 illustrates the results and interprets the findings. The final part, Sect. 30.5, discusses the conclusion and implication of the study.

30.2 Review of the Literature

Literature available specifically addressing copper co-movement with currencies and equity indices are limited. A further hindrance to the process is the selection of variables as well as the time period and methodology applied to evaluate the data is different between the studies. The most notable studies focused on the co-movement and volatility analysis which include copper will be briefly discussed.

Guo (2018) examines the co-movement of international copper prices with Chinese economic activity represented by industrial production and stock returns represented by the Shanghai Stock Exchange Composite Index from January 1991 to December 2015. The study applied a cross-correlation and GARCH methodology to focus on the volatility effects. The results obtained indicated three important findings, namely there are significant volatility cross-effects between the copper price and the economic activity of China; past stock returns are important in forecasting future volatility in copper prices, but the reverse does not apply; finally, negative dynamic correlations between copper prices and stock returns during the 2008 financial crisis provides an indication that copper can be used to hedge the risk of stock investments in China.

Choi and Hammoudeh (2010) investigated the volatility behaviour of oil, copper, gold and silver with the S&P 500 index for a period from 2 January 1990 to 1 May 2016 on a weekly basis. A univariate Markov-switching heteroscedasticity model with two regimes as well as a dynamic conditional correlation (DCC) multivariate GARCH model is applied in the study to measure the switch in return volatility and duration of the volatility, as well as evaluate the dynamic correlation with a final objective to obtain a comparison of patterns of persistence of volatilities and the convergence to long-run equilibriums. Copper along with gold showed the least amount of volatility in the findings. In addition, copper showed the lowest relative switch volatility. Choi and Hammoudeh (2010) stated that copper had extensive linkages to the overall economy which added to the predictability it provided. Copper seemed to be able to be used as a predictor for business cycles so that hedging decisions could be made against volatility.

Sadorsky (2014) analysed the volatility and dynamic correlations of emerging market stock prices with copper, oil and wheat prices using VARMA-AGRACH and DCC-AGRACH models with a final objective of obtaining hedge ratios and optimal portfolio weights. Daily data from 3 January 2000 to 29 June 2012 was included in the study. The results showed that a moderate positive correlation exists between the emerging market and copper. The average hedge ratio obtained from the DC-AGARCH model between the emerging market and copper is 26 cents in copper for a $1 position in the emerging market. The VARMA-AGRACH model obtained an average value of 25 cents. The portfolio weights analysis shows an 80/20% split to emerging markets and copper respectively.

Majority of previous literature has focused on volatility analysis, with sparse analysis linked to co-movement of the variables to determine interlinking relationships. In addition, this study will provide a comparison of four static hedge ratios between copper and the 15 countries that produce copper selected for this study.

30.3 Data and Methodology

The dataset included in this study includes copper as well as the currencies and main equity indices of the 15 countries that produce the largest amount of copper as well as the BRICS countries. The countries are: Chile, Peru, China, United States (not included in this study), Australia, Congo, Zambia, Mexico, Indonesia, Canada, Russia, Poland, Kazakhstan, Brazil, South Africa and India. An index for Congo was not available. To evaluate the overall effect on copper to emerging markets, the MSCI Emerging Market 50 Index was also included as part of the variables.

Data from 1 August 2011 to 9 April 2018 was included in this study with a total of 1746 data points. The prices of the datasets are daily spot prices available for the included commodities, currencies and index as well as the copper future price obtained from the Thomson Reuters Datastream database. Eviews was utilised as the tool to run the financial econometric models.

The variables and references code is shown below:

S&P/ASX 200 - PRICE INDEX	ASX200I
AUSTRALIAN $ TO US $ (WMR&DS) - EXCHANGE RATE	AUSTDOI
BRAZILIAN REAL TO US $ (WMR) - EXCHANGE RATE	BRACRU$
BRAZIL BOVESPA - TOT RETURN IND	BRBOVES
CHILEAN PESO TO US $ (WMR) - EXCHANGE RATE	CHILPE$
CHINESE YUAN TO US $ (WMR) - EXCHANGE RATE	CHIYUA$
SHANGHAI SE A SHARE - PRICE INDEX	CHSASHR
RUSSIAN ROUBLE TO US $ (WMR) - EXCHANGE RATE	CISRUB$
CANADIAN $ TO US $ (WMR) - EXCHANGE RATE	CNDOLL$
SOUTH AFRICA RAND TO US $ (WMR) - EXCHANGE RATE	COMRAN$
NIFTY 500 - PRICE INDEX	ICRI500
CHILE SANTIAGO SE GENERAL (IGPA) - PRICE INDEX	IGPAGEN
INDONESIAN RUPIAH TO US $ (WMR) - EXCHANGE RATE	INDORU$
INDIAN RUPEE TO US $ (WMR) - EXCHANGE RATE	INDRUP$
IDX COMPOSITE - PRICE INDEX	JAKCOMP
FTSE/JSE ALL SHARE - PRICE INDEX	JSEOVER
KAZAKHSTAN TENGE TO US $ (WMR) - EXCHANGE RATE	KAZAKT$
KAZAKHSTAN SE KASE - PRICE INDEX	KZHKASE
LME-Copper, Grade A 3 Months U$/MT	LCP3MTH
LME-Copper Grade A Cash U$/MT	LCPCASH
MEXICAN PESO TO US $ (WMR) - EXCHANGE RATE	MEXPES$

(continued)

(continued)

MSCI EM 50 - PRICE INDEX	MSEME5L
MEXICO IPC (BOLSA) - PRICE INDEX	MXIPC35
S&P/BVL GENERAL(IGBVL) - PRICE INDEX	PEGENRL
PERUVIAN SOL TO US $ (WMR) - EXCHANGE RATE	PERUSO$
WARSAW GENERAL INDEX - TOT RETURN IND	POLWIGI
POLISH ZLOTY TO US $ (WMR) - EXCHANGE RATE	POLZLO$
RUSSIA RTS INDEX - PRICE INDEX	RSRTSIN
S&P/TSX COMPOSITE INDEX - PRICE INDEX	TTOCOMP
CONGO (DRC) FRANC TO US $ (WMR) - EXCHANGE RATE	ZAIRER$
ZAMBIA LUSAKA ALL SHARE - PRICE INDEX	ZAMALSH
ZAMBIAN KWACHA (R) TO US $ (WMR) - EXCHANGE RATE	ZAMKWA$

The methodology applied to identify co-movement relationships includes graphical illustration of the differenced log data, followed by descriptive statistics, unit root tests, correlation, VAR, Johansen Cointegration, Granger Causality (Asteriou and Hall 2011; Johansen 1991; Luetkepohl 2011; Watson 1994).

The methodology adopted in this study to evaluate the volatility effects includes GARCH family models. The models that will be used are the generalised autoregressive conditional heteroscedastic (GARCH) model, Threshold GARCH (TGARCH) model also known as the Glosten-Jagannathan-Runkle generalised autoregressive conditional heteroscedastic (GJR-GARCH) model, and the exponential GARCH (EGARCH) model. The best fitting model will be determined by the Akaike information criterion (AIC) (Akaike 1974) and the Schwarz information criterion (SIC) (Schwartz 1978).

The GARCH model as specified by Brooks (2014) is:

$$\sigma^2 = \omega + \alpha\mu_{t-1}^2 + \beta\sigma_{t-1}^2$$

σ in the above equation represents the estimated conditional variance for one period ahead of the selected variable. In GARCH models, it allows for the conditional variance to be dependent on the included variables own lags.

The GJR-GARCH model includes leverage effects and is specified by Brooks (2014) as:

$$\sigma^2 = \omega + \alpha\mu_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma\mu_{t-1}^2 I_{t-1}$$

where

$$I_{t-1} = \begin{cases} 1 \; if \; \mu_{t-1} < 0 \\ \; Otherwise \end{cases}$$

where γ equals the asymmetry term representing the leverage effect. If the asymmetry term is positive and statistically significant, there is leverage present.

The EGARCH model also includes leverage effects and is specified by Brooks (2014) as:

$$\ln\left(\sigma^2\right) = \omega + \beta \ln\left(\sigma_{t-1}^2\right) + \gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha\left[\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right]$$

where γ equals the asymmetry term representing the leverage effect. If the asymmetry term is negative and statistically significant, there is leverage present.

The final part of the analysis includes the graphical representation of dynamic conditional correlations in order to view the moving correlations. Thereafter four static hedge ratios will be calculated for the data using the future copper price and the spot currency and equity index prices. The four methods that will be applied is the OLS methodology, ECM methodology, VECM methodology and finally the ECM-GARCH methodology.

The static risk-minimising hedge ratio (h^*) can be written as an element of covariance and variance, such that:

$$h^* = \frac{-cov_{sf}}{\sigma_f^2}$$

where $-cov_{sf}$ is the covariance between the spot and future price variable and σ_f^2 is the variance of the futures price variable with itself.

Using the ordinary least squares method to calculate the minimum-variance hedge ratio, the regression equation that is obtained is (Coakley et al. 2008):

$$\Delta c_t = \beta_0 + \beta_1 \Delta f_t + \varepsilon_t$$

where the estimated value of β_1 is the minimum variance hedge ratio. β_0 is assumed to be zero as the cash position is initially equal to zero. The futures variable is not considered as an endogenous variable in this context (Kumar et al. 2008).

In order to calculate the hedge ratio, minimum variance hedge ratio (h) is also the beta coefficient (β) and is calculated as:

$$h = \rho \frac{\sigma_i}{\sigma_j}$$

where ρ is the correlation coefficient between the returns of i and j and σ_i and σ_j are the standard deviations of returns of i and j respectively which is similar to h being expressed in terms of covariance (Howard and D'Antonio 1984; Johnson 1960).

In order to determine the hedge ratios based on ECM, the classical hedge ratio from OLS was compared by taking into account the long run stable relationship between the two time series. The analysis is based on the Engle and Granger two-step estimation technique (Engle and Granger 1987). The initial step in the Engle and Granger two-step estimation technique is to test for a unit root or non-stationarity by means of the augmented Dickey-Fuller test (Dickey and Fuller 1981). The unit root test was verified by the Phillips-Perron test (Puhle 2013; Alexander 1999; Perron 1989).

Following on, a relationship of non-stationarity is required, therefore the null hypothesis of non-stationarity should not be rejected. The next step would be to estimate the static equilibrium model and test the residuals for a stationary time series by means of the unit root test, augmented Dickey-Fuller test. The critical values used to determine if the null hypothesis is rejected or not rejected are based on the Engle and Yoo (1987) critical values as the series is now an estimated one. In this step we aim to reject the null hypothesis of non-stationarity to obtain two cointegrated variables (Puhle 2013; Alexander 1999).

Once two cointegrated variables are obtained, the Error-Correction Model (ECM) will be estimated based on the Autoregressive Distributed Lag (ARDL) cointegration model, which was proposed by Pesaran (1997) and adapted by Chen et al. (2004). The ARDL model includes lags for the dependent and independent variables in order to obtain the optimal lag selection (Greene 2008). The logged returns will be used for the ECM methodology, and the coefficient obtained for the slope of the futures returns with no lag therefore provides the hedge ratio based on the ECM model using the ARDL methodology. The ECM is a dynamic model in that it looks at how the system returns to its static equilibrium as well as how long it takes to return to the static equilibrium. The ECM methodology is mainly utilised for short-term forecasts, as the correction back to equilibrium in the long term is moderately slow (Scutaru 2011).

The VECM methodology requires the VAR process to be followed in that two variables, one spot and one future will be analysed within a VAR based on logged prices, cointegration results obtained from the ECM model, and VECM model testing based on logged returns. The starting point for this methodology is to determine the appropriate lag length required in order to obtain the applicable VAR model that leads into the VECM testing, if applicable based on the cointegration results, in order to obtain the hedge ratio results. The VECM hedge ratio is calculated using the standard deviation of the residuals. The inputs for the equation are obtained from the VECM outputs as well as the correlation coefficient and standard deviations of the residuals of the two variables.

The ECM-GARCH methodology is similar to the ECM methodology, but takes into account the volatility clustering present within the variables in order to determine the hedge ratio. If volatility clustering is present, tested by means of the Lagrange Multiplier test, also known as the autoregressive conditional heteroscedasticity (ARCH) LM test, a univariate GARCH model will be applied in order to obtain the hedge ratio. The value of the coefficient of the futures returns represents the hedge ratio in the ECM-GARCH (1,1) model.

The ECM-GARCH method extends the ECM model from Chou et al. (1996) in that the hedge ratio obtained from the ECM with GARCH is as follows (Bollerslev and Wooldridge 1992):

$$\Delta S_t = c + a\hat{\varepsilon}_{t-1} + b\Delta F_t + \theta_1 \Delta F_{t-1} + \emptyset_1 \Delta S_{t-1} + u_t$$

where $u_t = \sigma_t z_t$; and $\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2$.

The logged prices are used to obtain the residual series for the first part of the analysis. The second part of the analysis is based on the logged returns as well as the generated residual series.

30.4 Empirical Results

The graphical representation of the log differenced data is illustrated in Fig. 30.1. The log return graphs indicate that volatility clustering is present in majority of the variables.

The descriptive statistics of the variables are shown in Table 30.1. All the variables exhibit excess kurtosis, however there is mixed results with regards to skewness.

The Augmented Dickey-Fuller (ADF) (Dickey and Fuller 1981) and Phillips-Perron (PP) (Perron 1989) tests are undertaken to determine if unit roots exist which is required to continue with the analysis. The results of the test ADF and PP tests are show that all the variables are stationary at first difference at a one percent significance level.

The correlation results show that no strong positive or negative correlation relationships (above 0.50 or below −0.50) exist between copper and the variables based on a log return basis.

VAR analysis and Johansen cointegration test was run between combinations of variables, which were between copper and the currencies and well as indices to determine the long-run relationships between the variables. The summary of the optimal lag lengths and cointegrating analysis are shown in Table 30.2.

The results indicated that only the Chinese Yuan, Indian Rupee, Kazakhstan Tenge, Mexican IPC Index, Russian RTS Index, as well as the copper future price has cointegrating relationship. The remainder of the results showed no cointegration.

Bilateral or feedback Granger causality relationships at a 5% level of significance are found between the following variables (Table 30.3):

- Chilean Peso and copper future
- Chilean Peso and copper spot
- Copper spot and copper future
- Indian Rupee and copper future
- Indian Rupee and copper spot

Unidirectional causal relationships at a 5% level of significance are found between the following variables:

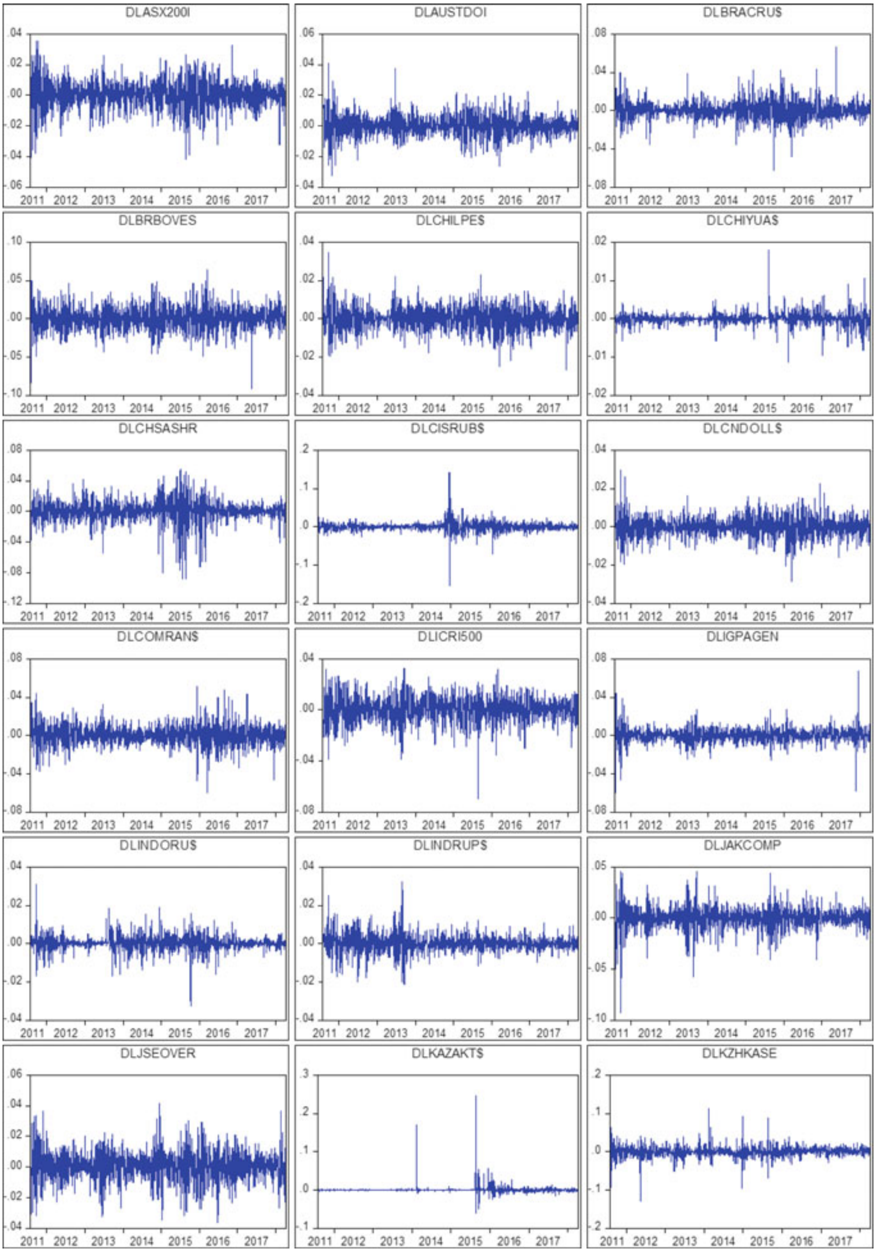


Fig. 30.1 Graphical representation of movement in the six variables. *Source* Researcher's analysis

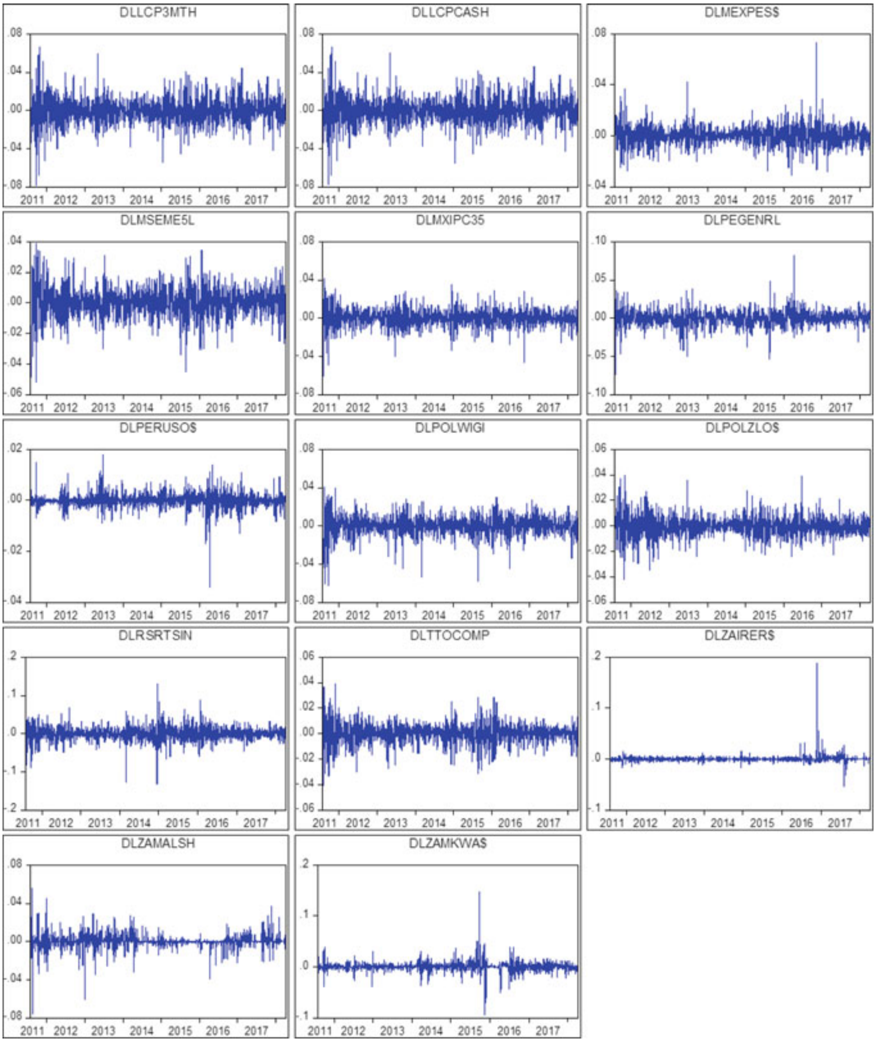


Fig. 30.1 (continued)

- From Brazil Bovespa Index to copper spot and future
- From Canadian S&P/TSX Composite Index to copper spot and future
- From Chilean Santiago SE General Index to copper future
- From copper spot and future to Australian ASX 200 Index
- From copper spot and future to Chinese Shanghai SE A Share Index
- From copper spot and future to Chinese Yuan
- From copper spot and future to Indian Nifty 500
- From copper spot and future to Indonesian IDX Composite Index
- From copper spot and future to Indonesian Rupiah

Table 30.1 Descriptive statistics

	DLASX200I	DLAUSTDOI	DLBRACRU$	DLBRBOVES	DLCHILPE$	DLCHIYUA$	DLCHSASHR	DLCISRUB$
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.036	0.041	0.067	0.064	0.035	0.018	0.056	0.143
Minimum	−0.042	−0.033	−0.062	−0.092	−0.027	−0.011	−0.089	−0.155
Std. Dev.	0.009	0.007	0.009	0.014	0.006	0.002	0.014	0.011
Skewness	−0.315	0.168	0.199	−0.156	0.067	0.627	−1.111	−0.031
Kurtosis	5.080	5.731	7.799	5.357	4.830	21.079	10.779	41.554
Jarque-Bera	343.295	550.459	1686.069	410.941	244.906	23,878.830	4758.858	108,072.500
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	0.256	0.355	0.779	0.353	0.273	−0.019	0.149	0.776
Sum Sq. Dev.	0.131	0.075	0.151	0.362	0.059	0.004	0.324	0.226
Observations	1745	1745	1745	1745	1745	1745	1745	1745
	DLCNDOLL$	DLCOMRAN$	DLICRI500	DLIGPAGEN	DLINDORU$	DLINDRUP$	DLJAKCOMP	DLJSEOVER
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.030	0.052	0.033	0.067	0.031	0.033	0.046	0.042
Minimum	−0.029	−0.060	−0.069	−0.060	−0.033	−0.021	−0.093	−0.036
Std. Dev.	0.005	0.010	0.009	0.007	0.004	0.004	0.010	0.009
Skewness	−0.035	0.156	−0.473	−0.187	−0.493	0.378	−0.861	−0.170
Kurtosis	5.561	6.124	5.839	14.839	14.126	8.920	10.927	4.690
Jarque-Bera	477.292	716.477	650.874	10,200.750	9071.593	2589.765	4784.991	216.099
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	0.282	0.587	0.729	0.271	0.487	0.388	0.398	0.585
Sum Sq. Dev.	0.044	0.176	0.151	0.094	0.025	0.034	0.178	0.146
Observations	1745	1745	1745	1745	1745	1745	1745	

(continued)

Table 30.1 (contiued)

	DLKAZAKT$	DLKZHKASE	DLLCP3MTH	DLLCPCASH	DLMEXPES$	DLMSEME5L	DLMXIPC35	DLPEGENRL
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
Maximum	0.246	0.113	0.066	0.067	0.073	0.039	0.042	0.083
Minimum	−0.061	−0.130	−0.078	−0.078	−0.031	−0.052	−0.061	−0.074
Std. Dev.	0.009	0.014	0.013	0.013	0.007	0.010	0.009	0.010
Skewness	15.245	−0.308	0.027	0.043	0.701	−0.261	−0.363	−0.245
Kurtosis	377.284	17.339	6.153	6.051	10.342	5.071	6.553	10.420
Jarque-Bera	10,253,184.000	14977.280	723.069	677.517	4061.709	331.540	955.971	4020.186
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	0.790	0.466	−0.346	−0.349	0.438	0.248	0.296	−0.044
Sum Sq. Dev.	0.145	0.321	0.296	0.303	0.097	0.158	0.136	0.172
Observations	1745	1745	1745	1745	1745	1745	1745	
	DLPERUSO$	DLPOLWIGI	DLPOLZLO$	DLRSRTSIN	DLTTOCOMP	DLZAIRER$	DLZAMALSH	DLZAMKWA$
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.018	0.041	0.040	0.132	0.039	0.189	0.056	0.148
Minimum	−0.034	−0.062	−0.042	−0.133	−0.041	−0.053	−0.076	−0.094
Std. Dev.	0.003	0.010	0.008	0.018	0.008	0.006	0.007	0.010
Skewness	−0.832	−0.756	0.068	−0.378	−0.373	16.525	−0.673	1.132
Kurtosis	17.421	7.699	6.049	10.307	6.018	501.802	23.551	43.260
Jarque-Bera	15,321.700	1771.570	677.181	3923.732	702.546	18,169,473.000	30,839.000	118,222.300
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	0.167	0.243	0.190	−0.595	0.162	0.564	0.323	0.674
Sum Sq. Dev.	0.015	0.170	0.103	0.588	0.104	0.067	0.083	0.168
Observations	1745	1745	1745	1745	1745	1745	1745	

Source Researcher's analysis

Table 30.2 Optimal lag lengths and cointegration

LLCPCASH	Lag number	Cointegration or not	Number of cointegrating equations
LASX200I	5	None	
LAUSTDOI	2	None	
LBRACRU$	1	None	
LBRBOVES	2	None	
LCHILPE$	3	None	
LCHIYUA$	2	Yes	2
LCHSASHR	2	None	
LCISRUB$	3	None	
LCNDOLL$	2	None	
LCOMRAN$	3	None	Except 1 at quadratic intercept and trend
LICRI500	2	None	
LIGPAGEN	4	None	
LINDORU$	2	None	Except 1 at none no intercept no trend
LINDRUP$	6	Yes	1
LJAKCOMP	5	None	
LJSEOVER	3	None	Except 1 at none no intercept no trend
LKAZAKT$	4	Yes	1
LKZHKASE	4	None	
LLCP3MTH	8	Yes	2
LMEXPES$	5	None	
LMSEME5L	2	None	Except at linear intercept and trend as well as quadratic intercept and trend
LMXIPC35	4	Yes	2
LPEGENRL	2	None	
LPERUSO$	2	None	Except at linear intercept and trend as well as quadratic intercept and trend
LPOLWIGI	6	None	
LPOLZLO$	2	None	
LRSRTSIN	3	Yes	2
LTTOCOMP	2	None	
LZAIRER$	2	None	Except at none no intercept no trend
LZAMALSH	2	None	
LZAMKWA$	3	None	

Source Researcher's analysis

- From copper spot and future to Kazakhstan SE Kase Index
- From copper spot and future to Polish Warsaw General Index
- From copper spot and future to Russian RTS Index
- From copper spot and future to South African FTSE/JSE All Share Index
- From copper spot and future to the MSCI Emerging Market 50 Index

Table 30.3 Granger causality

Null hypothesis	Obs	F-statistic	Prob.
DLLCP3MTH does not Granger cause DLASX200I	1743	52.959	0.000
DLLCPCASH does not Granger cause DLASX200I	1743	52.479	0.000
DLBRBOVES does not Granger cause DLLCP3MTH	1743	4.261	0.014
DLBRBOVES does not Granger cause DLLCPCASH	1743	3.480	0.031
DLLCP3MTH does not Granger cause DLCHILPE$	1743	4.947	0.007
DLCHILPE$ does not Granger cause DLLCP3MTH	1743	6.530	0.002
DLLCPCASH does not Granger cause DLCHILPE$	1743	5.093	0.006
DLCHILPE$ does not Granger cause DLLCPCASH	1743	5.667	0.004
DLLCP3MTH does not Granger cause DLCHIYUA$	1743	4.788	0.008
DLLCPCASH does not Granger cause DLCHIYUA$	1743	4.928	0.007
DLLCP3MTH does not Granger cause DLCHSASHR	1743	7.322	0.001
DLLCPCASH does not Granger cause DLCHSASHR	1743	6.994	0.001
DLCISRUB$ does not Granger cause DLLCP3MTH	1743	3.698	0.025
DLCISRUB$ does not Granger cause DLLCPCASH	1743	3.647	0.026
DLCOMRAN$ does not Granger cause DLLCP3MTH	1743	4.675	0.009
DLCOMRAN$ does not Granger cause DLLCPCASH	1743	4.222	0.015
DLLCP3MTH does not Granger cause DLICRI500	1743	4.242	0.015
DLLCPCASH does not Granger cause DLICRI500	1743	4.207	0.015
DLIGPAGEN does not Granger cause DLLCP3MTH	1743	3.242	0.039
DLLCP3MTH does not Granger cause DLINDORU$	1743	6.898	0.001
DLLCPCASH does not Granger cause DLINDORU$	1743	7.148	0.001
DLLCP3MTH does not Granger cause DLINDRUP$	1743	4.536	0.011
DLINDRUP$ does not Granger cause DLLCP3MTH	1743	3.275	0.038
DLLCPCASH does not Granger cause DLINDRUP$	1743	4.734	0.009
DLINDRUP$ does not Granger cause DLLCPCASH	1743	3.113	0.045
DLLCP3MTH does not Granger cause DLJAKCOMP	1743	12.515	0.000
DLLCPCASH does not Granger cause DLJAKCOMP	1743	12.205	0.000
DLLCP3MTH does not Granger cause DLJSEOVER	1743	4.600	0.010
DLLCPCASH does not Granger cause DLJSEOVER	1743	4.471	0.012
DLLCP3MTH does not Granger cause DLKZHKASE	1743	32.172	0.000
DLLCPCASH does not Granger cause DLKZHKASE	1743	31.861	0.000
DLLCPCASH does not Granger cause DLLCP3MTH	1743	6.473	0.002
DLLCP3MTH does not Granger cause DLLCPCASH	1743	6.544	0.002
DLMEXPES$ does not Granger cause DLLCP3MTH	1743	3.495	0.031
DLLCP3MTH does not Granger cause DLMSEME5L	1743	5.887	0.003
DLMXIPC35 does not Granger cause DLLCP3MTH	1743	6.547	0.002
DLPEGENRL does not Granger cause DLLCP3MTH	1743	3.875	0.021
DLLCP3MTH does not Granger cause DLPOLWIGI	1743	4.256	0.014
DLLCP3MTH does not Granger cause DLRSRTSIN	1743	5.160	0.006
DLTTOCOMP does not Granger cause DLLCP3MTH	1743	9.375	0.000

(continued)

Table 30.3 (continued)

Null hypothesis	Obs	F-statistic	Prob.
DLLCP3MTH does not Granger cause DLZAMKWA$	1743	4.585	0.010
DLMEXPES$ does not Granger cause DLLCPCASH	1743	3.108	0.045
DLLCPCASH does not Granger cause DLMSEME5L	1743	5.626	0.004
DLMXIPC35 does not Granger cause DLLCPCASH	1743	6.135	0.002
DLPEGENRL does not Granger cause DLLCPCASH	1743	3.193	0.041
DLLCPCASH does not Granger cause DLPOLWIGI	1743	4.292	0.014
DLLCPCASH does not Granger cause DLRSRTSIN	1743	5.052	0.007
DLTTOCOMP does not Granger cause DLLCPCASH	1743	8.526	0.000
DLLCPCASH does not Granger cause DLZAMKWA$	1743	4.556	0.011

Source Researcher's analysis

- From copper spot and future to Zambian Kwacha
- From Mexican IPC Index to copper spot and future
- From Mexican Peso to copper spot and future
- From Peruvian S&P/BVL General Index to copper spot and future
- From Russian Rouble to copper spot and future
- From South African Rand to copper spot and future

Relationships exist between all the variables except for seven currencies and one index, namely, the currencies for Australia, Brazil, Canada, Kazakhstan, Peru, Poland and Congo. The Index that does not show any relationship is the Zambian Lusaka All share Index.

Table 30.4 shows the ARCH LM tests results that indicates copper spot and future were statistically significant at a one percent level of significance using one lag. Based on these results, the GARCH family models were estimated and included in the next section.

The GARCH results for GARCH(1,1), GJR-GARCH(1,1) and EGARCH(1,1) are displayed in Table 30.5. The GJR-GARCH model that is deemed to be the best fitting model is the model with the smallest AIC and SIC result. The existence of volatility clustering as tested by the GARCH models is evaluated based on the α and β coefficients. If the coefficients are positive and statistically significant then it implies that volatility clustering present in the dataset. If the sum of α and β coefficients are close to one, it means that shocks to the conditional variance will be extremely persistent (Brooks 2014).

Table 30.4 ARCH LM test results

	Lag	F-statistic	Obs*R-squared
Copper spot	1	70.869***	68.177***
Copper future	1	73.836***	70.915***

Source Researcher's analysis
*** Statistically significant at a 1% level of significance

Table 30.5 GARCH, GJR-GARCH, and EGARCH results

GARCH Model	Variable	ω	α	β	γ	AIC	SIC
GARCH	Copper spot	0.000	0.040***	0.945***	–	−5.943	−5.930
	Copper future	0.000	0.040***	0.944***	–	−5.972	−5.959
GJR-GARCH	Copper spot	0.000	0.020***	0.946***	0.035***	**−5.948**	**−5.932**
	Copper future	0.000	0.021***	0.945***	0.034***	**−5.977**	**−5.961**
EGARCH	Copper spot	−0.205	0.084***	0.984***	−0.034***	−5.942	−5.927
	Copper future	−0.204	0.083***	0.984***	−0.033***	−5.972	−5.956

Source Researcher's analysis
*** Statistically significant at a 1% level of significance

The asymmetry term present in the GJR-GARCH and EGARCH model indicates the effect of leverage present in the dataset. For the GJR-GARCH model, the asymmetry terms needs to be positive and statistically significant to indicate leverage effects. For the EGARCH model, the opposite is true, the terms needs to be negative and statistically significant in order to indicate leverage effects. If leverage effects are found in either of the models, it implies that negative effects will have a greater rise in volatility. The results show that leverage effects exist.

Diagnostics checking was applied to the models in order to check for serial correlation. The dynamic correlations are shown in Fig. 30.2 which can be used to considering including more advanced GARCH models to evaluate copper and the selected currencies and indices.

The static hedge ratio summary is shown in Table 30.6, comparing the four methods. Hedging effectiveness has not been calculated as the objective of this study was to evaluate the overall relationships. Other than copper spot, the Russian RPS Index and copper future provided the largest value, followed by the Brazilian Bovespa Index and the Peruvian S&P/BVL General Index. On the negative values, the largest negative value is obtained for the South African FTSE/JSE All Share Index.

30.5 Conclusion and Implications

This paper analysed the co-movement between copper and the included currencies and indices. In addition, GARCH models were applied to evaluate the volatility present in the variables.

The countries included were Chile, Peru, China, Australia, Congo, Zambia, Mexico, Indonesia, Canada, Russia, Poland, Kazakhstan, Brazil, South Africa and India. An index for Congo was not available. To evaluate the overall effect on copper to emerging markets, the MSCI Emerging Market 50 Index was also included as part of the variables. The variables were evaluated from 1 August 2011 to 9 April 2018.

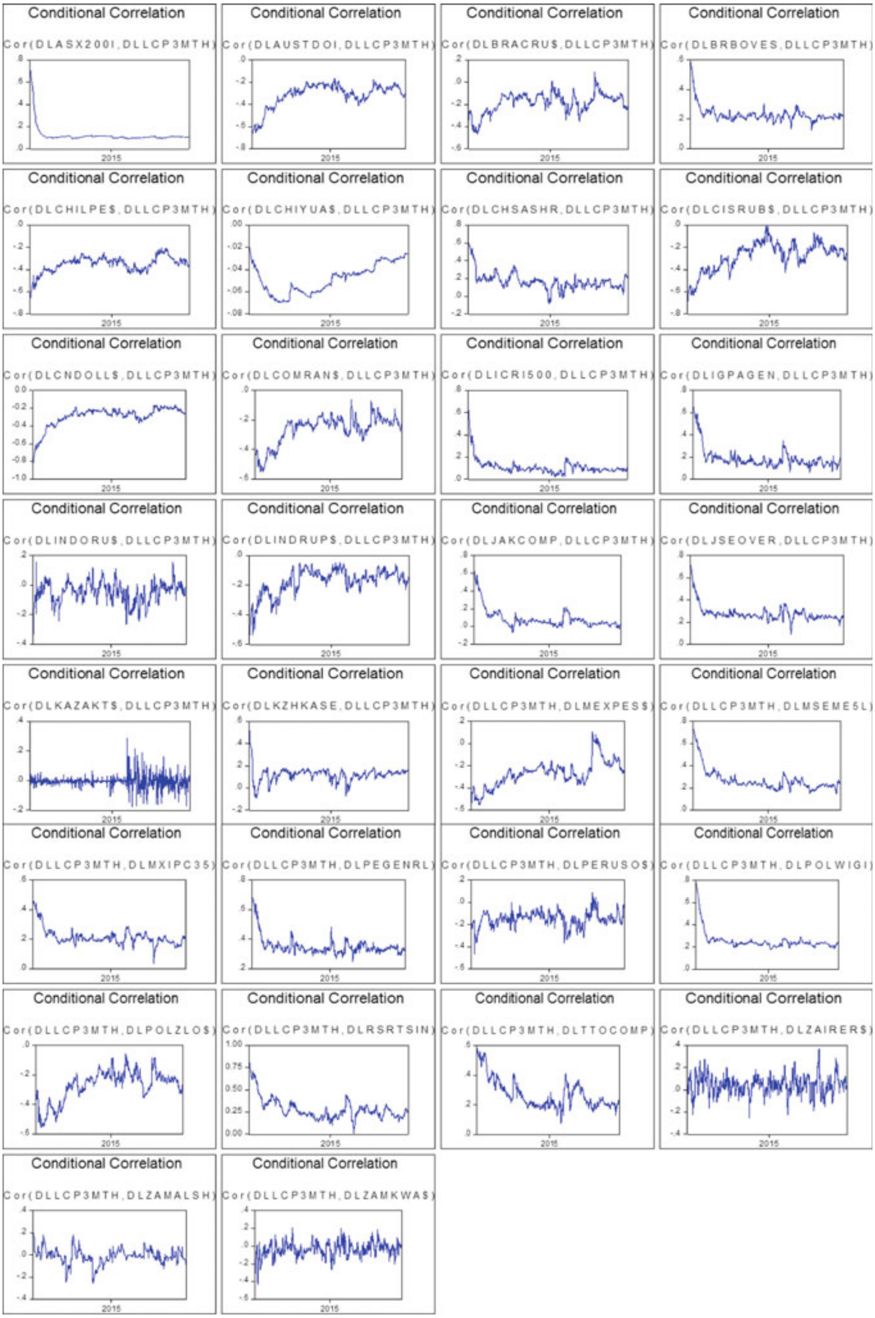


Fig. 30.2 Graphical representation of rolling correlations between variables. *Source* Researcher's analysis

Table 30.6 Static hedge ratios

LLCP3MTH	Lag length	Correlation	VECM OHR	OLS	Cointegrated at 5%	ECM (ARDL)	ARCH	ECM-GARCH
LASX200I	5	0.208	0.133	0.133	Yes	0.132	0.000	0.108
LAUSTDOI	2	−0.420	−0.212	−0.211	Yes	−0.213	0.014	−0.188
LBRACRU$	1	−0.250	−0.179	−0.178	Yes	−0.179	0.000	−0.154
LBRBOVES	2	0.313	0.348	0.342	No			
LCHILPE$	3	−0.421	−0.189	−0.185	Yes	−0.187	0.000	−0.168
LCHIYUA$	2	−0.072	−0.009	−0.008	No			
LCHSASHR	2	0.171	0.179	0.172	Yes	0.175	0.000	0.132
LCISRUB$	3	−0.280	−0.246	−0.241	Yes	−0.246	0.000	−0.218
LCNDOLL$	3	−0.379	−0.147	−0.146	Yes	−0.146	0.038	−0.138
LCOMRAN$	3	−0.346	−0.268	−0.264	Yes	−0.267	0.000	−0.248
LICRI500	2	0.189	0.135	0.132	No			
LIGPAGEN	4	0.284	0.157	0.165	No			
LINDORU$	2	−0.087	−0.025	−0.023	Yes	−0.026	0.000	−0.008
LINDRUP$	6	−0.251	−0.085	−0.081	Yes	−0.086	0.000	−0.055
LJAKCOMP	5	0.187	0.143	0.148	No			
LJSEOVER	3	0.386	0.270	0.266	Yes	0.264	0.000	0.245
LKAZAKT$	4	0.011	0.008	0.016	No			
LKZHKASE	4	0.166	0.168	0.169	No			
LCPCASH	8	0.998	1.010	1.010	Yes	1.010	0.000	1.007
LMEXPES$	5	−0.319	−0.182	−0.183	No			
LMSEME5L	2	0.399	0.286	0.284	No			
LMXIPC35	4	0.299	0.201	0.204	Yes	0.194	0.000	0.175
LPEGENRL	2	0.435	0.329	0.332	Yes	0.319	0.002	0.285
LPERUSO$	2	−0.218	−0.049	−0.047	Yes	−0.048	0.000	−0.033

(continued)

Table 30.6 (continued)

LLCP3MTH	Lag length	Correlation	VECM OHR	OLS	Cointegrated at 5%	ECM (ARDL)	ARCH	ECM-GARCH
LPOLWIGI	6	0.372	0.276	0.284	No			
LPOLZLO$	2	−0.365	−0.214	−0.214	Yes	−0.214	0.000	−0.163
LRSRTSIN	3	0.372	0.522	0.510	Yes	0.523	0.000	0.458
LTTOCOMP	2	0.391	0.232	0.234	Yes	0.225	0.000	0.164
LZAIRER$	2	0.036	0.017	0.017	No			
LZAMALSH	2	−0.011	−0.006	−0.007	No			
LZAMKWA$	3	−0.055	−0.040	−0.035	Yes	−0.036	0.000	−0.030

Source Researcher's analysis

The full methodology included graphical illustration of the differenced log data, followed by descriptive statistics, unit root tests, correlation, VAR, Johansen Cointegration, Granger Causality, the generalised autoregressive conditional heteroscedastic (GARCH) model, Glosten-Jagannathan-Runkle generalised autoregressive conditional heteroscedastic (GJR-GARCH) model, and the exponential GARCH (EGARCH) model. The final part of the analysis includes the graphical representation of dynamic conditional correlations and four static hedge ratios which are the OLS methodology, ECM methodology, VECM methodology and finally the ECM-GARCH methodology.

The co-movement analysis showed no strong positive or negative correlations between copper and the currencies and indices on a log differenced basis. Cointegration was present between the Chinese Yuan, Indian Rupee, Kazakhstan Tenge, Mexican IPC Index, Russian RTS Index, as well as the copper future price compared to the copper spot. Granger Causality showed a bilateral relationship between both the Indian Rupee and the Chilean Peso; against both copper spot and future. In addition, a bilateral relationship exists between copper spot and copper future. The unilateral analysis showed that a unilateral relationship exist from copper spot and copper future to the index of Australia, China, India, Indonesia, Kazakhstan, Poland, South African, the MSCI Emerging Market 50 Index as well as the currencies of China, Indonesia, and Zambia. The opposite unilateral relationships exist from the Index of Brazil, Canada, Chile (copper future only), Mexico, Peru, as well as the currencies of Mexico, Russia and South Africa to copper spot and future. Relationships exist between all the variables except for seven currencies and one index, namely, the currencies for Australia, Brazil, Canada, Kazakhstan, Peru, Poland and Congo. The Index that does not show any relationship is the Zambian Lusaka All share Index. The volatility analysis showed that the GJR-GARCH(1,1) model was the best fitting model for copper spot and future according to the AIC and SIC results. In addition, leverage effects exist which imply that negative shocks have a greater effect than positive shocks. The static hedge ratio analysis showed that Russian RPS Index and copper future provided the largest value, followed by the Brazilian Bovespa Index and the Peruvian S&P/BVL General Index. On the negative values, the largest negative value was obtained for the South African FTSE/JSE All Share Index.

Further research can be done in order to further analyse this dataset based on the results of this study. Alternative co-movement and volatility modelling models can be applied to the same dataset in order to further evaluate the effects present in the variables. In addition, other commodities and countries can be analysed in order to determine if the co-movement and volatility effects present in other variables are similar or not. Production and consumption trends can also be evaluated along with the prices of the commodities to identify and links that are present.

References

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control Ac, 19*, 716–723.

Alexander, C. (1999). Optimal hedging using co-integration. *Philosophical Transactions of the Royal Society of London A, 357*(1758), 2039–2058.

Asteriou, D., & Hall, S. G. (2011). *Applied econometrics* (2nd ed.). United Kingdom: Palgrave Macmillan.

Bollerslev, T. (1986). Generalised autoregressive conditional heteroskedasticity. *Journal of Econometrics, 3,* 307–327.

Bollerslev, T., & Wooldridge, J. M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. *Econometric Reviews, 11*(2), 143–172.

Brooks, C. (2014). *Introductory econometrics for finance* (3rd ed.). United Kingdom: Cambridge University Press.

Chen, S. S., Lee, C. F., & Shrestha, K. (2004). An empirical analysis of the relationship between the hedge ratio and hedging horizon: A simultaneous estimation of the short-and long-run hedge ratios. *Journal of Futures Markets, 24*(4), 359–386.

Coakley, J., Dollery, J., & Kellard, N. (2008). The role of long memory in hedging effectiveness. *Computational Statistics & Data Analysis, 52*(6), 3075–3082.

Choi, K., & Hammoudeh, S. (2010). Volatility behavior of oil, industrial commodity and stock markets in a regime-switching environment. *Energy Policy, 38,* 4388–4399.

Chou, W. L., Denis, K. F., & Lee, C. F. (1996). Hedging with the Nikkei index futures: The conventional model versus the error correction model. *The Quarterly Review of Economics and Finance, 36*(4), 495–505.

Copper Development Association Inc. (2017). *Copper—The World's most reusable resource.* https://www.copper.org/environment/lifecycle/g_recycl.html.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*(4), 1057–1072.

Engle, R., & Granger, C. (1987). Co-integration and error-correction: Representation, estimation and testing. *Econometrica, 55*(2), 251–276.

Engle, R., & Yoo, B. (1987). Forecasting and testing in co-integrated systems. *Journal of Econometrics, 35*(1), 143–159.

Glosten, L. R., Jagannathan, R., & Runkle, D. (1993). On the relation between the expected value and the volatility of the nominal excess return on stocks. *Journal of Finance, 48,* 1779–1801.

Greene, W. H. (2008). The econometric approach to efficiency analysis. *The Measurement of Productive Efficiency and Productivity Growth, 1,* 92–250.

Guo, J. (2018). Co-movement of international copper prices, China's economic activity, and stock returns: Structural breaks and volatility dynamics. *Global Finance Journal, 36,* 62–77.

Howard, C., & D'Antonio, L. (1984). A risk-return measure of hedging effectiveness. *The Journal of Financial and Quantitative Analysis, 19*(1), 101–112.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica, 59*(6), 1551–1580.

Johnson, L. (1960). The theory of hedging and speculation in commodity futures. *Review of Economic Studies, 27*(3), 139–151.

Kumar, B., Singh, P., & Pandey, A. (2008). Hedging effectiveness of constant and time varying hedge ratio in Indian stock and commodity futures markets. *Working Paper no. 2008-06-01*. Ahmedabad, India: Indian Institute of Management.

Luetkepohl, H. (2011). Vector autoregressive models. *European University Institute Working Papers ECO 2011/30.*

Nelson, D. B. (1991). Conditional Heteroskedasticity in asset returns: A new approach. *Econometrica, 59,* 347–370.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica, 57*(6), 1361–1401.

Pesaran, M. H. (1997). The role of economic theory in modelling the long run. *The Economic Journal, 107*(440), 178–191.

Puhle, M. (2013). Time series analysis. In G. Daróczi, M. Puhle, E. Berlinger, P. Csóka, D. Havran, M. Michaletzky, Z. Tulassay, K. Váradi, & A. Vidovics-Dancs (Eds.), *Introduction to R for quantitative finance* (pp. 15–18). Birmingham: Packt Publishing.

Sadorsky, P. (2014). Modeling volatility and correlations between emerging market stock prices and the prices of copper, oil and wheat. *Energy Economics, 43,* 72–81.

Schwartz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics, 6,* 461–464.

Scutaru, C. (2011). Possible evolutions of investment rate–error correction models scenarios. *Romanian Journal of Economic Forecasting, 14*(4), 141–162.

Watson, M. W. (1994). Vector autoregressions and cointegration. *Handbook of Econometrics, 4*, 2844–2910 (Amsterdam).

Chapter 31
Cobb-Douglas Production Function: The Case of Poland's Economy

Chaido Dritsaki and Pavlos Stamatiou

Abstract The aim of this paper is to analyze the relationship between international trade and economic and financial development for Poland for the period 1990–2016. For this long run relationship we apply the autoregressive distributed lag—ARDL technique as it was formed by Pesaran and Shin (Econometrics and economic theory in the 20th century. The Ragnar Frisch centennial symposium. Cambridge University Press, Cambridge, 1999) and Pesaran et al. (J Appl Econ 16:289–326, 2001) as well as the augmented Cobb-Douglas production function formed by Mankiw et al. (Quart J Econ 107:407–437, 1992). The results of ARDL test confirm the existence of long run relationship between examined variables. Capital seems to be an impetus of economic development both in the short and long run, while labor has a negative impact in Poland's economic growth. However, trade openness and financial development found to be insignificant on economic development both in the short and long run. Finally, causality results showed that there is a unilateral causal relationship between financial development and labor towards economic development and also a bilateral causal relationship between capital and trade openness with economic development.

Keywords Cobb-Douglas production function · ARDL bounds test
Vector error correction model · Granger causality analysis · Poland

JEL Classification F43 · C52 · C23 · 047

C. Dritsaki (✉) · P. Stamatiou
Department of Accounting and Finance, Western Macedonia
University of Applied Sciences, 50100 Koila, Kozani, Greece
e-mail: dritsaki@teiwm.gr

P. Stamatiou
e-mail: stamatiou@uom.edu.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_31

31.1 Introduction

Market openness and the financial sector are two important areas contributing to the economic growth of each country. A well-organized financial sector provides a variety of financial services in both the public and private sector. Of course, the impact of these financial services is more important in developed economies. Market openness contributes to the movement of resources from developed economies to developing countries with the help of technological progress. In addition, market openness allows foreign direct investment in the host country to help in supplementing the domestic capital and redefining the concept of economic efficiency by increasing productivity. Improvement of transport and, above all, communication helped to identify new markets for the exchange of goods and services globally. Grossman and Helpman (1990) argue that long-term market openness can contribute to economic growth with the help of technical knowledge by introducing high technology as a result of foreign direct investment. In conclusion, market openness will affect economic growth by taking advantage of the know-how of developed countries that boost productivity.

In the early 1990s, the countries of Central and Eastern Europe allowed the liberalization of capital flows to support their economic development. The most important event for these countries was the increase in foreign capital in the form of foreign direct investment. These investments were mainly focused on privatization, infrastructure development and structural reforms.

Poland has embarked on reforms since 1989 to tap foreign direct investment into its economic growth. However, in the 2000s there were strong short-term fluctuations, both upwards and downwards. Direct foreign investment inflows to Poland increased from $3659 million in 1995 to $9445 million in 2000. In the period 2001–2012, there was a strong change in the inflow of foreign direct investment, with upward trends during the years 2002–2004, 2006–2007 and 2010–2011. The highest foreign direct investment inflow was recorded in Poland in 2007 at $23,561 million. It was evident that Poland was the main destination of the inflows of foreign direct investment from the Central European countries. The role of Poland as an exporter was negligible, but since the 2000s it has grown. In the years 2002–2011 there was an increase in Polish foreign investment. During that time, it raised from $229 million to $7211 million, to finally reach a record of $8883 million in 2006. In 2012 foreign capital is withdrawn from abroad and Polish investor profits of $894 million are repatriated. As in the other Central European countries, the recession of 2001–2002, which came into the E.U. with the outbreak of the global financial crisis, contributed to the volatility of foreign direct investment inflows and outflows in Poland (Kosztowniak 2013).

The purpose of this paper is to investigate the impact of market openness on economic growth over the long term using the Cobb-Douglas production function as formulated by Mankiw et al. (1992) for Poland. In Sect. 31.2, the literature review is mentioned. In Sect. 31.3, the methodology of the production function is analyzed. Section 31.4 describes the data and econometric methodology. Section 31.5 gives the empirical results of this paper, and Sect. 31.6 presents the conclusions of the paper.

31.2 Literature Review

The economic literature provides empirical results of productivity and the impact of market openness on domestic production and hence on economic growth, increasing capital and productivity factors.

Krueger (1978) in his work argues that liberalization of trade encourages the specialization of industries that have economies of scale leading in the long run to improve efficiency and productivity.

Tyler (1981) uses data from the OPEC countries and the middle income of the economy and concludes in his work that an increase in processing exports leads to technological progress resulting in economic growth.

Nishimizu and Robinson (1984) showed that the increase in exports raises productivity by increasing competitiveness and economies of scale, while imports are delaying the growth of overall productivity.

Romer (1990) investigates the relationship between market openness and economic growth. In his work he points out that opening the market helps innovation to increase domestic production and hence economic growth.

Greenaway et al. (2002) investigated long-term and short-term relationships with the effects of trade liberalization using panel data and the j-curve on the relationship between trade liberalization and economic growth.

Barro (2003) found that the terms of trade are included in the determinants of economic growth, but the statistical result of his work was weak.

Economidou and Murshid (2008) used data from 12 OECD countries to examine whether trade increases the productivity of manufacturing industries. The results of their study showed a positive effect of trade on the productivity growth of the manufacturing industry.

Jenkins and Katircioglu (2010) use data from Cyprus to look at the long-term impact of market openness on economic growth as well as on the causality between market openness, exchange rate and economic growth. The empirical results of their study confirm the long-term relationship. Moreover, their results show that imports do not cause economic growth.

Das and Paul (2011) used data from 12 Asian economies to control the impact of market openness on economic growth, implementing the GMM approach. The results of their study showed a positive impact of market openness on economic growth, with capital playing an important role in accelerating domestic production.

Pradhan et al. (2015) examine the relationship between market openness in the financial sector and economic growth for India, using monthly data for the period 1994–2001. The analysis of their work was carried out using the ARDL technique for the long-term equilibrium relationship and the error correction model and the relation of causality. The results of their study showed that there is a long-term equilibrium between the opening of the financial market and economic growth, and the causality effects showed a two-way causal link between market openness and economic growth.

For the Polish economy, there are only few works that have been published. Out of these the study conducted by Kosztowniak (2013) highlights the importance of production factors in Poland's economic growth for the years 1995–2012. Particular attention is paid to the impact of foreign direct investment on economic growth. The research analysis is made by the Cobb-Douglas production function using two models. The first contains four variables and the evaluation is done using the CLS method. The result of the model shows that there is a linear correlation between the inflow of foreign direct investment and the economic growth; however, FDI is not a significant factor determining GDP growth. The really significant factors were gross domestic expenditure on fixed capital and expenditure on R&D. The second model with six variables and the same method, constrained least squares (CLS) regression method, for the assessment, shows that the only factor contributing to economic growth is the government spending. The remaining variables are insignificant.

In another study, Kosztowniak (2014) defines theoretically the aspects of foreign direct investment that affect economic growth in Poland. Then, she sets out the conditions that are essential in order to have a positive impact from the foreign direct investment in the host country. In the empirical part of her work she uses the Cobb-Douglas production function for Poland in 1994–2012 and the VECM to identify the factors that are important for Poland's economic development. The results of this work showed that the effect of gross fixed capital formation, employment, FDI net inflows, exports and Gross Domestic Expenditure on research and development (R&D) on changes in the GDP value is decisive.

31.3 Theoretical Framework

31.3.1 The Production Function

In economic terms, the function of production is the relationship between the quantities of the factors of production (capital and labor) used and the quantity of output achieved by these factors. The form of this function can be formulated as follows:

$$Q = f(L, K) \tag{31.1}$$

where

Q is the quantity of product produced.
L is the quantity (labor hours) needed for the quantity of product Q.
K is the quantity (labor hours of machinery) needed for the quantity of product Q.

The above function present the quantity produced from any combination of factors of production (labor and capital) getting the optimal production result. The basic goals of this production function are:

- Productivity measurement
- Determination of marginal product
- Determination of less costly combination of factors in the production for a specific quantity of product.

Cobb-Douglas production function is a specific form of production function. In 1928, Charles Cobb and Paul Douglas published a paper where they considered that production is determined from labor and capital. The function that was used is the following:

$$Q(L,K) = \mathrm{A}L^{\beta}K^{\alpha} \tag{31.2}$$

where

Q	total production (the real value of all goods produced in a year).
L	labor input (the total number of person-hours worked in a year).
K	capital input (the real value of all machinery, equipment, and buildings).
A	total factor productivity.
β and α	are the output elasticities of labor and capital, respectively.

31.3.2 Output Elasticity

The coefficient β measures the rate of increase in the variation of production for a percentage increase of labor, keeping capital stable. Respectively, coefficient α measures the rate of increase in the variation of production for a percentage increase of capital, keeping labor stable.

The partial derivatives of a Cobb Douglas production function are:

$$\frac{\partial Q}{\partial L} = \beta \mathrm{A}L^{\beta-1}K^{\alpha} \tag{31.3}$$

$$\frac{\partial Q}{\partial K} = \alpha \mathrm{A}L^{\beta}K^{\alpha-1} \tag{31.4}$$

The absolute value of the slope of an isoquant is the technical rate of substitution or TRS.

$$TRS = \frac{\frac{\partial Q}{\partial L}}{\frac{\partial Q}{\partial K}} = \frac{\beta \mathrm{A}L^{\beta-1}K^{\alpha}}{\alpha \mathrm{A}L^{\beta}K^{\alpha-1}} = \frac{\beta L}{\alpha K} \tag{31.5}$$

Equations (31.3) and (31.4) imply that the Cobb Douglas technology is monotonic, since both partial derivatives are positive. Equation (31.5) demonstrates the technology is convex, since the (absolute value) of the TRS falls as L increases and K decreases.

31.3.3 Returns to Scale

Suppose that all inputs are scaled up by some factor t. The new level of output is:

$$f(tL, tK) = \mathrm{A}(tL)^{\beta}(tK)^{\alpha} = t^{\beta+\alpha}\mathrm{A}L^{\beta}K^{\alpha} = t^{\beta+\alpha}f(L, K) \tag{31.6}$$

The sum of both coefficients $\beta + \alpha$ measures the return to scale and can be expressed as a typical response of output in a proportionate change in the two inputs.

If $\beta + \alpha = 1$ is an indication that return to scale is stable. In other words, we would say that if we double capital and labor, we will double the production.

If $\beta + \alpha > 1$ is an indication that return to scale increases, meaning that if we double capital and labor, we will more than double the production.

If $\beta + \alpha < 1$ is an indication that return to scale decreases. That means that if we double capital and labor, we will have less than double the production.

Following the studies of Mankiw et al. (1992) and Shahbaz (2012), we use Cobb-Douglas production function for period t as follows:

$$Q(t) = \mathrm{A}(t)K(t)^{\beta}L(t)^{1-\beta} \quad 0 < \beta < 1 \tag{31.7}$$

where

Q is domestic output,
A is technological progress,
K is capital stock and
L is labor.

On the above function, we assume that technology can be determined from financial development, international trade and skilled human capital. In other words, financial development and international trade jointly determine technology. Financial development causes economic growth via a channel which forms capital with direct investment whereas international trade determines technology and plays a vital role in economic growth. Thus, based on the aforementioned, the model of technology can be formulated as:

$$\mathrm{A}(t) = \mu TRA(t)^{\gamma}FD(t)^{\delta} \tag{31.8}$$

where

TRA	is the indicator of trade openness.
FD	is financial development.
μ	is a constant.

Replacing Eq. (31.8) on Eq. (31.7) we get:

$$Q(t) = \mu TRA(t)^{\gamma} FD(t)^{\delta} K(t)^{\beta} L(t)^{1-\beta} u^{e} \tag{31.9}$$

Dividing both parts on Eq. (31.9) with population and taking the logarithms we have the following equation:

$$\ln Q_t = \mu + \gamma \ln TRA_t + \delta \ln FD_t + \beta \ln K_t + (1 - \beta) \ln L_t + u_t \tag{31.10}$$

where

$\ln Q_t$	is log of real GDP per capita.
$\ln TRA$	is log of trade openness.
$\ln FD$	is real domestic credit to private sector per capita (used as a proxy to measure the financial development).
$\ln K$	is real capital stock per capita.
$\ln L$	is skilled labor proxies.
μ	is constant.
u_t	is error term that should be white noise

31.4 Data Collection and Econometric Methodology

Time series of the above model are annual covering the period 1990–2016. Data derive from OECD, UNCTAD Internet databases as well as world growth indices. The variable trade openness represents real exports per capita and real imports per capita. Real domestic credit to private sector per capita proxy for financial development.

31.4.1 Unit Root Tests

The primary step is to test the integration order of the variables. Thus, we use the Dickey-Fuller (1979, 1981) and Phillips-Peron (1988) test. The general form of augmented Dickey-Fuller (ADF) can be formed as follows:

$$\Delta Y_t = \delta_0 + \delta_1 t + \delta_2 Y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta Y_{t-i} + u_t \qquad (31.11)$$

where:

u_t is error term that should be white noise.
i 1, 2, …, ρ number of time lags

$$\Delta Y_t = Y_t - Y_{t-1}$$

The number of time lags on first differences on Eq. (31.11) denotes that there is no serial correlation on error term.

Phillips-Perron test differs from the augmented Dickey-Fuller test as far as autocorrelation and heteroscedasticity are concerned.

31.4.2 Auto Regressive Distributed Lag (ARDL) Cointegration

In applied econometrics, cointegration techniques have been applied to determine the long-run relationship between time series that are non-stationary. Also, time series create an error correction model for short-run dynamics and long-run relationship of the variables. Avoiding traditional cointegration techniques (different integration techniques, small samples), we apply the autoregressive distributed lag (ARDL) as it was formed by Pesaran and Shin (1999) and Pesaran et al. (2001). Thus, the advantages of this test refer to the flexibility of ARDL technique as far as the integrating order of the variables is concerned, whereas Monte Carlo technique provides consistent results of small samples. (see Pesaran and Shin 1999).

The ADRL (p, q) model specification is given as follows:

$$\mathrm{A}(L)y_t = \mu + \mathrm{B}(L)x_t + u_t \qquad (31.12)$$

where

$$\mathrm{A}(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \cdots - \alpha_p L^p$$
$$\mathrm{B}(L) = 1 - \beta_1 L - \beta_2 L^2 - \cdots - \beta_q L^q$$

L is a lag operator such that $L^0 y_t = y_t$, $L^1 y_t = y_{t-1}, \ldots$
y_t and x_t are stationary variables.
u_t is a white noise.
μ is intercept term.

The ADRL (p, q_1, q_2, …, q_k) model specification is given as follows:

$$\mathrm{A}(L)y_t = \mu + \mathrm{B}_1(L)x_{1t} + \mathrm{B}_2(L)x_{2t} + \cdots + \mathrm{B}_k(L)x_{kt} + u_t \tag{31.13}$$

31.4.2.1 The Steps of the ARDL Cointegration Approach

Step 1: Determination of the Existence of the Long Run Relationship of the Variables

In the first stage, the existence of long run relationship among variables is examined using as endogenous each variable of the model and exogenous the same variables. Test is employed with F statistic and is compared with critical bounds quoted by Pesaran et al. (2001) to ascertain the existence of cointegrating relationship or not. The empirical formulation of ARDL technique for cointegration is given below:

$$\begin{aligned}\Delta \ln Q_t = {} & \beta_0 + \gamma_T T + \delta_Q \ln Q_{t-1} + \delta_{TRA} \ln TRA_{t-1} + \delta_{FD} \ln FD_{t-1} + \delta_K \ln K_{t-1} \\ & + \delta_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln Q_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-i} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-i} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-i} + \varepsilon_{1t}\end{aligned} \tag{31.14}$$

$$\begin{aligned}\Delta \ln TRA_t = {} & \beta_0 + \gamma_T T + \delta_{TRA} \ln TRA_{t-1} + \delta_Q \ln Q_{t-1} + \delta_{FD} \ln FD_{t-1} + \delta_K \ln K_{t-1} \\ & + \delta_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln TRA_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln Q_{t-i} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-i} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-i} + \varepsilon_{2t}\end{aligned} \tag{31.15}$$

$$\begin{aligned}\Delta \ln FD_t = {} & \beta_0 + \gamma_T T + \delta_{FD} \ln FD_{t-1} + \delta_{TRA} \ln TRA_{t-1} + \delta_Q \ln Q_{t-1} + \delta_K \ln K_{t-1} \\ & + \delta_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln FD_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-i} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln Q_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-i} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-i} + \varepsilon_{3t}\end{aligned} \tag{31.16}$$

$$\begin{aligned}\Delta \ln K_t = {} & \beta_0 + \gamma_T T + \delta_Q \ln Q_{t-1} + \delta_{TRA} \ln TRA_{t-1} + \delta_{FD} \ln FD_{t-1} + \delta_Q \ln Q_{t-1} \\ & + \delta_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln K_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-i} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln Q_{t-i} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-i} + \varepsilon_{4t}\end{aligned} \tag{31.17}$$

$$\begin{aligned}\Delta \ln L_t = {} & \beta_0 + \gamma_T T + \delta_Q \ln Q_{t-1} + \delta_{TRA} \ln TRA_{t-1} + \delta_{FD} \ln FD_{t-1} + \delta_K \ln K_{t-1} \\ & + \delta_Q \ln Q_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln L_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-i} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-i} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln Q_{t-i} + \varepsilon_{5t}\end{aligned} \tag{31.18}$$

where Δ are the first differences, β_0 is the drift, γ_T is the trend, δ_Q, δ_{TRA}, δ_{FD}, δ_K, and δ_L are the long run coefficients and ε_{1t}, ε_{2t}, ε_{3t}, ε_{4t} and ε_{5t} are the error terms of white noise.

The null hypothesis of non cointegration among variables on Eqs. (31.14), (31.15), (31.16), (31.17) and (31.18) are:

$$H_0 : \delta_Q = \delta_{TRA} = \delta_{FD} = \delta_K = \delta_L = 0$$
(there is no cointegration-long run relationship)

Against the alternative of cointegration

$$H_1 : \delta_Q \neq \delta_{TRA} \neq \delta_{FD} \neq \delta_K \neq \delta_L \neq 0$$

Step 2: Choosing the Appropriate Lag Length for the ARDL Model/ Estimation of the Long Run Estimates of the Selected ARDL Model

The lag length for each variable of ARDL model is very important in order to avoid non-normality, autocorrelation and heteroskedasticity. To determine the optimal lag in each variable for long run relationship, we use the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) or Hannan-Quinn Criterion (HQC). ARDL model is estimated with variables in their levels. Lags on variables interchange until we find the model with the smallest values of Akaike, Schwarz, and Hannan-Quinn criteria or the smallest standard errors or the highest value on R^2 with statistical significant coefficients.

The selected ARDL (k) model long run equation is:

$$\ln Q_t = \beta_0 + \gamma_T T + \sum_{i=1}^{k} \alpha_{1i} \ln Q_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \ln TRA_{t-i} + \sum_{i=1}^{k} \alpha_{3i} \ln FD_{t-i} + \sum_{i=1}^{k} \alpha_{4i} \ln K_{t-i} + \sum_{i=1}^{k} \alpha_{5i} \ln L_{t-i} + \varepsilon_{1t} \tag{31.19}$$

where k is the number of optimum lag order.

The best performed model provides the estimates of the associated Error Correction Model (ECM).

Step 3: Reparameterization of ARDL Model into Error Correction Model
In order to avoid spurious regression, we transform model's variables in first differences to become stationary. The spurious regression may be solved but the first order equation provides only the short run relationship among variables. As the long run relationship is more important for researchers, cointegration and the error correction model were examined connecting the short and long run relationship of the variables of the model. The error correction model can be formed as follows:

$$\Delta \ln Q_t = \beta_0 + \gamma_T T + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln Q_{t-1} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-1} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-1} + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-1} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-1} + \lambda_1 ECM_{t-1} + e_{1t} \tag{31.20}$$

$$\Delta \ln TRA_t = \beta_0 + \gamma_T T + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln TRA_{t-1} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln Q_{t-1} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-1} + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-1} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-1} + \lambda_2 ECM_{t-1} + e_{2t} \tag{31.21}$$

$$\Delta \ln FD_t = \beta_0 + \gamma_T T + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln FD_{t-1} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-1} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln Q_{t-1} + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln K_{t-1} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-1} + \lambda_3 ECM_{t-1} + e_{3t} \tag{31.22}$$

$$\Delta \ln K_t = \beta_0 + \gamma_T T + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln K_{t-1} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-1} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-1} + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln Q_{t-1} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln L_{t-1} + \lambda_4 ECM_{t-1} + e_{4t} \tag{31.23}$$

$$\Delta \ln L_t = \beta_0 + \gamma_T T + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln L_{t-1} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta \ln TRA_{t-1} + \sum_{i=0}^{q_2} \alpha_{3i} \Delta \ln FD_{t-1} + \sum_{i=0}^{q_3} \alpha_{4i} \Delta \ln Q_{t-1} + \sum_{i=0}^{q_4} \alpha_{5i} \Delta \ln Q_{t-1} + \lambda_5 ECM_{t-1} + e_{5t} \tag{31.24}$$

The ECM term derives from cointegration models and is referred to estimated equilibrium errors. The coefficient λ of ECM is the short run adjustment coefficient and presents the adjustment velocity from equilibrium or the correction of inequilibrium for each period. The sign of λ coefficient should be negative and statistical significant and it varies from 0 to 1. Finally, it should be mentioned that ARDL and ECM models are estimated with least squares methodology (LS).

31.4.3 Granger Causality Tests Under the Framework of VECM

After establishing for long run relationship, we determine causality direction among variables. Granger (1969) claims that if the estimated variables are cointegrated then there is a causal relationship among them in at least one direction. Granger test for causal relationship among variables is employed using error correction models [see Eqs. (31.20)–(31.24)].

31.5 Empirical Results and Discussions

In our paper, the Cobb-Douglas production function is used to analyze the long run causal relationship between trade openness of economic growth and financial development as well as between capital and labor. At first, we test for series stationarity.

Table 31.1 Unit root tests

Variable	ADF		P-P	
	Levels			
	C	C, T	C	C, T
LQ	0.258(0)	−1.869(1)	0.180[1]	−3.659[3]**
LTRA	−1.870(0)	−1.325(0)	−1.997[2]	−1.325[0]
LFD	−0.303(0)	−3.121(1)	−0.278[3]	−2.430[2]
LK	−0.680(5)	−5.459(4)*	−0.526[0]	−2.644[2]
LL	−0.109(0)	−2.490(0)	−0.589[3]	−2.490[0]
	First differences			
	C	C, T	C	C, T
ΔLQ	−6.989(0)*	−3.788(5)**	−6.989[0]*	−7.892[5]*
ΔLTRA	−4.763(0)*	−5.210(0)*	−4.763[1]*	−5.212[1]*
ΔLFD	−4.369(1)*	−4.273(1)**	−4.023[7]*	−3.941[7]**
ΔLK	−4.604(4)*	−4.319(4)*	−3.806[5]*	−4.598[8]*
ΔLL	−3.549(0)**	−4.166(0)**	−3.490[1]**	−4.161[1]**

Notes
1. *, ** and *** show significant at 1, 5 and 10% levels respectively
2. The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals
3. The lag lengths for ADF equation were selected using Schwarz Information Criterion (SIC)
4. Mackinnon (1996) critical value for rejection of hypothesis of unit root applied
5. The numbers within brackets followed by PP statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel
6. C = Constant, T = Trend, L = Δ = First Differences

In Table 31.1, the results of unit root test, Dickey-Fuller and Phillips-Peron test are provided.

From the above results we can see that all variables are stationary in first differences. In other words, all variables are integrated order one I(1). So, we can use the Johansen (1988) procedure for the long run equilibrium relationship. This procedure is subject to asymptotic properties meaning that is suitable only for large samples. In small samples, Johansen test is found to be upward biased, rejecting null hypothesis more often than what asymptotic theory suggests. Thus, if the size sample is small, the results will be unreliable and the Auto Regressive Distributed Lags (ARDL) test of Pesaran et al. (2001) should be used. Furthermore, ARDL approach is sensitive on the measurement of lags in the model. The mistaken number of time lags gives biased results (see Shahbaz 2010, 2012). For the number of time lags in the model, we use the Akaike criterion. In Table 31.2, the results of ARDL bounds tests are given. The critical bounds derive from Narayan's paper (2005), which are appropriate for small samples.

The results of the above table show that we get five cointegrating vectors. So, we can see that there is a long run relationship among the examined variables for Poland for the period 1990–2016.

Table 31.2 The ARDL bounds testing cointegration approach analysis

Bounds testing to cointegration			Diagnostic tests			
Estimated models	Optimal lag length	F-statistics	Jarque-Bera	ARCH (1)	RESET	LM(1)
F_Q(Q/TRA, FD, K, L)	(1, 3, 3, 3, 3)	8.211*	11.48*	0.236	0.062	4.023
F_{TRA}(TRA/Q, FD, K, L)	(2, 2, 3, 1, 3)	7.515*	0.986	0.025	0.015	12.83*
F_{FD}(FD/TRA, Q, K, L)	(2, 2, 3, 2, 2)	11.36*	1.273	0.323	1.893	10.80*
F_K(K/TRA, FD, Q, L)	(1, 2, 2, 0, 0)	9.675*	1.119	0.172	0.798	0.170
F_L(L/TRA, FD, K, Q)	(3, 3, 3, 3, 2)	9.019*	0.825	3.445**	0.688	10.79*

Notes
*, **, *** represent significance at 1, 5, 10% levels respectively. Appropriate lag length of the variables is selected following AIC
According to Narayan (2005), the existing critical values reported in Pesaran et al. (2001) cannot be used for small sample sizes because they are based on large sample sizes. Narayan (2005) provides a set of critical values for sample sizes ranging from 27 observations. They are 2.68–3.53 at 90%, 3.05–3.97 at 95%, and 3.81–4.92 at 99%

After the confirmation of long run relationship among the variables the next step is to determine the short and long run elasticity. The results on these dynamics are presented on Table 31.3.

The results of Table 31.3 show that market openness and capital have positive effect in the economic growth of Poland whereas financial development and labor seems to be correlated negative. Because capital variables and labor are statistical significant in 1 and 10% level of significance, we can say that 1% capital increase will cause increase in development by 0.20% approximately while a labor increase by 1% will affect development negatively by 0.13% approximately. This result is in accordance with Kosztowniak (2013) paper which claims that the real important factor for economic growth is gross domestic expenditures of fixed capital.

The short run results on Table 31.3 show that the short run coefficient on error correction term is −0.806 and statistical significant in 1% level of significance. That implies that there is a long run relationship among variables for Poland. Moreover, this result shows that the short-run change from the long-run equilibrium is corrected by 80.6% each year. The results from short run analysis are similar to those coming from long run. Market openness and capital have positive effect in economic growth whereas financial growth and labor are negative. Also, labor and capital are statistical significant in 1% level of significance. Finally, diagnostic tests, both in the short and long run satisfy all the assumptions of the linear regression model where autocorrelation and heteroscedasticity are absent and residuals are normally distributed.

Table 31.3 ARDL long-run and short-run results

Dependent variable: LQ			
Long-run results			
	Coefficients	S.Error	t-statistic
Constant	8.884	0.909	9.771*
Trend	0.024	0.005	4.703*
LTRA	0.065	0.072	0.896
LFD	−0.024	0.023	−1.071
LK	0.198	0.045	4.386*
LL	−0.128	0.074	−1.735***
Adjusted R^2	0.997		
F-statistic	1820.5*		
X^2N	1.285		
X^2SC	3.178		
X^2ARCH	0.685		
Dependent variable: ΔLQ			
Short-run results			
	Coefficients	S.Error	t-statistic
Constant	0.032	0.004	7.758*
ΔLTRA	0.032	0.046	0.694
ΔLFD	−0.035	0.014	−2.448**
ΔLK	0.197	0.028	6.822*
ΔLL	−0.194	0.071	−2.707*
ECM_{t-1}	−0.806	0.177	−4.542*
Adjusted R^2	0.818		
F-statistic	23.591*		
X^2N	1.085		
X^2SC	1.223		
X^2ARCH	0.166		

Notes
*, **, *** represent significance at 1, 5, 10% levels respectively
X^2N, X^2SC, and X^2ARCH are normality (Jarque-Bera), Lagrange multiplier values for serial correlation), and ARCH tests for heteroscedasticity

Granger causality test is accomplished according to error correction model. At first, the variables on levels were estimated in an unrestricted VAR model. For lag length, the Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) were selected. The unrestricted VAR was estimated with one time lag and an absence of serial correlation was found. After, we apply three types of Granger causality. The short run causality tests for independent variables with Wald F statistic, the long run causality tests the error correction coefficient with t-student and the joint short and long run causality with the lagged independent variables and the corresponding error correction term

Table 31.4 Results of Granger causality tests

	Short run					Long run	Joint long-and-short run causality				
	ΔLQ	ΔLTRA	ΔLFD	ΔLK	ΔLL	ECM_{t-1}	ΔLQ, ECM_{t-1}	ΔLTRA, ECM_{t-1}	ΔLFD, ECM_{t-1}	ΔLK, ECM_{t-1}	ΔLL, ECM_{t-1}
ΔLQ		0.251***	−0.026*	0.114**	−0.308*	−0.411*		3.661*	3.364*	4.947*	6.888*
ΔLTRA	1.850*		0.117	0.032	0.593**	−0.034*	2.576*		1.049	0.994	2.649**
ΔLFD	1.042	0.081		0.483	−1.301	−0.848	1.852	0.098		1.294	1.018
ΔLK	1.464**	0.116	0.183		0.276	−0.405*	3.428*	0.265	3.108		1.595
ΔLL	−0.396	0.227	−0.160	0.059		−0.572	2.089	0.461	0.342	0.901	

Note
*, ** and *** show significance at 1, 5 and 10% levels respectively

using Wald F test. On Table 31.4, the results of Granger causality with the three types are given.

The results on Table 31.4 show a short run causal relationship among market openness, financial development, capital and labor with economic growth. Also, there is a short run causal relationship between economic growth, labor and market openness as well as between economic growth and capital. Based on the results of error correction coefficient, there is a long run relationship between market openness, financial development, capital and labor with economic growth as well as between economic growth, labor and market openness. Finally, for the joint causality there are causal relationships between market openness, financial development, capital and labor with economic growth as well as between economic growth and capital, and labor with market openness.

31.6 Conclusions

Market openness promotes economic growth through various channels such as attracting foreign direct investment, accessing advanced technology to boost domestic production, and enhancing productivity. In theoretical literature and empirical research there are many different explanations for the role and implications of market openness in host countries. Other works show a positive impact on economic growth, while others have come to different results. However, in all of them there is a broad consensus regarding the assertion that the increase in productivity is necessary for creating wealth and improving the competitiveness of a country.

This paper examines whether market openness promotes or hampers economic growth in Poland in the long run. For this purpose, we used the Cobb-Douglas production function as formulated by Mankiw et al. (1992). The paper was carried out for the period 1990–2016 and the recently developed econometric ARDL cointegration technique was used for the long-term equilibrium relationship of the time series of the model, while the causality direction was investigated using the Granger error correction model (VECM Granger causality approach).

The results of the paper have shown that long-term market openness and capital have a positive impact on Poland's economic growth, while financial development and labor appear to be negatively related. This result is partly in line with the study conducted by Kosztowniak (2013) which argues that the really important factor for increasing economic growth is the gross domestic expenditure on fixed capital. Also, the results of the short-term analysis are similar to those of the long-term. Market openness and capital have a positive effect on economic growth, while the effect of financial growth and labor is negative.

Finally, the results achieved with the use of the error correction model for causality showed that there is a long-run and short-run one-way causal relationship between financial growth and labor towards the economic growth and a bilateral causal relationship between capital and market openness to economic growth.

In conclusion, we may say that in the period under review the opening of the market and mainly capital are the main factors for the economic growth in Poland both in the short and long term.

References

Barro, R. (2003). Determinants of economic growth in a panel of countries. *Annals of Economics and Finance, 4,* 231–274.

Cobb, C. W., & Douglas, P. H. (1928). A theory of production. *American Economic Review, 18* (1), 139–165.

Das, A., & Paul, B. P. (2011). Openness and growth in emerging Asian economies: Evidence from GMM estimation of a dynamic panel. *Economics Bulletin, 31,* 2219–2228.

Dickey, D. A., & Fuller, W. A. (1979). Distributions of the estimators for autoregressive time series with a unit root. *Journal of American Statistical Association, 74*(366), 427–431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*(4), 1057–1072.

Economidou, C., & Murshid, A. P. (2008). Testing the linkages between trade and productivity growth. *Review of Development Economics, 12,* 845–860.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica, 37*(3), 421–438.

Greenaway, D., Morgan, C. W., & Wright, P. W. (2002). Trade liberalisation and growth: New methods, new evidence. *Journal of Development Economics, 67,* 229–244.

Grossman, G. M., & Helpman, E. (1990). Comparative advantage and long-run growth. *American Economic Review, 80,* 796–815.

Jenkins, H. P., & Katircioglu, S. T. (2010). The bounds test approach for cointegration and causality between financial development, international trade and economic growth: The case of Cyprus. *Applied Economics, 42,* 1699–1707.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Economic Dynamic Control, 12,* 231–254.

Kosztowniak, A. (2013). Foreign direct investment as a factor of economic growth in Poland. Empirical analysis for the period 1995–2012. *Advances in Economics and Business, 1*(2), 203–212.

Kosztowniak, A. (2014). Analysis of the Cobb-Douglas production function as a tool to investigate the impact of FDI net inflows on gross domestic product value in Poland in the period 1994–2012. *Oeconomia Copernicana, 5*(4), 169–190.

Krueger, A. O. (1978). *Foreign trade regimes and economic development: Liberalization attempts and consequences*. Cambridge, MA: Ballinger.

MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics, 11*(6), 601–618.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics, 107,* 407–437.

Narayan, P. K. (2005). The savings and investment nexus for China: Evidence from cointegration tests. *Applied Economics, 37,* 1979–1990.

Newey, W. K., & West, K. D. (1994). Automatic lag selection in covariance matrix estimation. *Review of Economic Studies, 61*(4), 631–654.

Nishimizu, M., & Robinson, S. (1984). Trade policies and productivity change in semiindustrialized countries. *Journal of Development Economics, 30,* 93–102.

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-led modeling approach to cointegration analysis. In S. Strom (Ed.), *Econometrics and Economic Theory in the 20th Century. The Ragnar Frisch Centennial Symposium*. Cambridge: Cambridge University Press.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of long run relationships. *Journal of Applied Econometrics, 16,* 289–326.

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75,* 335–346.

Pradhan, R. P., Arvin, M. B., Norman, N. R., & Hall, J. H. (2015). A quantitative assessment of the trade openness–economic growth nexus in India. *International Journal of Commerce and Management, 25*(3), 267–293.

Romer, P. M. (1990). The problem of development: A conference of the institute for the study of free enterprise system. *Journal of Political Economy, 98,* 1–11.

Shahbaz, M. (2010). Income inequality-economic growth and non-linearity: A case of Pakistan. *International Journal of Social Economics, 37,* 613–736.

Shahbaz, M. (2012). Does trade openness affect long run growth? Cointegration, causality and forecast error variance decomposition tests for Pakistan. *Economic Modelling, 29*(6), 2325–2339.

Tyler, W. J. (1981). Growth and exports expansion in developing economies: Some empirical evidence. *Journal of Development Economics, 9,* 121–130.

Chapter 32
The Digitization of Business and the Industry: Opportunities, Challenges and the Technology Behind

Spyridon Adam, Loukas Pol. Michalis and Spiros Panetsos

Abstract We go through automated passport checking, at airports and use automatic cashiers at supermarkets. Google and Tesla are road testing their autonomous vehicles and in a while we will do our online banking not through forms or graphical interfaces, but through chatbots with which we will be able to speak in our natural language, as we do with a human operator over the phone or the bank's counter. These changes are merely the beginning of the deep changes that digitization and AI will bring to businesses and the industry, transforming them to an extent that to a special report by the Economist, will amount to the third industrial revolution. In this paper, we set out to discuss how digitization and AI will transform business and the industry, the key technology and ideas—deep learning, Internet of Things, Graphics Processing Units that will underlie this transformation and how this transformation will enhance productivity and innovation.

32.1 Introduction

The European Union has set as the primary target of Horizon 2020, its research funding program, the digitization of business and the industry. This is not a new idea. The decision by the EU to shift the focus of research on the ideas and the technology that will bring about the digital industry comes to confirm the changes that have been going on for some time, but which are gathering pace and according to a special report published by the Economist back in April 21, 2012, will have such consequences that will amount to a third industrial revolution (Markillie 2012a).

S. Adam · L. Pol.Michalis (✉) · S. Panetsos
Department of Electrical and Electronics Engineering Educators,
School of Pedagogical and Technological Education (ASPETE),
Neo Heraklion 14121, Greece
e-mail: lmichali@ta.aspete.gr

S. Adam
e-mail: spadam@aspete.gr

S. Panetsos
e-mail: spanetsos@aspete.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_32

As always with a groundbreaking idea or invention, the digitization of manufacturing is brought about by a combination of things: the rise of Artificial Intelligence and its increasing adoption in business, the breakthroughs in nanotechnology, resulting in novel materials, more advanced robots, new processes, notably 3D printing and a whole range of web-based services, comprising the cloud.

The recent revival of Artificial Intelligence or AI, for short, owes mainly to the choice by businesses to digitize and automate as much of their operations, thus aiming to achieve greater efficiencies. Initially, technology companies like Google and Amazon started using AI, for tasks like product recommendations, targeted advertising and forecasting demand (Suich Bass 2018). Amazon, for example, has been using AI widely, for guiding the robots in its warehouses and optimising packing and delivery, as well as detecting counterfeit goods and powering its speaker, Alexa. Vodafone has been using AI to predict problems with its network and with users' devices, before they arise (Suich Bass 2018).

Companies and industries, such as finance, that generate a lot of data and investment banks that have to make predictions on stock market trends, have also been relying on AI and many of them have built their own AI-enhanced systems (Suich Bass 2018).

But AI has been spreading beyond the technology sector. Johnson & Johnson and Accenture, a consultancy, use AI to sort through job applications and pick the best candidates (Suich Bass 2018). Bloomberg, a media and financial-information firm, uses AI to scan companies' earnings releases and automatically generate news articles (Suich Bass 2018). Leroy–Merlin now uses algorithms to take in past sales data and other information that could affect sales, such as weather forecasts, in order to stock shelves more effectively (Suich Bass 2018). Banks will soon introduce chatbots, for online transactions. AI has made its entry even into the legal world. Law firms in the US and the UK, writes the FT, use AI in an attempt to predict the outcome of complex cases, like compliance before reach to the court.

There are firms from several other sectors, including education that have started or attempting to use AI, but the rise of AI has a new ingredient. Several start-ups in neurotechnology and AI have been created in Silicon Valley and elsewhere, some with aims so ambitious, as to border on science fiction (Palmer 2018). Kernel was founded to build Brain Computer Interfaces (BCIs) that would enable us to communicate with others by means of telepathy (Palmer 2018). Elon Musk the owner of SpaceX and Tesla, has founded Neurlalink to create new forms of neural implants with the goal of creating a Brain Computer Interface (BCI), for clinical use for people with disabilities (Palmer 2018). A BCI called BrainGate has already been built and at a trial stage, is surgically implanted in the brain of paralyzed people to help them type words or move damaged muscles or a robotic arm that will allow them to eat or drink. Another start-up, Open water, is also working on a non-invasive neural-imaging system, while Facebook recently revealed a project on a "silent speech" interface that would allow people to type at a rate of 100 words a minute straight from their brain (Palmer 2018).

We have reviewed above the range of AI applications, from Amazon's warehouses to financial institutions and law firms and from Google's self-driving car to the BCIs envisioned by start-ups in Silicon Valley. Underlying all these applications, is the promise in AI to better understand and build aspects of our human intelligence—our ability to learn, recognize, manipulate objects and predict events, into systems, thus creating autonomous systems, whether for predicting the future prices of stocks, selecting applicants for a company, forecasting demand and making inventory decisions or controlling the robots in the digitized factory. In the next section, we will discuss the systems—AI, robotics, Internet of Things, driving the digitization of the industry, present the current state of the art and the target, in an entirely digitized factory.

32.2 Digitization of the Industry—The Factory of the Future

The traditional tools of manufacturing are changing in a number of remarkable ways that will transform the future of manufacturing (Markillie 2012a). Old-school engineers worked with lathes, drills, stamping presses and molding machines. These still exist, but gradually, they will be getting replaced by automated milling machines that can swap their own tools, cut in multiple directions and "feel" if something is going wrong, together with 3D printers and robots equipped with vision and other sensing systems (Markillie 2012a).

The men in overalls will be replaced by operators, men and women, sitting in front of computer screens or operating, controlling and checking the highly automated robotic machinery from tablets or laptops. The materials being used to make things will change as well. Carbon-fiber composites are replacing steel and aluminum, in products ranging from mountain bikes to airliners. And sometimes it will not be machines doing the making, but micro-organisms that have been genetically engineered for the task (Scudellari 2018). Everything in the factories of the future will be run by smarter software.

32.2.1 Assembling Ikea Furniture—The Present State of the Art in Industrial Robotics

Have we already reached or how far are we from that target? Have we already built robots so advanced as to be able to replace the human labor, in the assembly lines of factories, making the digitized factory a thing of the present? The present state of the art of the research in the robots of the digital factory can be illustrated by a recent article in the New York Times. In the article, a team of researchers from Nanyang Technological University, programmed a robot to create and execute a plan to piece together most of Ikea's $25 solid-pine Stefan chair on its own, exhibiting several human skills in performing this task (https://www.nytimes.com/2018/04/18/science/robots-ikea-furniture.html) (Chokshi 2018).

The robot was made of custom software, a three-dimensional camera, two robotic arms, grippers and force detectors. The work got significant attention and publicity because the robot, by assembling the chair, showed complex and largely human characteristics, including 'perception, planning, interaction with the environment and coordination, since the task required manipulating an object with two arms simultaneously' (Chokshi 2018).

Ikea seems to inspire, or at least provide the test bed for robots, for the industry. For another team of researchers, from MIT, has built the IkeaBot (https://spectrum.ieee.org/automaton/robotics/home-robots/mit-ikeabot-autonomous-furniture-assembly-robots) (Ackerman 2013), an autonomous robotic system capable of assembling another piece of IKEA furniture, the Lack table. The robot works autonomously to assemble the particular piece in 10 min.

There were no detailed step-by-step instructions as to how to assemble the table, built into the robot. Instead, the robot used a "geometric reasoning system" and a "symbolic planner" to figure out how a bunch of parts should be attached to one another, keeping in mind that all screw holes should be used and that no parts should be left over (Ackerman 2013). The bots just know that one thing must attach to another thing in a given way, and they keep on doing that until assembling all the parts.

Of interest in the robot is also the design of the gripper, in the prototype of the Canadarm (the robotic arm on the International Space Station) that uses two counter-rotating wheels joined by rubber bands to grip just about any shape with a high amount of compliant torque, and then rotate it (Ackerman 2013).

The MIT researchers say they're working to make their system applicable to a general set of assembly tasks, though for larger pieces they would have to use larger and stronger arms. Another aim is to create a robot that can build a chair by following spoken directions or by watching someone else do it first, or eventually, develop one that assembles furniture in a way that is truly human: by ignoring the manual altogether.

32.3 Hardwired Versus Adaptive Knowledge—Adaptive Machines

The two robots perform similar tasks. However, they illustrate fundamentally contrasting approaches to the design of robots for the industry. One, the robot from the Nanyang Technological University relies on a built-in knowledge of how to perform its task—how to assemble the Ikea chair, in the form of a program. The program running in the robot's microcontroller, instructs the robot how to assemble the chair, piece-by-piece. Where to start from, what piece to take in each subsequent step, how to handle each piece and fit it with the rest, until it assembles the chair. It is as though the robot is hardwired to perform this task. It merely executes the program without really knowing/understanding what it does.

The robot from MIT exemplifies a different approach, having some built-in knowledge of its task, but also exhibiting some learning, a skill to improvise and try out various actions, evaluate the outcome/effect of each action and make decisions as to proceed or retract to a previous step and try an alternative action. The robot, through this process of trial and error, manages at the end to assemble the table, without requiring a priori knowledge of how to perform this task. Through trial and error, the robot figures out how to fit together the various pieces and assemble the chair. Thereafter, he can use its experience or acquired knowledge to assemble similar tables, without going back and forth. The main advantage is that the robot, being able to learn, is not limited to assembling the particular table, but can learn to assemble a new piece of furniture.

Either approach—the built-in and the adaptive seems to work. Since each task along the assembly line of a factory, is highly specialized, we can build and explicitly program robots to perform each one of these tasks. Since each robot will be explicitly programmed to perform a particular task, it could successfully carry out this task, even though the knowledge of the task will be built into the program.

On the other hand, a robot that blindly executes instructions, without understanding what it is doing, it will exhibit the same drawback we do when we mechanically perform a task. It will not be able to check on its actions and identify and correct errors. It will get easily stalled or produce erroneous action to minor variations in the conditions of its task.

There is however a more serious drawback. Explicitly programming a robot to perform a particular task is a narrow and limited perception of what robotics is all about. The real aim in robotics is not to build machines that have the frame of humans or animals and imitate their behavior, but far more to *build machines that have something of the human or animal intelligence* that can learn and operate autonomously. Only to the extent that we can build intelligence into machines, we will manage such groundbreaking effects in the business and the industry as to bring about the third industrial revolution.

32.4 Machine Learning—The Digitization of Thought

Intelligence, in its simplest form, means identifying and correcting errors. Correcting an error, means learning. Thus, we come to the idea of machine learning. At first approximation, machine learning means the capacity by the machine—a robot to figure out how to solve a problem or successfully perform a task by employing some method. The most immediate method, being trial and error.

But machine learning has a more general sense than learning new motor tasks. It also means machines that can learn all or several of the things that we learn: to identify objects, foods, smells, learn new places, even the words of a spoken language and since key to our survival is the ability to perceive, process stimuli and make predictions as to swiftly and appropriately respond to the events in our environment so too, machine learning also involves the ability by the machine to process potentially vast quantities of data, find patterns and make predictions, without being explicitly programmed to do so. The outcomes are often similar to what an army of statisticians with unlimited time and resources might have come up with, but they are achieved far more quickly, cheaply and efficiently (Suich Bass 2018).

Attempting to build into machines, skills like learning new tasks and making predictions, amounts to *digitizing intelligence*. Machine learning, bit by bit, in the past few years, has managed significant success in this endeavor, having achieved enormous progress in Computer Vision, Speech Recognition, Machine Translation, trend analysis and predictions and many other tasks (Trask 2018).

But how does machine learning work? How and to what extent, machine learning manages to automate animal intelligence and build key aspects of this intelligence into machines? In the next section, we will have a closer look on machine learning, through its most modern and popular form, which is deep learning.

32.4.1 Deep Learning

AI goes and grows through cycles of sky high optimism and exuberant expectations, followed by periods of let down and slow activity. The recent revival of AI, after a period of little if any progress, primarily, owes to deep learning (Goodfellow et al. 2016; Hwang 2016; Kim 2017; Sejnowski 2018; Trask 2018).

But what is deep learning that is driving the recent surge in AI? Deep Learning is a subset of Machine Learning that largely relies on Neural Networks which are a class of algorithms loosely inspired by the human brain, for building learning and memory skills into machines, thus unpacking what it means to think, to reason, and to create (Sejnowski 2018).

32.4.1.1 Learning Means Discovering Rules, *not* Following the Instructions of a Program

Deep learning and more generally, machine learning *does not mean programming* a robot to perform a task. In machine learning, we do not program the robot. Instead, we show the robot, *examples* of inputs and the appropriate response to each of these inputs. By learning, the robot attempts to extract the *underlying rule* by which a given input elicits a particular output (Sejnowski 2018). If the robot manages to extract that rule then it will correctly respond not only to the input patterns in the examples we have shown it, but even to patterns that have not been in these examples.

Ourselves, we extract the rules governing our world by falling back and reflecting on past experience. A simple way, for example, to predict tomorrow's weather, is to average the weather data from the past few days or if we keep a longer record of the weather, this time of the year, to average that data. In this example, prediction involves averaging. More generally, prediction involves looking at the past to identify similarities, analogies and differences with the present and based on those to modify or *adapt* past behavior to make it fit to the present.

32.4.1.2 The Architecture of Deep Learning

Deep learning draws from the structure and organization of memory, in our brain where sensory stimuli are processed by the interactions between *neurons*, over several layers of processing through the cortex to extract stimulus-to-stimulus associations by repeated coincidence and stimulus-to-response combinations that regularly lead to reward. Where moreover, the memory of these relations or response—outcome combinations is laid down in the *synaptic contacts* of the connections between the neurons in a population, little by little as these relations or combinations are regularly repeated in our environment (Sejnowski 2016). Learning, that is the learning of objects and goal directed behavior arises as an *emergent property* of the gradual laying down of these relations, in memory.

Deep learning replicates this architecture and functioning of the brain, in networks composed of several layers, in the paradigm of the neuronal networks of learning and memory, in our brain. Each layer in a deep learning network consists of several nodes, corresponding to the neurons of our brain. The *artificial neurons* in each layer are connected to other neurons in the same layer and to the nodes–neurons, in the immediately higher layer (Fig. 32.1). These connections, as the connections between the real neurons in our brain serve two functions. They *gate* and thus regulate the signal, from one cell to another within the same layer or to the higher layer and they provide the *substrate of memory* in the network (Sejnowski 2016; Trask 2018).

The input data representing the present state of the environment, is fed to the first layer of the network. Then, this data is propagated through the network. But the data, in its propagation through the network, is modified by the *gating* of signals from the artificial neurons in one layer to the next, by the *weights*, that is the *strengths* of the connections to next layer up (Fig. 32.1). This gating of signals through the network, layer by layer, modifies the original input to produce the network's response to that input, in the output layer.

Learning in this network occurs by *modifying the strengths* of the connections form the neurons in one layer to the next (Fig. 32.1). During a *training phase*, the network is presented with a set of example inputs, along with the appropriate response to each one of these inputs. The network is left to process each input in the example set and produce its response. That response is then compared with the correct or desired response to the particular input and an error is computed as the difference of the produced from the desired response. The network *memorizes*

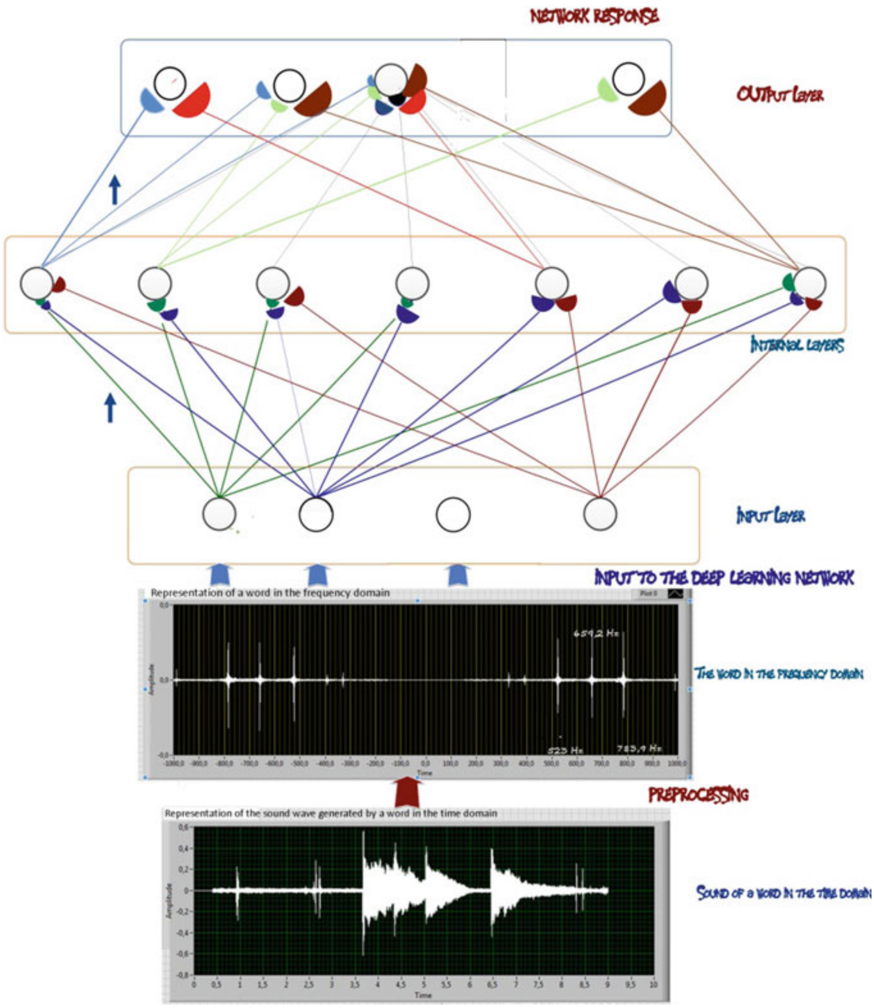


Fig. 32.1 The architecture of deep learning, like the architecture of the brain is made up of networks composed of several layers and several nodes, in each layer, corresponding to the neurons of our brain. Inputs are fed to the first layer of the network and the activity generated by each input propagates through the network, until it reaches the output layer where the network produces its response to the particular input

the correct response by modifying the strengths of the connections that gate the signals from the neurons in one layer to the next.

In the example of our memory that is gradually formed by *small changes* to repeated coincidence, the strengths of the connections in the network are only *slightly modified* by each input–output pair, in the example set. The idea is for the network *not to perfectly memorize each input–output pair* in the example set, but to extract the underlying rule. *Making small changes* in the strengths of the connections that will decrease, rather than make the error to each input–output training pair zero, works for the network to extract common features and contrast—the *underlying regularities* in the input–output pairs of the training set and memorize these regularities, rather than the example pairs themselves. If the network succeeds in that, then it will be able to generalize and correctly respond to patterns that have not been in the training set and has not seen before.

As an example, the network of Fig. 32.1 learns to speak words of a spoken language. In the training phase, we train the network with a subset of words. Along with presenting each word to the input layer of the network, we show the network the correct response it should produce, for that word, at its output layer. We *do not directly* input to the network the representation of a word in the time domain, that is the voltage pattern generated by the microphone, in the utterance of this word. Rather, there is a *pre-processing stage* in which we convert the time domain representation of a word, in the frequency domain, computing the Fourier transform of the time domain signal and we feed to the network, this frequency pattern (Fig. 32.1).

The activity generated by each word in the input layer, will propagate through the network, activating the nodes in each layer and eventually, the nodes in the output layer to produce the network's response to the word. Then, during training, we compare that response with the desired or target response by the network to the particular word. We use that error to modify the strengths of the connections from the nodes of one layer to those of the next layer up (Fig. 32.1). This change *constitutes the network's learning*. The next time we present that word to the network, it will make a smaller error, its response will be closer to the desired response and if we go through the words in the training set several times, then the network will learn to produce at its output, the correct response to each word, it will learn the correct utterance of each word.

32.4.1.3 Recurrent Networks for Learning to Perform Tasks

We can extend the feedforward architecture of the network of Fig. 32.1, with feedback, from the output to the input layer, building a class of deep learning networks called *recurrent networks*. As the output at some time t, is fed back to the input layer, it serves along with the input at time $t + 1$ to *modulate* the network's output at $t + 1$. Thus, the output in recurrent nets is determined as much by the network's output response, at the previous unit of time, as by the present input. Since tasks involve a sequence of actions in which each action in the sequence is dependent upon the one preceding it, recurrent nets are more suited than simple feedforward networks, for learning to perform tasks.

32.4.1.4 The Mathematics of Deep Learning

The mathematics of learning are the *equations for modifying the weights* of the connections in the network (Fig. 32.2). The weights determine the network's response to each input pattern from a data set. The network, by modifying these weights seeks to learn to correctly map inputs to outputs, producing the correct output to each input pattern or at least, minimizing the error.

One of the simplest rules for modifying the weights in a deep learning network, is the *delta rule* (Trask 2018). The rule seeks to minimize the error E calculated as the mean square error or difference between the network's output $\boldsymbol{y^k} = (y_1^k, y_2^k, \ldots, y_n^k)$ to an input and the desired output $\boldsymbol{t^k} = (t_1^k, t_2^k, \ldots, t_n^k)$ to that that pattern

$$E = 1/2 \sum (t_j^k - y_j^k)^2 = 1/2 \sum \left(t_j^k - \sum w_{ji} x_i^k\right)^2 \tag{32.1}$$

We can minimize that error by modifying each weight w_{ji} in the network, in the direction of the gradient of the error E

$$\Delta w_{ji} = -a\, \partial E / \partial w_{ji} \tag{32.2}$$

For the weights w_{ji} to the output layer, calculating the partial derivative, gives a rule having the form

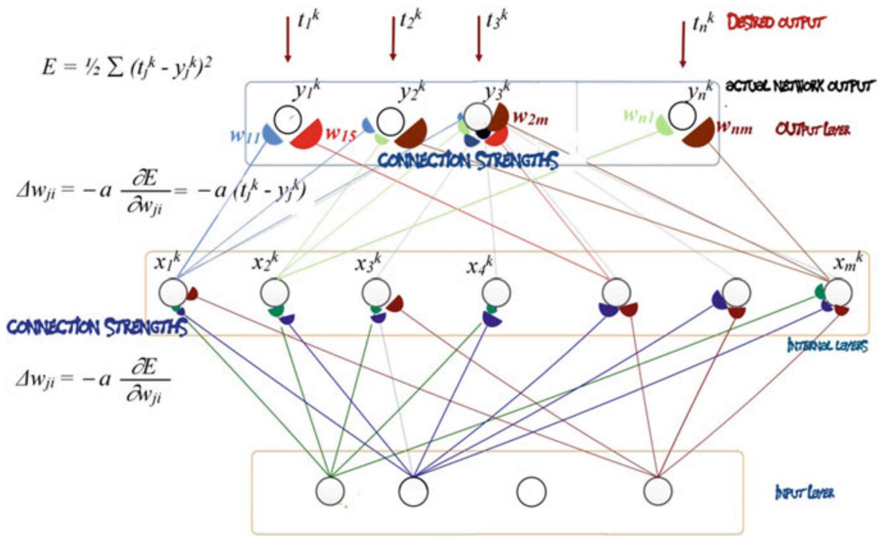


Fig. 32.2 The memory of a robot is formed by changing the strengths of the connections between the artificial neurons, in the robot's learning networks, much as our memory is formed by the adaptive change of the synapses of the connections between the neurons of our brain. *Source* Authors

$$\Delta w_{ji} = -a\,\partial E/\partial w_{ji} = -a\left(t_j^k - y_j^k\right) \tag{32.3}$$

The process of modifying the network weights along the gradient of the error E, starting from the weights to the output layer and moving down the network to similarly change the weights of the lower layers, is known as *gradient descent* and will tend to minimize the error in the network's response.

As a simple demonstration, we have trained a small robotic arm—the meArrm to learn to pick up small things, from one location in space and move them to another (Fig. 32.3).

32.5 Towards the New Computer Architecture

Machine learning leads to a new, *radically different model for computing and computations*, inspired by the functioning of our brain. Machine learning enables a robot to learn its environment and perform tasks in this environment, much the way we learn, as opposed to having this knowledge built into it, in the form of a program running in its microcontroller and telling it how to perform each action. By doing

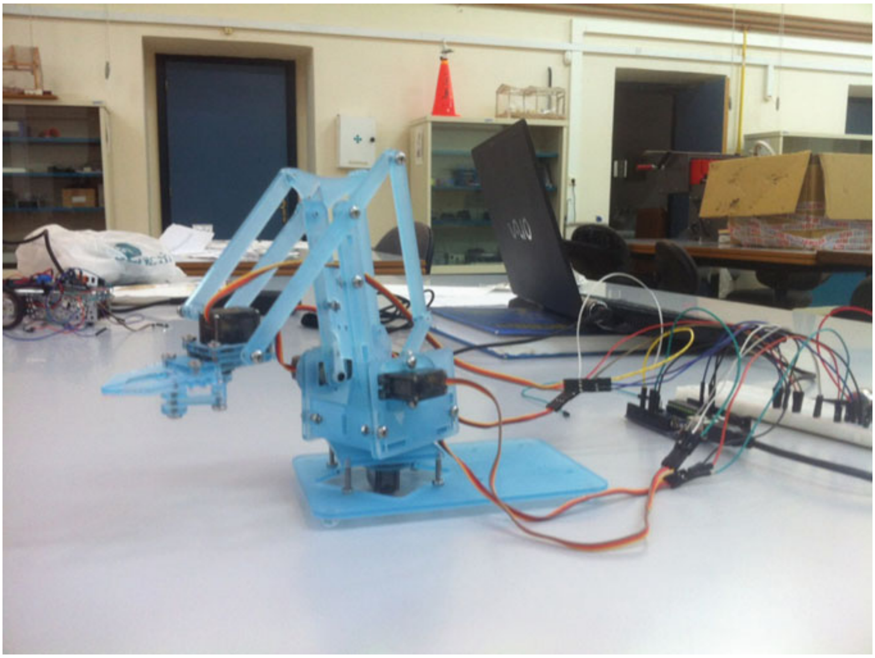


Fig. 32.3 A small robotic arm—the meArm that using deep learning, learns to pick up things, from one location in space and move them to another. *Source* Authors

so, not only it manages to build truly autonomous systems, embedding something of biological memory and learning, into a machine, but going full circle, it establishes a new computer architecture and a new form of programming, entirely different from the present programming languages.

A program in the conventional programming languages, *performs a mapping*, from a set of inputs to a set of outputs. Machine learning too performs a mapping from input to output patterns, though not through logical and arithmetic operations as a program does, but by *going through examples of input–output pairs*, extracting and memorizing the underlying regularities and generalizing to new inputs not in the example set.

This idea points to a new computer architecture inspired by the brain that breaks away from the Von Neumann architecture of present day computers and a new programming formalism. In the new computer architecture, the artificial neuron will replace the transistor as the unit of computation. Computations will not have the form of arithmetic and logical operations carried out in the Arithmetic and Logical Unit, but will be more like the interactions between the artificial neurons, in a deep learning network.

The programs running in this computer will not be made up of loops, assignments and the conditionals of present day languages. They will solve problems differently. Instead of presenting the computer with detailed instructions as to how to solve a problem, they will specify a *network structure and dynamics*, for solving that problem, namely, the number layers the network will have, the number of nodes, the connectivity and the learning equations, for modifying the strengths of the connections, so that the network can figure out how to solve the problem, from examples.

Deep learning, more than showing an alternative to building and programming robots, provides us with a *vision, for the computer and the programming of tomorrow*. Where computations will not be carried out by comparators, adders, multipliers and dividers, but by the exchange of signals between artificial neurons and programs will not contain loops and conditionals, but will rather specify a network structure and learning equations, for the network to *learn* how to solve a problem, *rather being coded* the solution.

32.5.1 Chips off the Old Block

There is already progress made in this direction. New chips have started to be built on architectures that draw inspiration from the brain. A key feature of these chips is the *distributed architecture* (Metz 2017), as opposed to the centralized one of the modern Central Processing Units (CPUs). One of these new chips, is the *Graphics Processing Unit (GPU)* made by Nvidia (Metz 2017). Another is the *Tensor Processing Unit (TPU),* built by Google (Metz 2017).

Originally, this new class of processors was developed to deal with the increased volume of processing that would result in Google's and Microsoft's data centers, from AI apps that would enable a smartphone to recognize spoken words or faces in photographs (Metz 2017). But the use of the new chip has spread to other applications, including robotics and the autonomous car, as well.

In contrast to the classical Central Processing Unit (CPU) that does the processing in today's computers and consists of a few cores, the Graphics Processing Unit (GPU) is composed of thousands of cores that can be programmed in parallel (Metz 2017). The result is a processor that combines the two most desirable properties: it consumes much less power while it is thousands of times faster that the most modern CPU. Thanks to these features, the Graphics processing Unit (GPU) is used as the control unit in the autonomous cars that Google, Tesla and other car makers are building.

32.6 Networks and the Cloud

We commonly refer to the present times, as the digital era. But it is also the era of big data and technology, of mobile devices and mobile comms, apps, services, virtual machines and the *cloud*. The modern network architecture is the architecture of the cloud and the fog (Stallings 2014). Enterprises large and small, writes William Stalling, 'increasingly rely on processing and analyzing massive amounts of data' (Stallings 2016). To process large quantities of data within tolerable time periods, big data need distributed file systems, distributed databases, Internet storage, and cloud computing platforms (Stallings 2016).

The cloud, provides storage for potentially massive amounts of data, for companies. But the cloud, apart from storage, comprises several other services. To individual users of PCs and mobile devices, apart from storage for backing up their data, the cloud offers them, the capability to sync devices and share files, using personal cloud computing (Stallings 2016). To enterprises, the cloud provides databases, memory, bandwidth, virtual machines, and data analytics to process the enterprise's data (Stallings 2016).

32.7 The IoT Era Begins

However complex and fast the modern networks are, they will get on the sidelines by another, even more modern, faster and bigger—the biggest possible network, the *Internet of Things (IoT)* which will connect not only computers, tablets and smartphones, but every device, from the electrical appliances and the installation in our home to our car and from sensors and drones to the robots in the assembly line of a factory and the engines of a ship. In this extended network, data will not only come from company computers, but from sensors monitoring and giving information about traffic, the environment, our home. This extended network referred as the IoT, is considered to be the next Great Idea in Computer Science.

The IoT 'provides unprecedented opportunities for users, manufacturers and service providers in a wide variety of sectors, including health care, home monitoring and automation, the industry, the smart grid, farming, transportation, inventory and product management and several others' (Stallings 2016). The IoT will enable us remotely to access the data from sensors and devices to see, for example, the available parking spots, both free and paid, in the area of our destination or images, from the camera at home while we are away. But primarily, through the IoT we will be able to *monitor and control motors and devices*, from far away, whether to turn off the cooking range at home or to operate the machines and robots, in the assembly line of a factory.

32.8 How Digitization Will Transform the Industry—Additive Manufacturing

The factory of the past was based on mass production. The factory of the future, writes the Economist, will be based on mass customization (Markillie 2012a). For a 3D printer, economies of scale matter much less. Its software can be endlessly altered and it can make just about anything. The cost of setting up the machine is the same whether it makes one thing or as many things as can fit inside the machine (Markillie 2012a).

The cost of producing much smaller batches of a wider variety, with each product tailored precisely to each customer's taste, is falling. 3D printers, for example, are being used to produce from hammers to hearing aids and high-tech parts of military planes in customized shapes. In a while these machines 'will be able to make almost anything, from a garage to an African village and that will change the geography of supply chains' (Markillie 2012a). An engineer working in the middle of the desert who finds he lacks a certain tool will no longer have to have it delivered from the nearest city. He will simply be able to download the design and print it (Markillie 2012a).

The revolution will affect not only how things are made, but where (Markillie 2012a). Factories used to move to low-wage countries to reduce labor costs. In the digitized industry, as the assembly line will be staffed by robots, labor costs will becoming less and less important. Offshore production will increasingly move from the developing countries to the technologically advanced countries 'not because Chinese wages will rise', but because the products will be more sophisticated and the production process highly automated (Markillie 2012a).

32.8.1 New Opportunities

Digitization in manufacturing will have a disruptive effect every bit as big as in other industries that have gone digital, such as office equipment, telecoms, photography, music, publishing and films (Markillie 2012a). And the effects will not be confined to large manufacturers. In fact, they will need to watch out because much of what is coming will empower small and medium-sized firms and individual entrepreneurs (Markillie 2012a). Launching novel products will become easier and cheaper.

32.9 How AI and Digitization Can Enhance Productivity

Company bosses, primarily, see in AI the potential for cost and labor savings (Markillie 2012a). But AI will bring broader opportunities, allowing companies that embrace it to operate more efficiently, generate more data, improve their services, attract more customers and offer lower prices (Markillie 2012a).

AI will also allow for enhanced decision making. The case of Law firms using AI to predict the outcome of complex cases, like compliance before those reach the court, is very characteristic of how AI can help in decision making. There is still a greater promise.

AI will automate not only decision making but several aspects of a business operation and the assembly lines in the industry. All the data from a company's operation—cases, activities, transactions—will be uploaded to cloud or IoT platforms where they will be stored, analyzed and used by AI algorithms to devise plans and make decisions. Those algorithms will even have the potential for self-improvement, from learning, using the new data to get re-trained and improve their predictions and decision making. In factories, industrial robots will team-up with humans (Markillie 2012b) in the assembly line and work day and night, in the 80s idea of "lights-out" manufacturing, meaning a 'factory so highly automated that the lights could go out and the robots left to do the production on their own' (Markillie 2012b). The robots, with their intricately designed arms, the vision and the intelligence built into them, would perform every single task along the assembly with the accuracy and precision of a skilled worker, only faster. Sensors inside the machines and in the factory will measure and wirelessly transmit every information, about the condition of the machines and the state of the production process, so that the whole process be monitored and controlled from distance. What benefits this automation will achieve?

32.9.1 Cost Savings and Enhanced Productivity

Deep Learning and industrial robots will provide a low-cost alternative to skilled labor. The automation of the assembly line in factories with optimally operating robots will cut labor costs and bring bigger revenue gains. But it will bring these gains not merely from savings in labor, but from an increase in productivity. The idea is that if people on the factory floor or in workshops were teamed-up with robots, they could become more productive. These new robots along with innovative manufacturing technologies could enormously enhance productivity (Markillie 2012b).

32.9.2 Effects on the Economy

While AI and the digitization of the industry will eliminate some jobs, nevertheless, they will create others. Manufacturing will still need people (Markillie 2012b). Automated machines will require people to service them and they will not necessarily replace human workers, but work with them, 'fetching and carrying parts, holding things, picking up tools, sorting items, cleaning up and making themselves useful, in myriad other ways (Markillie 2012b).

Much as the invention of the computer did not make office workers redundant, but merely, changed the tasks they do and has created a new industry, so AI and the digitization of the industry will create a new industry. We already see the early form of this industry through companies like iRobot and Boston Dynamics that manufacture robots for commercial and military applications. Several start-ups based on AI are being founded (Suich Bass 2018), making from neural implants and neurotechnology to sensors and AI apps and algorithms.

32.9.3 Enhanced Innovation—Automating Drug Design

While AI has been used in health care to diagnose certain diseases and it does that very reliably, potentially, it can have an even greater impacts on the health industry. AI has started to be used to discover and develop new drug compounds. Today, 'at least 18 pharmaceutical companies and more than 75 startups are applying machine learning to the complex and expensive process of identifying and testing new drug compounds' (Scudellari 2018).

The expectation is that AI will lead to new and better drugs (Scudellari 2018). The first molecules generated by AI algorithms are already on clinical trials and are seen to 'be more efficient, having lower molecular weight and sometimes better biopharmaceutical properties (Scudellari 2018). The main benefit of using AI in new drug discovery comes from the feature of AI algorithms to deal with imperfect, messy and complex data (Scudellari 2018).

32.10 Conclusions

The convergence of AI, a new class of processors in the form of GPUs and IoT will spark a wave of innovation. These ideas will transform business and the industry, automating data processing, decision making and the assembly line in factories. They will build intelligence into things—cars and robots but even tiny devices, leading to such products as driverless cars, industrial robots, bots and chatbots. AI will bring us closer to understanding the working of our brain and the nature of our intelligence and it will enable us to build one of the most complex and amazing creations of man: a machine having an intelligence that shares something with our own creativity and intelligence. Will these intelligent machines bring the third industrial revolution, as the cotton mill began the first and the assembly line, the second one? Certainly, the intelligent robot will have a deep impact on our economy, creating a new industry and new jobs. It will redefine business and the industry and have very deep effects in our habits, our work, our cities and the world.

Acknowledgements The authors Spyridon Adam, Loukas Michalis and Spiros Panetsos acknowledge the financial support, for the dissemination of this work, from the Special Account for the Research in ASPETE, through the funding program "*Strengthening ASPETE's research*".

References

Ackerman, E. (2013). *MIT robots can assemble your Ikea Furniture for you*. IEEE Spectrum, May 8, 2013.

Chokshi, N. (2018). *Robot conquers one of the hardest human tasks: Assembling Ikea Furniture*. New York Times Science, April 18, 2018.

Goodfellow, I., Bengio, Y. & Courville, A. (2016). *Deep learning*. Boston: MIT Press.

Hwang, K. (2016). *Cloud computing for machine learning and cognitive applications*. Boston: MIT Press.

Kim, P. (2017). *MATLAB deep learning: With machine learning, neural networks and artificial intelligence*. New York: Apress.

Markillie, P. (2012a). *A third industrial revolution*. Special report: Manufacturing and innovation. The Economist, April 21, 2012.

Markillie, P. (2012b). *Making the future*. Special report: Manufacturing and innovation. The Economist, April 21, 2012.

Metz, C. (2017). *Chips off the old block: Computers are taking design cues from human brains*. New York Times, September 16, 2017.

Palmer, A. (2018). *Thought experiments*. The Economist, January 6, 2018.

Stallings, W. (2014). *Data and computer communications*. Boston: Addison-Wesley.

Stallings, W. (2016). *Foundations of modern networking SDN, NVF, QoE, IoT and cloud*. Boston: Addison-Wesley.

Scudellari, M. (2018). *AI could redesign the drug development process*. IEEE Spectrum, April 27, 2018.
Sejnowski, T. J. (2016). *The computational brain*. Boston: MIT Press.
Sejnowski, T. J. (2018). *The deep learning revolution*. Boston: MIT Press.
Suich Bass, A. (2018). *GrAIt expectations non-tech businesses are beginning to use artificial intelligence at scale*. The Economist, March 31, 2018.
Trask, A. (2018). *Deep learning*. New York: Manning Publications.

Chapter 33
Theoretical Background of Facility Management

Martina Paliderova and Katarina Frajtova Michalikova

Abstract The article deals with the fundamentals of Facility management, its theoretical foundations and presents the characteristics of the current state of Facility management. Facility Management addresses the management of the organization's support activities and the reduction of overhead costs incurred for activities that do not add value to the product, thereby increasing the competitiveness of the product on the market.

Keywords Core business · Support activities · Costs · Facility management Efficiency

33.1 Introduction

The beginnings of the Facility Management (FM) in the USA are dated in the 70s of the last century. It covered services relating to the management and operation of tangible fixed assets and buildings. A major change occurred during the operation of the building where it was important to meet the requirements of dynamic development of the society both in technical and economic terms. For this reason, the requirements for a professional solution of the technical background of the building, security of persons and things have emerged. Later, support activities have also been added to the services related to the management and operation of buildings, e.g. energy management, building repairs, maintenance, rental accounting and related services, reception, security services, storage services and others.

In 1981 the International Facility Management Association (IFMA) was established in the United States. Europe meets the term FM in the early 1990s. Among

M. Paliderova (✉) · K. F. Michalikova
Faculty of Operation and Economics of Transport and Communication, Department of Economics, University of Zilina, Univerzitna 1, 01026 Zilina, Slovakia
e-mail: martina.paliderova@fpedas.uniza.sk

K. F. Michalikova
e-mail: katarina.michalikova@fpedas.uniza.sk

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_33

the first countries that adopted FM were the United Kingdom, France, the Benelux countries and Scandinavia. Five years later, this discipline expanded into German-speaking countries (Vyskocil and Strup 2003).

33.2 Facility Management

Facility means simplicity, ease, dexterity, skill, accessibility, advantage, appropriate equipment, means, fluency, talent. Management—management, administration, control, dexterous treatment.

Various professional publications have different FM definitions that are similar in meaning. According to the British International Facility Management (BIFM).

"Facilities management encompasses multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace". On the other hand, in Germany, the GEFMA (German Facility Management Association) defines facility management as an analysis of the optimization of all relevant processes relating to a building, other building site or enterprise performance that are not part of the core business. Facility Management (FM) (Kuda and Kuta 2006) is a multidisciplinary discipline of integrated management of support services for each organization and its management is a necessary condition for the growth of a successful company or institution in an increasingly intensive competitive environment. Effective FM has the following role:

- Encourage integration of different service processes,
- Simplify the links between strategic, tactical and operational levels,
- Ensure constant communication (bottom-up and vice versa within the organization)
- Develop and cultivate relationships and partnerships between clients (end-users) and suppliers (service providers).

Facility Management (FM) is a multidisciplinary discipline that deals with managing business support activities. CSN/EN 15221 defines FM as the integration of activities within the organization to secure and develop agreed services that support and increase the efficiency of its core business. According to this standard, FM is divided into two areas of process access to production activity:

- Space and infrastructure: space, technical infrastructure, cleaning, outdoor space, workplace including specific space and infrastructure requirements.
- People and organization: health and safety, nutrition, information and communication, logistics, integrated management, advice and administrative support, specific organization requirements.

For example, for universities we can identify teaching and research as two main activities and all other activities can be characterized as supportive. Thus, within the supporting processes we can include, e.g. area management, building management and maintenance, study department operation, fleet management, energy management, external relations management, property registration and others.

The goal of FM is the integrated management of all services that support the company's core business.

According to IFMA, Facility Management is understood as a set of the management methods that help organizations to reconcile working environments, workers, and work. It includes the principles of business administration, architecture, humanities and technical sciences. This definition is often presented as the "3P" symbol:

- Workers—human resources,
- Processes—activities,
- Spaces—environment, place of performance.

The resulting effect of interrelationships is to strengthen all the processes by which workers in their workplaces, in a pleasant environment that supports performance, deliver optimal performance. Thus, the facility management contributes positively to the economic growth of the company and the increase of its competitiveness.

According to Ondrej Strup, who is considered to be the spiritual father of facility management, this discipline integrates activities within the organization to ensure and develop the agreed services that support and enhance the efficiency of their business. It applies to every building user, optimizes workplace background and environment in all premises, unifies planning and asset management and all other services.

Facility management includes methods and techniques for managing building administration, organizational infrastructure management, and methods of overall organization alignment. It includes the management and development of the work environment. It has close ties to human resources management, organization management, and service management. Facility management is often mistakenly linked to external outsourcing, but it does not matter for the facility management itself whether these processes are secured by some form of outsourcing or whether the organization processes or services are provided by itself. Because each enterprise, each organization has some infrastructure, asset or work environment, facility management is concerning, in some form, any enterprise.

Facility management includes several different process groups such as:

- Building Management,
- Cable management,
- Area management,
- Cleaning management,
- and others.

Facility management covers mostly:

- operation, maintenance and servicing of technological equipment—provision of operational maintenance of the building and technical equipment;
- warranty and post-warranty service—representation of clients in negotiations with third parties,
- revisions, technical inspections—ensuring revisions in accordance with applicable regulations and standards (e.g. electrical, lifts, appliances, etc.);
- remote monitoring—connection of the object to the measurement and control system, distant fault capture, fault message and others;
- continuous emergency service—possibility to prevent further damage to property, removal of errors;
- Occupational safety and health—inspection by fire engineers, revision of fire extinguishers;
- Key Economy Management—Key Economy Evidence, Generic Key System.

33.2.1 Benefits of Facility Management

Benefits of facility management: reduction of operating costs, reduction of spatial claims, strategic planning review, accounting and inventory refinement, resource optimization, cost precision (Chorvathova 2006):

- Reduction of operating costs, a benefit that is one of the most important for FM clients. In Slovakia, where there has not been a rigorous transformation of ownership and no personal, organizational audit, this saving is greatest.
- The reduction of spatial claims, thorough organizational and operational analysis of real estate and operations (analysis of premises and areas) and due to the reduction of employees, an office area, resp. suitable manufacturing facilities are available for rent at a commercial market price. Since many FM companies have real estate activity in their core business, finding a potential tenant should not be a problem.
- Exact cost addressing—By high-quality central records and corresponding software we can accurately track directness of the costs. In terms of facility management, such software asset is advantageous that covers asset management and maintenance, maintenance and service management, site pass porting, asset records, supply/demand management, payment tracking, consumption evaluation. We objectively analyze individual centers, buildings, floors, premises, monthly and annually, and any discrepancies can be resolved operatively.
- By optimizing resources and services—By analyzing media consumption, services and resources, we often see unnecessary waste and undue consumption. The experienced facility manager can identify these discrepancies and offer solutions. For example, regulating and automating the heating system means 20% saving on heat consumption. Many solutions mean a certain amount of

investment in the first stage, but they overall will bring savings. Already in the planning phase it should be assumed that the property will not be used for the whole lifetime for only one purpose, it is necessary to allow variability.

Enforcing facility management is the process that consists of several phases. The first step is a thorough analysis of all the activities and processes running in the organization. In the second phase, this information is evaluated and optimized; the result of this optimization is the third phase—the project of deployment with a complete design of data flows and processes with connection to the CAFM (Computer Aided Facility Management) system. CAFM systems work on the principle of linking graphical information to alphanumeric data. In practice this means, for example, that the floor plan of the room is directly linked to the database of information about the number, name and function of the room, with information about the person working in this room. The advantage of the CAFM system is complexity, user-friendliness and clarity, connection to enterprise accounting. The disadvantage of these systems is costly hardware equipment. In the next fourth phase, the operating costs are monitored and the fifth phase is evaluative—all types of savings are evaluated over a certain period of time.

At present, the form of strategic outsourcing is well understood, organizations are aware of the importance of quality and confidential cooperation with an external contractor in the case of outsourcing activities closely connected to core activity. These are long-term contracts that, in the case of successful cooperation and the existence of a long-term well-functioning relationship, lead to a higher form of cooperation, the creation of strategic alliances or joint ventures with the aim to shift the boundaries of the possibilities of cooperation and its following benefits.

33.3 Determining the Core Activity

Determining the core activities or organizational capabilities is critical to the overall purpose of an outsourcing project, not to mention the importance of their understanding for the organization.

According to the Deloitte and Touche outsourcing consultant Eugene Procknow (Bruckner and Vorisek 1998), anything, although not precisely defined, should be take into account. It can avoid serious problems by applying this rule. Proper understanding and defining of core activities is very important also for identifying the interface between the organization and the future provider and for clear formulating the outsourcing contract. Its correct identification can lead to the relocation of complementary organizational activities outside the organization with aim to activate its own resources exactly for the purpose of the core business.

For a better understanding, the following definition of key actions, formulated by Greaver (1999), can be helpful: “Key activities are innovative combinations of knowledge, special capabilities, patented technologies, information and unique operational methods that a product or service provides to a customer. Based on these, the customer evaluates the product or service and decides about its purchase."

The organization normally has many abilities but only some of them are combined and integrated in such a way that they can be labeled as key ones. These combinations are often found in places that are underestimated, misunderstood, or hidden from their perceptions and, in short, in a small amount. That's because of that the key combinations have not yet been identified in the organization.

Critical for an organization, to identify the key combinations, is their perception by the customers. If the skills or activities do not create the product or service that the customer sees as distinct, it is very likely they are not to be key ones. Often, however, an organization cannot identify its key activities, because it is unable to understand how the business is perceived by the customer (Bartosova and Vagner 2016).

33.3.1 The Shared Services Centers

The Shared Services Center (2007) (SSC) is a form of focused service whose role is to concentrate certain support activities and services of the company into specialized units managed by the parent company and providing services under the contract.

Its main goal is to force SSC to perform cheaper and more efficiently when compared to the situation where the same activities would be scattered directly within the organization. As already mentioned, SSCs are closely associated with offshoring.

The centers are not directly the outsourcing, but they can become its precursors. If the centers have free capacities, they may, under certain conditions, offer commercial exploitation outside the parent organization and thus generate additional profit. It is the direction that the present SSCs are focused.

These centers are focused on securing the complete processes often established in countries with less expensive but economically efficient workforce in order to realize significant cost savings. Typically, organizations provide processes centrally within a larger geographic area.

Currently, the Central European countries, such as the Czech Republic, the Slovak Republic or Poland, enjoy the interest in building SSCs, which attract not only by cheap labor but also by its quality in terms of good language skills, education, etc.

By implementing SSCs in practice, savings can be achieved on average from 10 to 25%, in the Central and Eastern Europe region up to 35% (Bartosova and Valaskova 2017). However, it should be added that more than 80% of SSCs do not use so-called the best practice, which suggests large reserves in the quality of their operation and great possibilities for additional cost savings.

33.4 Conclusion

Globalization of society helps to develop facility management. A large sum of money is lost daily for support activities. Beginning with the improvements from above is out of question. It must start from the bottom of every business. Applying FM to businesses reduces costs. FM is understood as an effective management of all the supporting activities that are needed in the business to enable the enterprise to devote itself to its main activity that feeds it. Why is the facility management in Slovakia being applied slowly, in our opinion, is that the companies do not have the necessary information and, above all, do not know what the specific costs of the individual activities are.

The reality is that all the activities required to run an enterprise, are mostly done in some way, but they are not managed in the way that would be comparable to managing the business itself. They do not have their own strategy, their own budgets, their own business plan. Often the company does not care about the information. This is not about a small amount of money. For example, in an enterprise where turnover reaches four to five billion, fixed costs are approximately one billion, and half of these costs flow through business-related activities. Even though it is not a negligible amount, the FM is not given that kind of attention it deserves. FM is a way to manage support activities that make savings in its professionalism in this area and enable an enterprise to concentrate on the core business and develop its competitive edge.

References

Bartosova, V., & Vagner, L. (2016). Core business and supporting activities in Slovak enterprise. *Global Journal of Business, Economics and Management, 6*(2).

Bartosova, V., & Valaskova, K. (2017). Facility management in the globalized society. In *Globalization and Its Socio-economic Consequences: 17th International Scientific Conference, Rajecke Teplice, Slovak Republic*.

Bruckner, T., & Vorisek, J. (1998). Outsourcing informacnich systemu.

Chorvathova, D. (2006). Sustredme sa na svoj core business. In: Manazment v teorii a praxi.

Greaver, M. F. (1999). Strategic outsourcing.

Kuda, F., & Kuta, V. (2006). Inzenyring zivotneho cyklu jako nastroj facility managementu.

Pricewaterhousecoopers. (2007). Shared Service Center.

Vyskocil, V., & Strup, O. (2003). *Podpurne procesy a snizovani rezijnich nakladu*. New York: Professional Publishing.

Chapter 34
The Effect of Bitcoin Prices on US Dollar Index Price

I. Antoniadis, N. Sariannidis and S. Kontsas

Abstract The purpose of this paper is to explore the effects of Bitcoin (crude oil) and financial (equity, gold and stock prices) markets on the US dollar index. A GJR-GARCH model is used to test these relationships for the period August 2010 to September 2016 using monthly data. The results suggest that bitcoin gold and stock prices (*DSJI*) affect negatively and statistically significantly the returns of the US dollar index. There is also some evidence that there is asymmetry in the bitcoin market and its relation with the US dollar index and that the latter could be considered as a possible safe haven for gold, stock and bitcoin.

Keywords Cryptocurrency · Bitcoin · DSJI · Gold · US dollar index GJR-GARCH

JEL Classification F39 · G10 · G11 · G15

34.1 Introduction

The 2008 financial crisis had shed a heavy shadow of disbelief and mistrust towards traditional financial systems, leading investors and non-financial customers turn to other alternative methods of payment and "investment" such as digital banking

I. Antoniadis (✉)
Department of Business Administration, Western Macedonia University of Applied Sciences, Kozani, Greece
e-mail: iantoniadis@teiwm.gr

N. Sariannidis
Department of Accounting and Finance, Western Macedonia University of Applied Sciences, Kozani, Greece
e-mail: nsarianni@teiwm.gr

S. Kontsas
Department of Business Administration, Western Macedonia University of Applied Sciences, Grevena, Greece
e-mail: kontsas@windtools.gr

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_34

systems, and more specifically a new technology that was rising at the moment, a cryptocurrency named Bitcoin (BTC). The growth of Bitcoin and the cryptocurrencies that followed BTC was extraordinary, creating opportunities for investors, hedgers and speculators, but also substantial challenges for policy makers and regulators (Dyhrberg 2016a, b). It also created an immense field of research for economists, and econometricians as explaining the way that the prices of BTC formed and its volatility became a fruitful field of debate and research.

An important characteristic underlying the BTC blockchain technology is that it holds the identity of its users' secret, through a decentralized ledger. This gives bitcoin significantly greater levels of flexibility and speed to perform international transfers and transactions, providing BTC with a competitive advantage, compared to other currencies like the USD or EURO. This advantage provides an incentive to examine the effect that BTC prices have on the exchange rate of USD.

Despite the fact that BTC is neither a currency nor a commodity (Dyhrberg 2016), it attracted investors' and speculators' attention altogether as an alternative asset with high volatility and aspects similar to the ones of gold. Although most literature examines cryptocurrencies as an asset, most users are trading or even holding them for investment purposes (Chu et al. 2017). The increased attention, and the high margins of profits through speculation came with high levels of risk not only for the investors but for the global economy as well. Should BTC prices fluctuate erratically, or Bitcoin loses its value extremely, participants will avoid its use, which can damage efficient allocation of resources in the economy (Kurihara and Fukushima 2018), and may affect other currencies like USD or EURO, stock prices, and commodities like gold.

Notwithstanding, the overwhelming publicity and interest Bitcoin has attracted, the current economics and finance literature has still insufficient empirical evidence on its properties against other assets, and more specifically towards major world equities and stock market indices, bonds, oil, gold, the general commodity index and the US dollar index and exchange rate (Bouri et al. 2017). In this paper we examine the effect that Bitcoin has to the return of the US Dollar index, employing the GJR-GARCH method. Additionally, we examine the effect of gold and stock prices measured by the Dow Jones Sustainable index, as BTC has similar characteristics to gold and has become a part of risk and portfolio management reducing risk (Bouri et al. 2017b). To the best of our knowledge this is the first paper that examines the effect of Bitcoin in USD exchange rate in conjunction with gold and the DSJI index that consist of stocks that implement corporate social responsibility activities.

The rest of this paper is structured as follows. Section 34.2 reviews the relevant literature concerning the use of GARCH models to explain volatility of currency markets, gold, stocks and bitcoin. Section 34.3 presents the data and the methodology employed in our research, while Sect. 34.4 presents the empirical results and the estimated GARCH model. Finally, Sect. 34.5 concludes the paper offering a brief discussion on the presented results.

34.2 Literature Review

The relationship between USD, gold and stock prices has always been in the epicentre of research attention of both academics and practitioners. Gold has been proved to be an efficient hedge tool but also a safe haven for the US dollar (Reboredo 2013), although some researchers characterised gold as a "poor" one (Joy 2011),. Pukthuanthong and Roll (2011) found that the price of gold can be associated with currency depreciation whether it is US dollar, Euro or Yen, and that gold and the dollar are negatively related.

Stock prices and their relationship with the US dollar and exchange rates has also been researched in depth and the relationship has been found to be important (Wong 2017). Caporale et al. (2014) found that there is unidirectional relationship between exchange rates and stock prices, however little attention has been paid to a more interesting category of stocks that is included in the Dow Jones Sustainable Index (DJSI).

This index includes the top global companies that rigorously apply CSR practice in their worldwide operations (Giannarakis et al. 2017). Examining these companies in particular is important since responsible investment has attracted the attention of investors all over the world (Auer and Schuhmacher 2016), and have been found to be more resistant to risk, crises and volatility (Sariannidis et al. 2009; Giannarakis et al. 2017).

Notwithstanding the importance of sustainability for firms and investments, little work has been done to investigate these the effect that their stock returns have on other assets. Exchange rate volatility has been found to affect negatively the returns of the U.S. stock market, and mores specifically the DJSI (Sariannidis et al. 2010). The exchange rate of US dollar to major currencies has also been found to be negatively affected by stock returns of socially responsible companies (Giannarakis et al. 2017b). Pitoska et al. (2017) found that gold prices and the US dollar value to major currencies have a negative effect on the stock prices measured by the DSJI.

The issue however that has magnetised the interest of academic, practitioners and the public, are no longer gold or stock prices but a creation of the digital age: the Bitcoin cryptocurrency. Bitcoin, created in 2008, by "Shatoshi Nakamoto" as a decentralised digital currency used for online payments (Sahoo 2017), that uses blockchain technology and the Distributed Ledger Technology (Collomb and Sok 2016). From its conception until now bitcoin has grown in reputation and is considered to be the most innovative digital currency, and has a growing transaction volume, but also high levels of volatility (Sahoo 2017), laying the path for other cryptocurrencies such as Ethereum, EOS LiteCoin etc. Today there are more than 1634 cryptocurrencies with a total market capitalisation of 306.29 bn. $, and Bitcoin accounts for almost the 40% of this amount.[1]

An important question that oscillates academics, practitioners and policy makers is whether BTC should be treated as a currency or as a commodity. Bitcoin is fairly

[1]Data available from https://coinmarketcap.com/all/views/all/ (accessed in 29/5/2018)

liquid as one can exchange any currency for bitcoin at any time, but due to its scarcity it has liquidity limitations like other commodities (Dyhrberg 2016). The network and financial services related to Bitcoin are not regulated hence it is prone to increased volatility and speculative behaviour as most immature markets (Bouoiyour and Selmi 2015). Kurihara and Fukushima (2018) review a number of financial usages of Bitcoin, such as diversification of financial investments, the provision of a hedge instrument for performing financial transactions, a way to perform transaction etc. But the main usage of bitcoin that literature identifies, is speculation (Yermack 2015; Glasser et al. 2014; Sahoo 2017) that could lead to a serious financial crisis.

Szetzela et al. (2016) examined the relationship between the exchange rate for bitcoin to the leading currencies namely US Dollar, Euro, British Pound, and Yuan, using an exponential GARCH model reporting a relationship between the rate of return of Bitcoin USD, EURO and the Yuan. The link between gold and bitcoin is also examined by Dyhrberg (2016) who found a number of similarities between gold and the bitcoin including the fact that they are both "mined" and exist in limited "quantities", and that their prices are formed through supply and demand. Additionally, we must consider the fact that both gold and bitcoin are not controlled by any nation or institution, and that they are both valued and traded in the same means of exchange (Weber 2016).

Baur et al. (2017) extending Dyhrberg (2016) research using the GJR-GARCH methodology found that Bitcoin is a highly speculative asset, that has unique risk-return characteristics, following a different volatility process when compared with other assets and is also uncorrelated with assets such as gold the USD, or equities. Yermack (2015) also found that Bitcoin's daily exchange rates display virtually zero correlation with common used currencies (EUR, CHF, GBP, JPY) and with gold, making bitcoin inappropriate for risk management and extremely difficult for its owners to hedge. He also calls for attention to issues related to safety and practicality of using Bitcoin for everyday transactions. The risk assessment of Bitcoin must be performed considering the lack of regulation and the dubious and shady usages of cryptocurrencies (Stavroyannis and Babalos 2017).

Vo and Xu (2017) making a correlation analysis between BTC returns and a number of financial indices concerning the Dow Jones and the Australian stock exchange found that there is no relationship between BTC and the stock prices of these two stock exchanges. Dyhrberg (2016) investigated the financial asset capabilities of bitcoin as a means of exchange, and as a part of portfolio management, using GARCH models, finding that BTC displays significant similarities to both gold and USD. The results of his research indicates that BTC maybe useful in hedging against the dollar, in a similar way to gold, while a positive shock to the stock market (FTSE) may turn investors to riskier choices of assets, hence investing in alternative assets like bitcoin. Another interesting finding from Dyhrberg (2016) research is that the returns to BTC may function in a similar fashion to an exchange rate, therefore it is prudent to use it an independent variable to estimate the returns of USD. Bouri et al. (2017b) found that BTC may act as a safe-haven property, that can lead to effective risk reduction in portfolios consisted of US equities, but that would not be the case for gold (Al-Khazali et al. 2018). In a similar study Dyhrberg (2016b) investigated the Bitcoin relationship to the US dollar, EURO and GBP exchange rate, and the FTSE stock, finding that Bitcoin can be used as a hedging instrument towards stock prices, while for the US dollar correlations was found to be very small as Yermack (2015) also pointed out.

Stavroyannis and Babalos (2017) examined the relationship between the Bitcoin and the US stock market to point the capabilities of the cryptocurrency as an investment instrument to hedge, diversify or act as a safe-haven, and also the direction of their relationship compared with the one with gold. Their results indicate that Bitcoin prices are not affected by global macro-financial developments, reflected by the formation of the SP500 index, nor in the long-run or in the short-run.

34.3 Data and Methodology

Engle and Bollerslev (1986) have proposed the GARCH model methodology (Generalized ARCH models) for dealing with time series. GARCH model allows the dependency—connection of the conditional deviation σ_t^2 with its previous lags. GARCH model for the conditional variance can be expressed as an ARMA model. The simpler and most used expression for this model is:

$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + \beta \sigma_{\tau-1}^2 GARCH(1,1), \tag{34.1}$$

The conditional autoregressive heteroscedasticity model (ARCH) and its extension to the conditional generalized autoregressive heteroscedasticity model, have the advantage to take into consideration, not only the changing conditional volatility, but also volatility clustering phenomena (Brooks 2008 p. 394). One of the major disadvantages of ARCH and GARCH models is that they perceive the reactions of volatility in positive and negative shocks as symmetrical. The solution to this problem came from the asymmetric models, that are able to incorporate asymmetric characteristics of returns.

The most well-known asymmetric models provided by the relevant literature are the GJR-GARCH model that is an extension of GARCH with an additional term added to include potential asymmetries, and the EGARCH model. The methodology we are going to use in the present paper is the GJR-GARCH model since literature identifies it as the most appropriate for dealing with the volatile nature of cryptocurrencies time series (Chu et al. 2017). The model that we are going to estimate is the following

$$USALL_t = b_0 + b_1 DJSI_t + b_2 GOLD_t + b_3 BITCOIN_t + u_t \tag{34.2}$$

$$\begin{aligned} \sigma_t^2 &= a_0 + a_1\sigma_{t-1}^2 + a_2 u_{t-1}^2 + a_3 S_{t-1}^- u_{t-1}^2 \\ u_t &\sim N\left(0, \sigma_t^2\right) \end{aligned} \tag{34.3}$$

where $u_t \sim$ GED (0, σ_t^2), it is assumed to follow the GED (Generalized Error Distribution). We employ the GED because of its ability to accommodate leptokurtosis. Also,

$$\begin{aligned} S_{t-1}^- &= 1, \text{if } u_{t-1} < 0 \\ S_{t-1}^- &= 0, \text{elsewhere.} \end{aligned}$$

The leverage effect occurs when $\alpha_3 > 0$. The condition for a non-negative variance requires that $\alpha_0 \geq 0$, $\alpha_1 \geq 0$, $\alpha_2 \geq 0$, $\alpha_2 + \alpha_3 > 0$.

When $R_t - \hat{R}_t < 0$, then $u_t < 0$, which means that the observed return R_t is less than the estimated return (in other words, the mean return). Consequently, when S_t^- equals to 1, the negative change u_{t-1}^2 at time $t - 1$ correlates with the volatility at time t.

In this model, the good news ($u_{t-1} > 0$) related to the bad news ($u_{t-1} < 0$) has a different effect on the conditional variance. If $u_{t-1} > 0$, it implies that at time $t - 1$ we had good news, which had a positive effect on the return (over the mean return), and this is why the residual is positive. Good news reflects on the coefficient α_2 (α_3 absorbs the effect of the bad news). However, bad news has an effect on $\alpha_2 + \alpha_3$, because if $S_t^- = 1$, then Eq. (34.2) becomes:

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2 u_{t-1}^2 + \left(a_3 u_{t-1}^2 \cdot 1\right) = a_0 + a_1\sigma_{t-1}^2 + (a_2 + a_3)u_{t-1}^2, \tag{34.4}$$

when $\alpha_3 >$ 0, we have the leverage effect, which means that bad news has a greater effect on conditional volatility. When $\alpha_3 \neq 0$, we can simply state that the effect of news is asymmetrical.

The data that will be used in our empirical analysis were provided by the Robeco Sam data bank and include monthly observations for the Dow Jones Sustainability Index (*DJSI*), the Bitcoin prices and returns (*BITCOIN*), the price of gold in USD (*GOLD*), and finally the U.S. dollar index of the value of the *USD* relative to a basket of foreign major currencies[2] (*USALL*). The collected data covers a period from August 2010 to September 2016, namely 74 observations.

For the estimation of the model, every variable is converted into a logarithmic form with the following function $R_t = 100 \cdot \log \frac{p_t}{p_{t-1}}$, where R_t and p_t are the monthly average returns and prices respectively. Results are presented in the following section.

[2]namely Euro (EUR), Japanese yen (JPY), Pound sterling (GBP), Canadian dollar (CAD), Swedish krona (SEK), and Swiss franc (CHF).

34.4 Empirical Results

The following Table 34.1 presents briefly the main descriptive statistics of the variables we use for the model estimation. It should not come as a surprise that Bitcoin presents the highest average returns but also the highest volatility, measured by standard deviation, of the 4 variables as it is considered to be a highly speculative financial tool (Bouoiyour and Selmi 2015; Yermack 2015; Glasser et al. 2014; Sahoo 2017).

The median of the 4 variables of the sample is close to zero, meaning that the basic hypothesis of the zero median cannot be rejected in a 5% level. In terms of asymmetry for the first 3 variables since the asymmetry statistic is negative, while Bitcoin shows positive asymmetry. Kurtosis is positive for all the examined variables therefore we can argue that the distribution of the variables is *leptokurtic*. By examining the Jarque Berra statistic we conclude that *USALL*, *GOLD* and *DSJI* variables follow the normal distribution while BITCOIN does not, at a level of statistical significance of 5%.

Taking under consideration the properties of the time series examined, as described by the above statistics, the more appropriate model for the analysis of our model is the GJR-GRACH model (1, 1). It must be noted that this methodology is in line with relevant literature concerning the volatility of cryptocurrencies as a number of studies has used the proposed methodology (Baur et al. 2017; Vo and Xu 2017; Chu et al 2017; Katsiampa 2017).

As described in the previous section the GJR-GARCH model that is going to be estimated includes 3 independent variables:

$$USALL_t = b_0 + b_1 DJSI_t + b_2 GOLD_t + b_3 BITCOIN_t + u_t, \qquad (34.5)$$

while, the variance function of the GJR model is:

Table 34.1 Descriptive statistics

	USALL	DJSI	GOLD	BITCOIN
Average	0.002225	0.00531	0.0015	0.124598
Median	0.003043	0.006847	−0.0007	0.054724
Max. value	0.029484	0.109143	0.1151	1.706623
Min. value	−0.026339	−0.111432	−0.1171	−0.49856
Standard deviation	0.011294	0.042804	0.0529	0.393466
Asymmetry	−0.059699	−0.220179	−0.0403	1.660812
Kurtosis	2.674548	3.198593	2.5788	6.788625
Jarque-Bera	0.370538	0.72	0.57	78.2762
ADF	−5.80	−9.94	−10.10	−6.47
Observations	74	74	74	74

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2u_{t-1}^2 + a_3S_{t-1}^- u_{t-1}^2, \quad u_t \sim N\left(0, \sigma_t^2\right) \tag{34.6}$$

The necessary diagnostic tests were performed to assess the goodness of fit and appropriateness of the model. The standardized and squared standardized residuals of the model are examined to determine whether they are free from serial correlations. The results presented in Table 34.2 suggest the absence of heteroscedasticity in the residuals of the estimated model.

Table 34.3 presents the Regression results for the coefficients of the Eq. (34.5). According to the results, coefficients b_0, b_1, b_2 and b_3 are statistically important in a level of 5%, since z-statistic exceeds 2 and the relevant p-value is zero for b_0 and b_2, and almost zero for b_1 and b_3.

Furthermore, we must mention that the negative sign of the coefficients b_1, b_2 and b_3, illustrates the negative relationship between the independent variables and the dependent variables we have examined. This means that the US dollar is strengthened, when the global prices for gold, the Bitcoin and the DJSI index are falling, acting as a safe haven in times of crisis.

The variance equation can be written as follows:

Table 34.2 Diagnostics on standardized and squared standardized residuals

Residuals				Squared residuals			
Lags	Autocorrelation	Partial correlation	LB (n)	Lags	Autocorrelation	Partial correlation	LB (n)
1	0.007	0.007	0.0036	1	0.002	0.002	0.0004
2	0.031	0.031	0.0788	2	−0.041	−0.041	0.1304
3	−0.15	−0.15	1.8496	3	0.093	0.093	0.8167
4	−0.018	−0.017	1.8761	4	0.137	0.136	2.3212
5	0.085	0.097	2.4598	5	−0.066	−0.06	2.6785
6	−0.019	−0.043	2.4898	6	−0.17	−0.174	5.0599
12	−0.066	−0.079	5.2673	12	0.022	−0.005	7.0935
24	−0.008	−0.006	11.907	24	−0.067	−0.103	15.822

Table 34.3 Mean equation estimates

Variable	Coefficient	Standard error	Z-Statistic	p-values
C	0.004522	0.001071	4.2224499	0
DJSI	−0.095063	0.024544	−3.87314	0.0001
GOLD	−0.09066	0.017978	−5.04281	0
BITCOIN	−0.005348	0.001699	−3.1478	0.0016
R^2	0.2713			
Adjusted R^2	0.2401			

$$\sigma_t^2 = 0.0000358 + 0.072766\sigma_{t-1}^2 - 0.35723u_{t-1}^2 + 0.701292S_{t-1}^- u_{t-1}^2, \quad (34.7)$$

Equation (34.7) is known as the autoregressive procedure of the conditional heteroscedasticity or ARCH. The coefficient value of $\alpha_1 = 0.072766$ provides evidence that past information affect volatility less than most recent ones, as $\alpha_2 = -0.35722$ concerns last month's effect. Moreover, the value of $\alpha_3 = 0.70129$ means that the phenomenon of asymmetry is present and significant in the Bitcoin market.

34.5 Conclusions

The aim of this paper was to investigate the relationship between the returns of stock prices measured by the Dow Jones Sustainable Index (DJSI), Bitcoin, gold and the U.S. dollar index for a period of 74 months (August 2010 to September 2016). Considering the properties of the examined time series, as well as relevant statistical tests, we have used the the GJR-GRACH model (1, 1) to analyze the effect share prices gold and bitcoin have to the USD index. Appropriate econometric tests on the squared residuals, has also indicated a lack of heteroscedasticity in the residuals of the model in question.

The general conclusion drawn from the model that we have presented is that for the time period examined, US dollar acted as a safe haven for other forms of investments since it was negatively (and statistically important) related to bitcoin, gold and stock prices. Bitcoin was found to be inversely related to the returns of gold, the dollar and the DJSI. Rise of returns of gold can be attributed to the uncertainty created due to financial and political crises, therefore Bitcoin, that is extremely sensitive to the economic conditions and uncertainty due to its speculative nature, moves to the opposite direction. The relationship between Bitcoin the US dollar index and the DJSI index was also negative. As US dollar is considered to be a reserve currency, investors prefers it in times of economic and financial uncertainty. In bullish periods for the markets, investors also turn in shares rather than in bitcoin and other cryptocurrencies. Another important finding is the bitcoin ad the US dollar market behavior that is characterized by asymmetry, and reacting to bad news in a larger extent.

Our results provide useful insights for portfolio managers and investors. US dollar could be considered a safe haven, while Bitcoin returns have a negative effect on the price of US dollar. However further research should be conducted focusing in the causal relationship between Bitcoin and other financial assets, extending both the period of time examined and the period of average returns (weekly instead of monthly), to capture the effect of speculative behavior.

References

Al-Khazali, O., Elie, B., & Roubaud, D. (2018). The impact of positive and negative macroeconomic news surprises: Gold versus Bitcoin. *Economics Bulletin, 38*(1), 373–382.

Auer, B. R., & Schuhmacher, F. (2016). Do socially (ir)responsible investments pay? New evidence from international ESG data. *The Quarterly Review of Economics and Finance, 59,* 51–62.

Baur, D. G., Dimpfl, T., & Kuck, K. (2017). Bitcoin, gold and the US dollar—A replication and extension. *Finance Research Letters*.

Bouoiyour, J., & Selmi, R. (2015). What does Bitcoin look like? *Annals of Economics & Finance, 16*(2).

Bouri, E., Azzi, G., & Dyhrberg, A. H. (2017a). On the return-volatility relationship in the Bitcoin market around the price crash of 2013. *Economics-The Open-Access, Open-Assessment E-Journal, 11,* 1–16.

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., & Hagfors, L. I. (2017b). On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? *Finance Research Letters, 20,* 192–198.

Brooks, C. (2008). *Introductory econometrics for finance*, 2nd ed. Cambridge University Press.

Caporale, G. M., Hunter, J., & Ali, F. M. (2014). On the linkages between stock prices and exchange rates: Evidence from the banking crisis of 2007–2010. *International Review of Financial Analysis, 33,* 87–103.

Chu, J., Chan, S., Nadarajah, S., & Osterrieder, J. (2017). GARCH modelling of cryptocurrencies. *Journal of Risk and Financial Management, 10*(4), 17.

Collomb, A., & Sok, K. (2016). Blockchain/Distributed ledger technology (DLT): What impact on the financial sector? *Communications & Strategies*, (103), 93.

Dyhrberg, A. H. (2016a). Bitcoin, gold and the dollar—A GARCH volatility analysis. *Finance Research Letters, 16,* 85–92.

Dyhrberg, A. H. (2016b). Hedging capabilities of bitcoin. Is it the virtual gold? *Finance Research Letters, 16,* 139–144.

Engle, R. F., & Bollerslev, T. (1986). Modelling the persistence of conditional variances. *Econometric reviews, 5*(1), 1–50.

Giannarakis, G., Garefalakis, A., Lemonakis, C., & Konteos, G. (2017a). The drivers of social responsible stock index: The case of Dow Jones sustainability index world. *Corporate Ownership & Control, 14*(2), 173–180.

Giannarakis, G., Garefalakis, A., Lemonakis, C., & Sariannidis, N. (2017b). The impact of Dow Jones sustainability index on US dollar value. *International Journal of Economics and Financial Issues, 7*(2), 556–561.

Glaser, F., Zimmermann, K., Haferkorn, M., Weber, M., & Siering, M. (2014). Bitcoin-asset or currency? Revealing users' hidden intentions. In *ECIS 2014 (Tel Aviv)*. Available at SSRN: https://ssrn.com/abstract=2425247.

Joy, M. (2011). Gold and the US dollar: Hedge or haven? *Finance Research Letters, 8*(3), 120–131.

Katsiampa, P. (2017). Volatility estimation for Bitcoin: A comparison of GARCH models. *Economics Letters, 158,* 3–6.

Kurihara, Y., & Fukushima, A. (2018). How does price of Bitcoin volatility change? *International Research in Economics and Finance, 2*(1), 8.

Pitoska, E., Katarachia, A., Giannarakis, G., & Tsilikas, C. (2017). An analysis of determinants affecting the returns of Dow Jones sustainability index United States. *International Journal of Economics and Financial Issues, 7*(3), 113–118.

Pukthuanthong, K., & Roll, R. (2011). Gold and the dollar (and the euro, pound, and yen). *Journal of Banking & Finance, 35*(8), 2070–2083.

Reboredo, J. C. (2013). Is gold a safe haven or a hedge for the US dollar? Implications for risk management. *Journal of Banking & Finance, 37*(8), 2665–2676.

Sahoo, P. K. (2017). Bitcoin as digital money: Its growth and future sustainability. *Theoretical & Applied Economics*, *24*(4).

Sariannidis, N., Giannarakis, G., Litinas, N., & Kartalis, N. (2009). Empirical analyses of determinants of DJSI US mean returns. *International Journal of Social and Human Sciences, 3,* 521–526.

Sariannidis, N., Giannarakis, G., Litinas, N., & Konteos, G. (2010). Á GARCH examination of macroeconomic effects on us stock market: A distinction between the total market index and the sustainability index. *European Research Studies, 13*(1), 129–142.

Stavroyiannis, S., & Babalos, V. (2017). Dynamic properties of the Bitcoin and the US market. Available online: https://ssrn.com/abstract=2966998. Accessed on May 14 2018.

Szetela, B., Mentel, G., & Gędek, S. (2016). Dependency analysis between Bitcoin and selected global currencies. *Dynamic Econometric Models, 16*(1), 133–144.

Vo, N. N., & Xu, G. (2017). The volatility of Bitcoin returns and its correlation to financial markets. In *2017 International Conference on Behavioral, Economic, Socio-cultural Computing (BESC)*, pp. 1–6. IEEE.

Weber, W. E. (2016), A Bitcoin standard: Lessons from the gold standard, Bank of Canada Staff Working Paper, 2016-14, http://www.bankofcanada.ca/wp-content/uploads/2016/03/swp2016-14.pdf.

Wong, H. T. (2017). Real exchange rate returns and real stock price returns. *International Review of Economics & Finance, 49,* 340–352.

Yermack, D. (2015). Is Bitcoin a real currency? An economic appraisal. In *Handbook of digital currency* (pp. 31–43).

Chapter 35
Prospects for Climate Services for Sustainable Agriculture in Tanzania

Moammar Dayoub, Jaakko Helminen, Ville Myllynpää, Nicolas Pope, Mikko Apiola, Tomi Westerlund and Erkki Sutinen

Abstract Climate services offer information on temperature, rainfall, wind, soil moisture, early warnings, and long-term forecasts for agriculture. The objectives of this study are to explore the current state of climate services for farmers in the Morogoro region of Tanzania, to clarify the importance of climate services in decision-making, to identify sources of climate information available for farmers and to formulate the requirements to improve the system of climate services. The results show that accurate forecasts, both the short term and long term, could help farmers to decide when and what to plant and how to attend their crops. This information will be used to provide potential production choices, improved productivity and decreased risk. The major sources of information for farmers were essentially family, neighbours and friends. The results emphasised the importance of access to information and knowledge for farmers, for the agriculture sector and for general livelihood. The results showed that a participatory approach could achieve integration in designing and using a mobile application in agriculture to achieve sustainable development.

Keywords Climate services · Mobile application · Tanzania · Morogoro
Weather forecasting

35.1 Introduction

Climate services offer information on temperature, rainfall, wind, soil moisture, early warning, and long-term forecasts. Whilst there are numerous definitions of climate services; we define them as the provision of climate information in such a way as to assist decision-making (Buontempo and Hewitt 2018).

M. Dayoub (✉) · J. Helminen · V. Myllynpää · N. Pope · M. Apiola
T. Westerlund · E. Sutinen
University of Turku, 20014 Turku, Finland
e-mail: modayo@utu.fi

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_35

Since agriculture is mostly carried out in the open air, and always entails the management of inherently variable living plants and animals, it is especially exposed to various risks.

Production risks comes from the unpredictable nature of the weather and uncertainty about the performance of crops or livestock, as an example, through the incidence of pests and diseases (Hardaker et al. 2015).

Weather is an important production factor, and at the same time, one of the greatest sources of risk in agriculture. It is a matter of common knowledge that weather represents the major source of uncertainty in crop production. It is expected that weather fluctuations will increase in the future due to climate change (Oliver 2011).

In the shorter term, since farmer's dependence on rainfall, current weather variability and associated shocks are creating vulnerability for farmers. Therefore it is essential to help them to build their livelihood resilience through coping better with current weather-induced risk as a prerequisite to adapting to future climate change. A new weather information delivery system is proposed which enables effective, locally and purpose specific weather information delivery to farming communities and other stakeholders in the agricultural sector (Feleke 2015).

Whilst temperatures are already increasing and changing rainfall amounts and patterns may begin to become significant in the future, the question remains to what extent farmers will experience conditions under progressive climate change that they are not already experiencing today (Cooper and Coe 2011).

Climate services seek to allow decision makers to increase resilience to, or maximise gains from current and future climate conditions through the delivery and use of climate information (Golding et al. 2017). Over the past decade, there has been a dramatic increase in the awareness across society about the usefulness of integrating climate information in decision-making (Buontempo and Hewitt 2018).

We distinguish between scientific information and indigenous knowledge regarding weather and climate. Local knowledge encompasses "the knowledge and practices that are acquired by local people over a period of time through the accumulation of experiences over generations, society–nature relationships, and community practices and institutions" (Kniveton et al. 2014).

Weather and climate information has an important role in building the local knowledge which shape understanding of climate risks and guide decision-making across scales (Singh et al. 2017).

In order to get higher yields and resilient food crops, African farmers need access to knowledge to improve agricultural productivity (Hansen et al. 2011).

The United Republic of Tanzania is among the developing countries located in Eastern Africa, neighbouring to Kenya, Uganda, Ruanda, Burundi, Democratic Republic of Congo, Zambia, Malawi and Mozambique. Tanzania covers an area of 947,300 square kilometres and has a population of 54 million, according to the latest estimate. Used land area is divided in a following way; agriculture (43.7%), forestry (37.3%) and others 19%) (CIA 2017). It is estimated that 80% of the total working force in Tanzania consist of farmers and more than 90% of them are smallholder farmers living in rural areas. Among the smallholder farmers 49.9% are males and 50.1% are females (NBS 2013). Like other countries in the Sub Saharan Africa, Tanzania is experiencing the adverse impacts of climate change. Viable impacts of climate change in Tanzania include changing geographic and temporal patterns and intensity of drought, flooding, and seasonal rainfall shifts, with corresponding impacts on small scale agriculture and forestry.

Our research is implemented in the Morogoro region, which is among the 30 administrative regions of Tanzania. According to NBS (2013), by year 2012 the region had a total of 2.2 million people, with an average household size of 4.4. The economy of the region is dominated by agriculture and the allied activities. The major activities include small scale farming and cattle keeping. The major crops grown are Maize, Rise, Cassava and Banana (CIA 2017).

The uncertainty about seasonal weather forecasts is one of the most critical factors which forces farmers to continue using Indigenous Knowledge. Farmers need the provision of timely and accurate weather forecast information to enhance their coping and adaptation strategies under varying climate conditions, in addition to a clear policy framework on the dissemination of information related to weather patterns in rural Tanzania (Elia et al. 2014).

35.2 Objectives of the Research

The objectives of this study aimed to:

- Identify the current situation of climate services in the area of study;
- Understand the sources of weather information available for farmers and how they use forecasting in decision-making process; and
- Explore the framework of climate services for farmers by using a climate service mobile application.

35.3 Research Methods

For this research on the importance of climate services for local farmers, Tambuu village in the Morogoro region of Tanzania will be used as the case study. This district was selected due to its diversity in production and range of available ICTs such as TV, community radio and mobile phone networks.

Our first task was to answer the question: what is the source of information for forecasting available today and how do farmers use this information to make decisions.

Data was collected through interviews and workshops in Tambuu village. A total of 13 smallholder farmers participated in the interviews. We utilised the collected descriptive and statistical data, as well as other international and local Tanzanian datasets and materials to understand the relationship between farmers and weather information, and how they use this information, in order to create the prototype for Climate service mobile app.

35.4 Results and Discussion

35.4.1 Current Situation of Climate Services for Farmers in Morogoro Region in Tanzania

The World Weather Information Service, which operates under World Meteorological Organisation (WMO), coordinates the worldwide efforts that are prerequisite for the production of accurate and timely weather forecasts, (WMO 2014) and the Regional Climate Outlook Forums (RCOFs) produce consensus-based, user-relevant climate outlook products in the right time in order to reduce climate-related risks and support sustainable development for the coming season in sectors of critical socio-economic significance for the region in question. These Regional Climate Outlook Forums are followed by national forums to develop detailed national-scale climate outlooks and risk information, including warnings for communication to decision-makers and the public. At the same time, the Tanzania Meteorology Agency (TMA) is working with other Meteorological agencies in the developing world to provide longer-term forecasts tailored for farmer's needs. The Agency is responsible for the provision of Meteorological services; weather forecasts, climate services, warnings, and advisories information to the agriculture sector, in order to improve quality of production and hence reduce losses and risks.

By providing forecasts for a longer period and offering appropriate information to farmers, the Meteorological agency is trying to meet farmers' demand for climate information and better decision-making abilities.

Immediate priorities include the provision of tailored weather and climate forecasts to help pastoralists cope with drought, disaster managers to prepare for flooding and the health sector to anticipate outbreaks of malaria, cholera and other diseases (WMO 2014).

In Tanzania, as well as elsewhere in the world, information about weather conditions expected in the next couple of days is known as a "short range weather forecast". Whereas information ranging up to around ten days is called a "medium range weather forecast". Information about average weather conditions expected during the longer period is known as a "climate outlook" (Tanzanian Meteorological Agency 2018).

According to our interviews, smallholder farmers in Tanzania are already using seasonal forecasts and forecasts of the start and end of the rainy season, to aid in their decision-making. They identify a lack of additional forecast information, such as updates on the progress of the season, wind forecasts from the TMA, information on climate change impacts, among others, to be delivered at least one month before the rainy season.

35.4.2 Sources of Weather Information Available for Farmers and How They Use Forecasting in Decision-Making Process

There is a regular broadcast through television, radio, the TMA website (www.meteo.go.tz/) and via a mobile app (GSMA, 2016) to get information about weather. Users are most familiar with these short- and medium-range forecasts. However, there is a lack of trust in this weather information as farmers have found even the state of current weather forecasts to be inaccurate sometimes. The majority of farmers in Morogoro need information on weather conditions (95% of those asked), with mostly rice farmers complaining about a lack of current and timely information on weather conditions. This is probably because of climate change, which has resulted in unpredictable rains and variability, hence farmers fail to plan the right time to plant their crops (Benard et al. 2014).

Ministry of Agriculture, Food Security and Cooperatives, extension officers, non-governmental organisations (NGOs), and private sector actors use the short-term weather forecasts widely. Examples given by farmers on how the information is used includes: knowing when they should seed or when to use fertilizer. See Fig. (35.1).

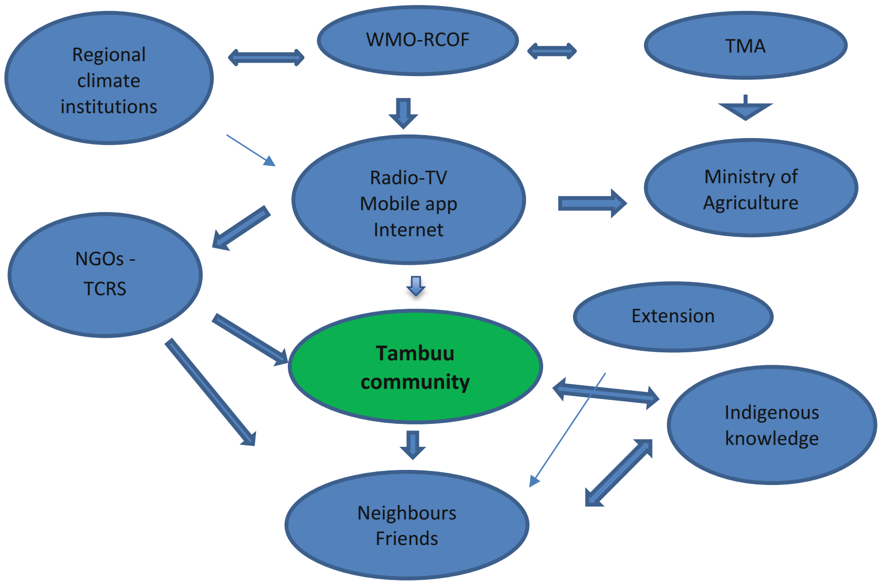


Fig. 35.1 Source of weather information for farmers. *Note* The thickness of the lines indicate the degree of the information flow

When most people think of a weather forecast, they usually think of a forecast for 1–10 days in advance. While these forecasts are the most familiar, they are only one end of a spectrum.

On the other hand, farmers in the developing world are increasingly using forecasts that range up to months in advance (climate outlooks) to make decisions that directly affect their livelihoods (climatesociety.ei.columbia.edu 2016).

Accurate forecasts at both the short term and long term could help farmers to decide when and what to plant and how to attend their crops. If farmers had a good way of telling when the rainy season would start, they could decide when to plant so that their seeds would get enough moisture. If they knew the conditions a week or more in advance, farmers could decide whether to apply fertilizers or pesticides. If they knew how wet the year's rainy season is going to be, farmers could make decisions about what crops to plant to get full advantage of the rainfall.

Farmers want to increase their crop yields and achieve maximum return in minimum cost, in order to improve their income. They require accurate, and timely agricultural information and knowledge about their farm potential, to support their decision making on their farms.

The weak linkage between farmers, researchers and extension staff in Morogoro leads communities to depend on indigenous knowledge.

Nowadays, the rapid development of using mobile phone technology and improved internet access in Africa presents an opportunity to develop new innovative and technological tools that promote agricultural sustainability through the provision of essential information on weather and best agricultural practises.

Farmers depend on friends and neighbours in getting information about weather. This takes a social form in exchange information and forecasting. Over many years this has become a fundamental component of decision making for farmers (Dare Kolawole et al. 2014).

Indigenous knowledge has a wide role in agriculture and mobile apps could be used to share and make this local experience available for other communities as well (Hansen et al. 2011).

However, this knowledge becomes less effective due the effect of climate change, resulting in poor decision making by farmers.

To help farmers, we need to rebuild the trust between the Meteorological agency and farmers. This requires, at first, offering accurate and on time information. It is important to focus on providing locally appropriate climate information, while at the same time engaging and training farmers for better understanding and use the information in their farming decisions. In this area, integration of meteorological information with local indigenous knowledge has been suggested to foster trust, local relevance and use, but rigorous evidence is still lacking (Tall et al. 2014).

35.4.3 Framework of Climate Service for Farmers by Using Mobile App

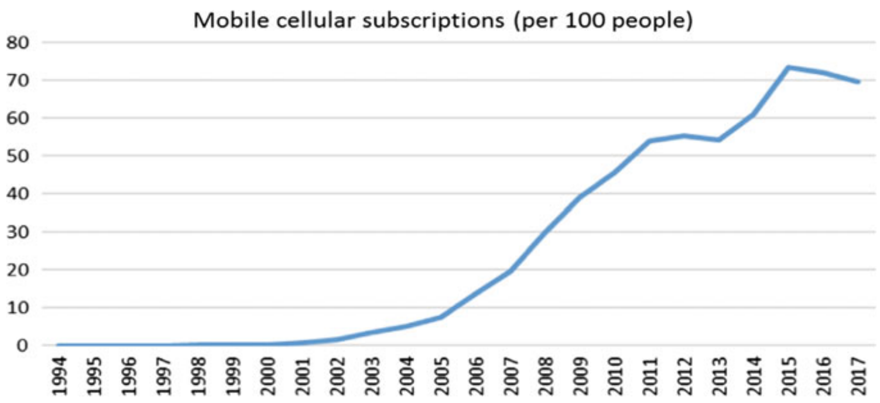
For African farmers there is not currently sufficient access to information, knowledge and practices through climate services. Instead they have only basic data to make decisions on their farms. This knowledge gab needs to be identified, so that specific and formal ability to use of Information and Communication Technologies, such as mobile phone technology can be build. Use of participatory approach in designing applications, to provide useful information for effective decision making that will enhance agricultural productivity and a sustainable livelihood, is critical.

The climate services app aims to provide farmers and extension staff with various information categories by using mobile application as a platform. It allows informed and accurate decision on agricultural and farm management practices by using the information on weather and climate generated through the use of mobile application.

In Tanzania, small scale farming is the main form of crop production, and employment in agriculture, while it is being increasingly challenged by the effects of the climate change (Government of Tanzania 2014). On the other hand, Tanzania had an estimated 19 million mobile internet users at the end of 2017 (Tanzania Communications Regulatory Authority 2018) and mobile use in Tanzania is among the cheapest in Africa (ResearchICTAfrica.org 2016).

The statistic showed that mobile-cellular subscriptions per 100 inhabitants in Tanzania are developing very quickly. See Fig. (35.2).

We can say that using a mobile application, as a platform for climate services, and a participatory approach in design, is a prominent way of generating income and employment for a large number of people and especially for small-scale farmers.



Data Source: World Development Indicators-Tanzania

Fig. 35.2 Develop mobile cellular subscription (1994–2017) in Tanzania. *Data Source* World development indicators-Tanzania

35.4.4 What Is Mobile Application of Climate Service

The Mobile Application of Climate Service is a smartphone-based application that is connected to internet-based database that allows users to access, use and share climate knowledge and information relevant to the unique potential of each farmer.

The Mobile Application of Climate Service allows individuals and organizations to use smart phones to determine the potential of any given farm in supporting certain crops under the prevailing climatic conditions. This is based on accurate weather data and climatic information, as well as on scientific and local knowledge, which enables users to identify the best practises and crops.

The app obtains site-specific data, including rainfall and temperature distributions per year, average annual precipitation, available soil moisture, elevation, length of growing period in days and the aridity index for given location. The MACS will be freely accessible on the Android platform and can also be used to collect local information from the farmers.

We will using participatory approach in designing the application. The MACS provides information for different user groups at varied scales. Therefore individual farmers or producers from various locations and backgrounds are able to use the app to answer questions about sustainable farm management options.

Extension workers are also able to directly access the best available information and interpret it in the context of local socio-economic conditions and local values, including crop choice.

By using MACS, policymakers are able to aggregate data across larger areas without losing key pieces of information, such as the attending of small, highly productive or vulnerable sites within a region.

Users will have the opportunity to provide data to feed into the app through answering to a series of feedback questions or submitting their own observations and best practices. This information will be used to provide potential production choices, for other farmers in similar conditions.

The framework of climate service shows that generating data comes from local weather stations and the National Meteorology Agency. This data is transferring through modelling to forecasting. Farmers can then access information and make decision in their farms. See Fig. (35.3).

The factors of production are land, which involves natural resources, labor is associated with human resources, capital includes manmade resources, and farm combines all the factors, to carry out the production process in the farm. The technology, in this case, can help farmers to increase investment capital, labor and land distribution. As a result, when a farmer's income increases, it leads to improving livelihood and helps to achieved sustainability.

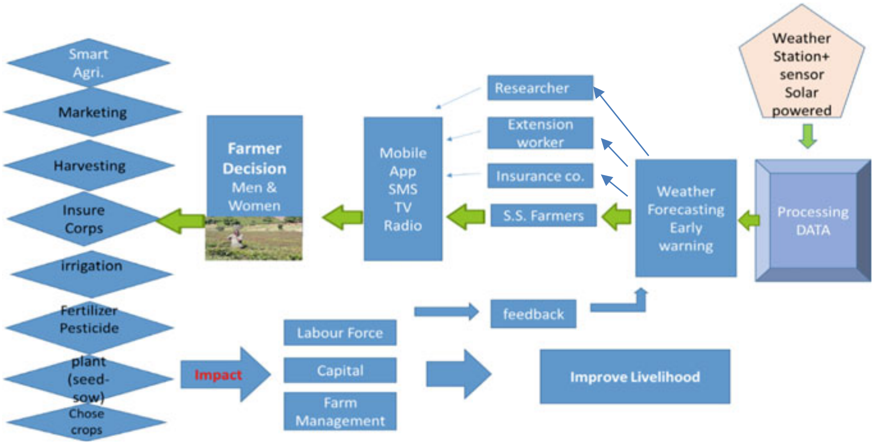


Fig. 35.3 Framework of climate service for farmers

35.5 Conclusions

- Climate Services play vital tool for farmers in decision making and increasing their income.
- Future mobile apps should cover more fields of agricultural activities, while being easy, simple and flexible to use for all users.
- Climate change and variability reduce the reliability of indigenous knowledge in forecasting, therefore farmers need urgent timely and accurate weather forecast information from National Meteorology Agencies.
- The main sources of information for farmers were essentially family, neighbours, and friends.

The result emphasised the importance of access to information and knowledge for farmers, agriculture sector and livelihood. The results showed that participatory approach could achieve sustainability in designing and using mobile application in agriculture to achieve sustainability.

References

Benard, R., Dulle, F., & Ngalapa, H. (2014). Assessment of information needs of rice farmers in Tanzania; a case study of Kilombero District, Morogoro. *Library Philosophy and Practice (e-journal),* 1071. http://digitalcommons.unl.edu/libphilprac/1071.

Buontempo, C., & Hewitt, C. (2018). EUPORIAS and the development of climate services. *Climate Services, 9*(January 2018), 1–4. https://doi.org/10.1016/j.cliser.2017.06.011.

CIA. (2017). The World Factbook—Tanzania. https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html.

Climatesociety.ei.columbia.edu. (2016). Retrieved from http://climatesociety.ei.columbia.edu/2016/07/09/heres-how-climate-information-can-guide-farmers-decisions/.

Cooper, P. J. M., & Coe, R. (2011). Assessing and addressing climate-induced risk in Sub-Saharan rainfed agriculture. *Experimental Agriculture, 47*(02), (April 2011): 179–184. Available at: https://doi.org/10.1017/S0014479711000019.

Dare Kolawole, O., Wolski, P., Ngwenya, B., & Mmopelwa, G. (2014). Ethno-meteorology and scientific weather forecasting: Small farmers and scientists' perspectives on climate variability in the Okavango Delta, Botswana. *Climate Risk Management, 4–5,* 43–58. https://doi.org/10.1016/j.crm.2014.08.002.

Elia, E. F., Mutula, S., & Stilwell, C. (2014). Use of indigenous knowledge in seasonal weather forecasting in semi-arid Central Tanzania. *South African Journal of Libraries and Information Science, 80*(1), (15 July 2014). http://sajlis.journals.ac.za/pub/article/view/1395.

Feleke, H. G. (2015). Assessing weather forecasting needs of smallholder farmers for climate change adaptation in the Central Rift Valley of Ethiopia. Ambo, Ethiopia: Department of Plant Science, College of Agriculture and Veterinary Science, Ambo University.

Golding, N., Hewitt, C., & Zhang, P. (2017). Effective engagement for climate services: Methods in practice in China. *Climate Services, 8*(December 2017), 72–76.

GSMA. (2016). Weather forecasting and monitoring: Mobile solutions for climate resilience. https://www.gsma.com/mobilefordevelopment/programme/magri/weather-forecasting-and-monitoring-mobile-solutions-for-climate-resilience/.

Hansen, J. W., Mason, S. J., Sun, L., & Tall, A. (2011). Review of seasonal climate forecasting for agriculture in Sub-Saharan Africa. *Experimental Agriculture, 47*(2), (April 2011), 205–240. https://doi.org/10.1017/S0014479710000876.

Hardaker, J. B., Lien, G., Anderson, J. R., & Huirne, R. (2015). Coping with risk in agriculture, 3rd Edition: Applied decision analysis. CABI.

Kniveton, D., Visman, E., Tall, A., Diop, M., Ewbank, R., Njoroge, E., et al. (2014). Dealing with uncertainty: Integrating local and scientific knowledge of the climate and weather. *Disasters, 39*(1), 35–53.

Musshoff, O., Odening, M., & Xu, W. (2011). Management of climate risks in agriculture–will weather derivatives permeate? *Applied Economics, 43*(9), 1067–1077. https://doi.org/10.1080/00036840802600210.

ResearchICTAfrica.org. (2016). OTT—Threat or opportunity for African Telcos?.

Singh, C., Daron, J., Bazaz, A., Ziervogel, G., Spear, D., Krishnaswamy, J., Zaroug, M., & Kituyi, E. (2017). The utility of weather and climate information for adaptation decision-making: Current uses and future prospects in Africa and India. *Climate and Development, 0*(0) (May 12, 2017), 1–17. https://doi.org/10.1080/17565529.2017.1318744.

Tall, A., Hansen, J., Jay, A., Campbell, B., Kinyangi, J., Aggarwal, P. K., & Zougmoré, R. (2014). Scaling up climate services for farmers: Mission Possible Learning from good practice in Africa and South Asia Scaling up climate services for farmers: Mission Possible. Retrieved from www.ccafs.cgiar.org.

Tanzania Communications Regulatory Authority. (2018). Quarterly communications statistics report—April–June 2018. https://www.tcra.go.tz/images/documents/reports/TelCom_Statistics_June_2018.pdf.

Tanzania National Bureau of Statistics. (2013). Formal Sector Employment and Earnings Survey Analytical Report 2013.

Tanzanian Meteorological Agency. (2018) http://www.meteo.go.tz/pages/climate-outlook-for-june-august-jja-2018.

weADAPT. (2014). Scaling up climate services in Tanzania. https://www.weadapt.org/knowledge-base/using-climate-information/scaling-up-climate-services-in-tanzania.

World Meteorological Organization. (2014). Tanzania: Climate services for action. https://public.wmo.int/en/media/news/tanzania-climate-services-action.

Chapter 36
Primary Producer Welfare Following a Policy Paradigm Shift: A Review of the Deregulation of the Australian Wheat Market

Stephanie Krezel

Abstract From a market strongly supported by a statutory grain marketing scheme, aimed at stabilising inherent market instability and protecting the financial and social welfare of primary grain producers, the Australian wheat market is now subject to a vastly different market policy structure. The sectoral policy paradigms of the Australian wheat sector have shifted from a state-assisted market paradigm to a market-liberal paradigm, which promotes competition and efficiency over government intervention. With this shift, the market has seen the emergence of a deregulated oligopolistic market structure, which facilitated the conversion of the statutory marketing scheme's domestic and export monopoly onto the six large-scale corporations which currently possess the majority of the sector's market power. With the rise of an oligopolistic market structure it is evident that there has been a significant disruption to primary producer welfare. Through understanding the scope and impact of this disruption it is possible to analyse the effect of the policy paradigm shift in regard to the economic and social welfare of Australian primary grain producers.

Keywords Deregulation · Agricultural policy · Primary producer welfare Australian wheat

36.1 The Australian Wheat Market

The design of a supply chain, and encompassing market structure, is denoted by a series of symbiotic relationships and interactions, which commonly seek to facilitate the exchange of goods and services. Within the remit of a sustainable supply chain design (SSCD), these relationships and interactions are contingent on various environmental, social and economic factors (Zeng et al. 2016). It is the interaction

S. Krezel (✉)
Centre of Supply Chain and Logistics, Deakin University, Melbourne, Australia
e-mail: skrezel@deakin.edu.au

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_36

and equilibrium obtained within the scope of these three crucial factors that permit the sustainability and profitability of the supply chain within its market structure (Elkington 2004). This concept is closely aligned with John Elkington's triple bottom line (TBL) concept of sustainability, whereby the environmental, social and economic factors of the supply chain must work in harmony to derive and maintain a whole value output (Elkington 2004).

36.1.1 Economic Significance

The whole value output and sustainability of the Australian wheat market is of crucial importance to the Australian economy, comprising to a significant proportion of the Gross National Product. Nationally, wheat is the most prominent grain cultivated, representing more than twice the export volume of other nationally cultivated coarse grains, including barley and corn (ABARES 2018). Estimations for the 2017/2018 season, by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (2018), forecast the export volume of wheat production within Australia to be valued at $5.17 billion and equating to over 16.8 million metric tonnes. It is notable that the production of export grain within the 2017/2018 season, is a considerable reduction on previous export volumes due to the prevalence of adverse growing conditions and a response to the international wheat surplus carried through from the 2016/2017 season. Irrespective of the fluctuating export volumes, wheat production continues to constitute a significant portion of the total Australian farm export production value, estimated at $47 billion in the 2017/2018 financial year (ABARES 2018). In addition to the economic importance, the wheat production sector, and greater grain production industry, supports approximately 22,000 primary producers across 13.8 million hectares of farmland (ANZ 2016). The rural employment and social aspects of the sector are instrumental in ensuring the prosperity and longevity of many rural regions across Australia.

36.1.2 Policy Paradigm Support

In acknowledging the significant contribution of Australian wheat production, sectoral policy paradigms have historically sought to maintain and promote the sustainability and profitability of the sector by facilitating a market environment conducive to the optimal equilibrium establishment with respect to the environmental, social and economic supply chain factors. Within the scope of the Australian wheat production sector, policy paradigms have aimed to support the profitability, longevity, and sustainability of the sector by promoting a specific market structure and a set of market conditions. However, these market conditions and structures have changed considerably throughout the history of Australian wheat market. This change can be attributed to a fundamental paradigm shift from the previous state-assisted regulated market structure to the current market-liberal deregulated market structure, facilitated by the removal of government intervention. In examining the paradigm shift that eventuated within the Australian wheat market it is feasible to analyse the effect of the policy paradigm changes on constituents of the market.

36.1.3 Primary Producer Social and Economic Welfare

Due to the significant changes of the Australian wheat market over the past few decades, the effect of the market's policy paradigm shift will be examined from the perspective of Australian primary grain producers. This group of key market stakeholders represent an essential part of the supply chain and, from a constructed knowledge viewpoint, are an effective medium to examine the effect of the policy paradigm shift as they have remained engaged through the tenure of both the regulated and deregulated market structures. Furthermore, primary grain producers are an integral contributor to the overall success of the Australian wheat market and are capable of providing thorough insight into the social and economic ramifications of the markets policy paradigm shift.

36.2 Market Reform—a Policy Paradigm Shift

It is widely recognised that the agricultural sector, with no exemption granted to the production of wheat and other coarse grains, is subject to the volatility and uncontrollability of environmental conditions, ranging from soil degradation through to extreme climatic events and water availability (GGL 2016; Keogh 2013; Botterill 2011). With acknowledgment of this fact, nations have historically chosen to set their sectoral policy paradigms to reflect these operating constraints (Skogstad 1998). The paradigm by which a nation, or state, configures their agricultural policy to provide vast levels of support and bolster the agricultural sector is termed as a state-assisted paradigm.

36.2.1 The State-Assisted Paradigm

The state-assisted paradigm is compounded by two distinct principles. The first principle acknowledges that the agricultural sector is deserving of concentrated attention and care due to the sector's substantial contribution to the nation's agenda (Coleman et al. 1997; Skogstad 1998). The contribution is represented by the establishment and provision of a nation's food security and the availability of safe and accessible food production sources. As food security is of high public interest, the preservation of this security is integral to a nation's agenda. The second principle of a state-assisted paradigm acknowledges that pricing mechanisms are inefficient and unsustainable as the sole mechanism for ensuring sector welfare and the subsequent sustained productivity and longevity of the agricultural sector (Coleman et al. 1997). The inefficiency of pricing mechanisms is exacerbated by the inherent risks associated with agricultural production, due to the occurrence of imperfect markets and the volatility of environmental production parameters, and thus bolsters the need for government invention and increased social welfare mechanisms (Skogstad 1998; Young et al. 2001).

In recognition of the principles of the state-assisted paradigm, agricultural policies have generally been geared towards three main outcomes (Coleman et al. 1997). These outcomes are based primarily on facilitating primary producer economic welfare through the underpinning of economic returns to primary producers to ensure a sufficient standard of living, investment and provision of technology to ensure the adoption of innovation and bolstered productivity of the sector, and, to assist disadvantaged primary producers in becoming commercially viable agricultural entities (Coleman et al. 1997).

The nature of a state-assisted paradigm is consistent with the nature and structure of the regulated Australian wheat market, observed in earnest from 1948 through to the start of its partial deregulation in 1989. The establishment and operation of state-assisted sectoral policy paradigms, such as that observed within the Australian wheat market, was observed commonly throughout history within multiple nations, including the USA, Canada, the European Union (McCorriston and MacLaren 2007; Young et al. 2001). However, as rising pressures of globalised agricultural markets increased, all of these countries, including Australia, undertook action to systematically move away from the state-assisted paradigm to an entirely contrasting sectoral policy paradigm; the market-liberal paradigm.

36.2.2 The Market-Liberal Paradigm

The market-liberal paradigm, which directly contrasts the principles of the state-assisted paradigm, determines the economic and political contribution of the agricultural sector to be equivalent to other sectoral contributions, with agricultural policy not overextending to assist in the serving of peripheral agendas (Skogstad 1998). The paradigm refuses the artificial bolstering of agricultural producers through government financial assistance and in turn advocates for the presence of a competitive market structure by which producers are subject to the financial impacts of market supply and demand, and, producer welfare is maintained by those that are active within the free market (Coleman et al. 1997).

A policy shift towards a market-liberal paradigm can be observed through the deregulation forces exerted on the Australian wheat market. These forces were in response to multiple concerns of key stakeholders present within the market. These regulated market critics favoured the market-liberal paradigm, which contrary to the state-assisted paradigm, emphasised natural market competition over government intervention and productivity and efficiency over equity (Coleman et al. 1997).

It is crucial to accurately analyse the structure, motivators, and practices of the regulated wheat market and the subsequent deregulated market to access the effectiveness of the market's policy paradigm shift, with specific reference to the social and economic market aspects and the subsequent conservation of the triple bottom line equilibrium.

36.3 The State-Assisted Paradigm—The Australian Wheat Board

The initial act of instating a state-assisted paradigm for the Australia's wheat sector, by the Australian government, was part of a temporary war-time effort in 1914 which eventually amounted to the establishment of the primitive Australian Wheat Board (AWB) in 1915 (Cockfield and Botterill 2007; Hick and Ireland 1997). The statutory marketing scheme, embodied by the AWB, came into establishment in earnest in 1948, as a result of rising grower concerns regarding the volatility and risk of free market conditions, as well as, a primed political environment of increased government intervention within the agricultural sector (O'Keeffe and Neave 2017). The policy basis of the formation of the AWB was the *Wheat Industry Stabilization Act 1948* which encompassed the government's desire to create national wheat marketing arrangements for the effective management of international markets (Pyburne 2008). The legislative platform allowed for the AWB to develop the domestic and export monopoly that would continue unchanged through to 1989 (Botterill 2011).

Like many state trading enterprises, the Australian statutory grain marketing scheme primarily generated sales, and subsequently ensured a guaranteed minimum price for wheat, through the use of regulated grain pool structures (NCC 2004). As a mechanism of facilitating the increased economic welfare of primary producers, pool structures marketed grain on behalf of the primary producer participants and delivered all derived economic returns, less the logistical and marketing costs, back to pool participants (NCC 2004). The pool structure mechanism utilised by the regulated Australian grain market was widely considered as an effective tool for minimising market risk and price volatility whilst stabilizing primary producer income and maximising economic welfare (Botterill 2011).

36.3.1 Catalyst for Change—Internal Market Tension

Notwithstanding the strong support for the agrarian focus of the statutory marketing scheme, the Wheat Industry Stabilization Act 1948 was reviewed and renewed frequently over the course of the statutory wheat marketing scheme's tenure by government agencies tasked with assessing the relevance and suitability of the legislative platform in the increasingly global wheat market (Botterill 2011). In a review conducted in 1979, undertaken by the Industries Assistance Commission, the government agency recommended for the cessation of the AWB's domestic monopoly, however, this recommendation for partial deregulation was subsequently rejected (Botterill 2011). The Industries Assistance Commission repeatedly recommended the deregulation of AWB's domestic monopoly in 1983, with final success achieved in 1988 in response to the Commission's third repeated recommendation and increasing evidence of tension within the statutory marketing scheme (Cockfield and Botterill 2007).

Irrespective of the great support initiated by the AWB from government, primary producers and key producer advocate organisations, due to the vast stabilization and economic welfare benefits, tension and criticism continued to increase as the Australian wheat market developed within the international trade market (Cockfield and Botterill 2007; NCC 2004; Whitwell 1993). The critics of the statutory marketing scheme held the view that potential market reform, and the subsequent disbanding of the AWB's domestic and export monopoly, would result in increased competition and economic welfare through the removal of concentrated market power, increased price transparency, greater infrastructure investment and greater primary producer profits due to increased selling options and higher gross prices received by traders, and ultimately the producer sector (Boaitey 2013; NCC 2004; Young et al. 2001). However, industry consultations, relating to the deregulation of the Australian statutory wheat marketing scheme, invited many dispersed and contradicting views (Botterill 2011; NCC 2004). Market players with a negative view of the market reform attributed deregulation with the overall weakening of the Australian grain production sector due to risks of exploitation by multinational companies which would have no loyalty to Australian grain producers, adding layers of costs to Australian grain sales and ultimately providing negative economic welfare impacts to Australian primary grain producers (O'Keefe and Neave 2017; NCC 2004). Further concerns relating to the deregulation of the AWB related to predicted losses in economies of scale relating to the logistical costs, decreased marketability of Australian grain products to international export markets, and, the potential for reducing industry investment specifically regarding research and development. These strong yet opposing concerns and criticisms of the statutory wheat marketing scheme would ultimately shape the path of deregulation for the Australian wheat market.

36.4 The Market-Liberal Paradigm—The Deregulation of the Australian Wheat Board

The deregulation of AWB's domestic market monopoly eventuated as a result of the establishment of the Wheat Marketing Act 1989. In addition to the cessation of the domestic market monopoly, the Wheat Marketing Act 1989 removed the provision of a guaranteed minimum price for wheat and instead facilitated a system by which primary producers could receive a license to trade independently of the collective marketing scheme (Cockfield and Botterill 2007; Krezel 2017). Irrespective that the wheat export monopoly had been preserved, the Wheat Marketing Act 1989 caused AWB to undergo a substantial change in regards to the culture and operating processes of the Board (Botterill 2011; GGL 2016). The new legislative platform reconfigured the capital base of the AWB, by which the scheme would now depend on wheat grower levies (Botterill 2011). Furthermore, the internal culture of the AWB was substantially altered as the Board moved away for the primary producer focused marketing entity, and adopted a trading focus upon which to ensure competitiveness within the now deregulated domestic market. With the new focus of the AWB, resultant from the demands of the competitive domestic market, the Board moved away from the pool structure and towards a 'cash' or 'spot' price structure of purchasing. Accompanying the altered purchase and payment structure adopted by the partially deregulated AWB, the Board also reconfigured its focus to now handle and sell grain for the primary purpose of increasing marginal revenue for the benefit of the Board (NCC 2004). This change was a vast cultural and procedural shift from the previous regulated pool structure which marketed grain for grower profit derivation.

36.4.1 Privatisation – the Australian Wheat Board Limited

As the AWB continued, within the deregulated domestic market, key industry players continued to discuss the complete deregulation of the AWB, which was proposed to result in the privatisation of the Board and dismantling of the wheat export monopoly. The traction behind the bid to privatise the AWB increased after 1995 when a series of negotiations between the AWB, Department of Primary Industries and Energy (DPIE) and the peak industry body, the Grains Council of Australia (GCA), commenced regarding the industry's future structure in the wheat export market (Botterill 2011). The negotiations had between the AWB, GCA and the relevant government department of the time, DPIE ultimately recognised the political and industry push for the privatisation of the AWB. However, in consideration of the continued support of primary producers and the key producer advocate organisations, regarding the long-standing merits of the regulated sector, negotiations geared themselves towards brokering an arrangement by which the AWB maintained the perceived grower values and collective benefits of the statutory marketing scheme, thus ensuring the continued competitiveness of the AWB within the international export market (Hicks and Ireland 1997).

Following two years of industry and primary producer consultation, the Minister for Primary Industries and Energy, on the 17th April 1997, announced the privatisation of the Australian Wheat Board as a result of the new legislative provisions set within the Wheat Marketing Amendment Bill 1997 (Hicks and Ireland 1997). The new grower-owned commercial entity, Australian Wheat Board Limited

(AWB Limited), would come into effect on 1 July 1999 and effectively remove all government intervention, in regard to the Australian wheat market, except for that in relation to the preserved export monopoly (Hicks and Ireland 1997). The configuration of AWB Limited appeased the concerns of many growers by ensuring the retention of the grower control and the export monopoly, which were commonly termed as the key aspects of the statutory marketing scheme (O'Keefe and Neave 2017; Krezel 2017).

Coinciding with the development of industry and government intent through to the final privatisation of the AWB and the listing of the AWB Limited on the Australian Stock Exchange in 2001, the market experienced a period of immense consolidation regarding the storage, handling and marketing of Australia wheat and grain products (Keogh 2013; Botterill 2011). The vast consolidation efforts, between 1995 and 2002, of large-scale Australian grain trading companies, such as GrainCorp and CBH, were consistent with the trends of market players seeking to obtain a scale of economy and market power within a deregulated market (GGL 2016; Young et al. 2001). Within the confines of the deregulated market, trading organisations sought to assume the market power previously obtained by the regulated state trading enterprise (Fulton et al. 2001; Boaitey 2013). This market power within the Australian wheat market was attributed to the capacity of the organisation to attract grain through competitive pricing, to which the provision of assets and subsequent fixed storage and handling costs were integral (Boaitey 2013).

36.4.2 The Oil-for-Food Programme

Under the competitive challenges of the new Australian grain industry environment, the new AWB Limited entity carried through many of the operating cultures developed through the deregulation of the domestic market. Botterill (2011) commented that the culture of AWB Limited had "emerged [as] an international grain trader prepared to sell wheat whatever it took". This ruthless operating mentality is criticised by many as the root of the eventual dismantling of the export market and subsequent demise of the grower-owned company (Boaitey 2013; Botterill 2011). The catalyst for the final dismantling of the export monopoly was AWB Limited's involvement in the Oil-for-Food programme and subsequent breaching of United Nations Security Council's (UNSC) sanctions against Iraq and Saddam Hussein's regime.

The UNSC developed an Oil-for-Food programme as a method of provisioning the export of humanitarian products to Iraq under sanctions introduced as a response to Iraq's invasion of Kuwait in August 1990 (Pyburne 2008). The Oil-for-Food programme utilised an escrow account by which companies providing humanitarian products were paid from the proceeds received from Iraqi oil sales (Botterill 2011). At the time of the UN sanctions, Iraq was Australia's largest export market, attributing to approximately 12% of all Australian wheat exports. In order to maintain the strong export market, AWB Limited heavily utilised the

Oil-for-Food programme to continue to export wheat to Iraq from 1990 through to 2003 (Botterill 2011; COA 2015). However, the Oil-for-Food programme, and Australia's participation in the programme, drastically altered as a result of the findings from the US incursion into Iraq in 2003 which provided evidence of the gross abuse of the programme. Evidence of a long-standing kickback scheme was discovered, whereby the Iraqi Government had procured more than $1.55 billion through the fraudulent manipulation of the Oil-for-Food programme (Botterill 2011; COA 2015). As a result of the evidentiary discoveries of 2013, the UNSC established the Independent Inquiry Commission (IIC) into the Oil-for-Food programme (Boaitey 2013; COA 2015). The IIC's final report, realised in November 2015, identified the significant actions of AWB Limited in facilitating the kickbacks to Saddam Hussein's regime and the subsequent breaches to the UNSC's sanctions and Australian government policy. As a result of the IIC's report, the Governor General of Australia appointed the Honorable Terence Cole as a commissioner for the investigation of the AWB Limited's involvement in the Oil-for-Food scandal (COA 2015). The Cole inquiry, as it is commonly referred to, identified that the AWB and AWB Limited entered into inflated and intentionally misleading contracts with the Iraq Grain Board, which included fees for fictitious transportation, thus serving as a mechanism for providing Iraq with approximately $US200 million worth of kickbacks across the duration of Australia's export into Iraq under the UNSC sanctions (COA 2015). In response to the damning evidence of AWB Limited's improper conduct, as published in the Commissioner Cole's *Report of the Inquiry into certain Australian companies in relation to the UN Oil-for-Food Programme* in November 2006, the Australian Government took immediate legislative action to limit the export power of AWB Limited (Pyburne 2008).

36.4.3 Complete Market Deregulation—the end of the Export Monopoly

The Wheat Marketing Amendment Act 2006, passed in December 2006, enabled the temporary cessation of AWB's power over the export of wheat from Australia (Pyburne 2008). The temporary cessation was renewed in 2007 with the Wheat Marketing Amendment Bill 2007 and eventually gave way to the establishment of the Wheat Export Marketing Act 2008 and subsequent Wheat Export Marketing (Repeal and Consequential Amendments) Bill 2008 which facilitated the repeal of the Wheat Marketing Act 1989 and dismantling of the export monopoly held by AWB Limited (Pyburne 2008).

With the repeal of the Wheat Marketing Act 1989, the greatest impediment to the market-liberal competitive market structure was removed. As a result of the deregulation of the export market, and final end to the market control exerted by AWB Limited, the sector was transformed through a wave of international market players entering the Australian wheat market. Large multinational corporations, such as Glencore and Cargill, occupied vast market segments and brought with them investments in regard to storage and handling and logistical infrastructure (Boaitey 2013; Keogh 2013). The deregulation of the export market also promoted the development of existing market players to expand upon the storage and handling aspects of their business to vertically integrate the now open export capabilities (Boaitey 2013).

36.4.4 Current Australian Wheat Market Structure

A decade after the deregulation of the final remnants of the statutory grain marketing scheme, the current Australian wheat market, and broader Australian grain market, currently has six large-scale corporations actively storing, handling, trading and exporting the majority of Australian wheat products (GGL 2016). These six large-scale corporations have effectively replaced the market power once occupied solely by the AWB, although represent altogether a vastly different trading and marketing ethos.

The deregulation of the Australian wheat market was a slow process staggered over many decades. The ultimate catalyst for the end of AWB Limited's export market control came as a result of the endeavour to manage the unattainable balance between trying to preserve the strong agrarian legacy of the AWB whilst working within an opposing policy paradigm. Through further analysing the dismantling of the statutory marketing scheme it is possible to identify the ramifications experienced by the sector, through the lens of primary producers, to assess the social and economic impacts of the policy paradigm shift.

36.5 Deregulated Australian Wheat Market-Policy Paradigm Shift Evaluation

The structure of a market following the removal of a state-assisted paradigm is significant in informing and ultimately determining the net effect of the market policy paradigm shift with respect to the social and economic aspects of the supply chain and market environment, and the subsequent preservation of the triple bottom line (TBL) equilibrium.

It is widely argued by many academics and researchers examining the effects of state trading enterprises, such as the AWB, that the removal of such enterprises can improve the welfare of the market constituents by increasing competition and ultimately benefiting the prices received within the supply chain (Boaitey 2013; Fulton et al. 2001; Young et al. 2001). However, these deregulation benefits require a perfect market structure, whereby natural supply and demand is well established and is free of any monopolistic or oligopolistic control.

36.5.1 Primary Producer Economic Welfare

The assumption that the removal of a state trading enterprise would result in a competitive market, or perfect market structure, is not consistent with the market configuration observed within the Australian wheat market. Instead, the Australian wheat market, like many other formerly state intervened markets, embodies the characteristics of an oligopolistic market structure (MacAulay 2011; Young et al. 2001). Empirical evidence regarding the inherent oligopolistic nature of the Australian wheat market can be observed through the current structure of the market. Due to various limitations, with respect to environmental, logistical and economic constraints, it is evident that the saturation of the Australian wheat market has been attained by an only a few large-scale corporations. Theoretically, the justification for the inherent oligopolistic nature of the sector is also strongly supported by the rationale that extensive assets and market power is required to operate efficiently and thus procure high-volumes of grain within concentrated harvest phases, coordinate large-scale logistics and service multiple international buyers (Fulton et al. 2001; MacAulay 2011). In acknowledging the oligopolistic nature of the market there is theoretical evidence to suggest that the welfare of the market constituents has not been improved as a result of deregulation.

With data collated from an Australian national study in 2015, the theoretical assumptions pertaining to the welfare of primary producers following deregulation were confirmed. The national study of 450 primary grain producers evaluated that the promised economic benefits of the deregulated market had not been fully realised (Marshall 2015). Nearly half of all primary producers surveyed stated that their financial returns had not increased following market deregulation and that their overall welfare was no better than that experienced within a regulated market structure (Marshall 2015; de Landgrafft 2015). In addition to the 49% of primary producers that experienced no economic welfare benefit from the deregulated market, a further 17% stated that they had experienced worse financial returns following market deregulation and thus considered themselves to have a weakened overall welfare as a result of the deregulated market (Marshall 2015; de Landgrafft 2015). The responses collected, within the framework of the national survey, were relatively uniform across Australia, therefore minimising the risk of a concentration of opinions due to any specific geographical factors (de Landgrafft 2015). The evidence confirming nil benefit or worsened economic benefits, resultant from the deregulated market environment, is consistent with the findings of similar research conducted regarding the economic welfare of primary producers following deregulation. Both Chang et al. (2003) and McCorriston and MacLaren (2007) examined the economic impact of the deregulation of the AWB and concluded that the policy paradigm shift had little effect on the profits and ultimate economic welfare of Australian primary grain producers.

36.5.2 Primary Producer Social Welfare

In addition to the overall negligible economic welfare outcomes observed as a result of a deregulate oligopolistic market, it is apparent that the many peripheral benefits of the regulated statutory marketing scheme were also removed with the market deregulation. Primary producer social welfare, market stability and national market cohesion were prized outcomes of the statutory marketing scheme. However, through responses received from the 2015 national survey, it was evident that many Australian primary grain producers viewed the current operation of the market with a sense of unease and confusion, attributed to increased marketing risks and selling options (Marshall 2015). These views were supported by evidence collected through a survey of 22 primary wheat producers within the Western Wimmera region of Australia (O'Keefe and Neave 2017). The Wimmera survey concluded that multiple concerns regarding the operation of the deregulated market were held by the primary grain producer survey participants. O'Keefe and Neave (2017) identified four key areas of concern relating to power, competition, complexity, and insecurity. The key themes from these concern areas referred to weakened grower leverage power to sell grain, exhaustive requirements regarding the skills and knowledge required to manage the complexity of the market, rising concerns surrounding the true competitiveness of the market, and, the increased prevalence of insolvencies amongst grain buyers. The perceptions of the primary producers surveyed within both the 2015 national survey and the Wimmera survey provide evidence that reduced social welfare has been experienced as a result of market deregulation amongst primary producers.

Through the review of current research findings, it is possible to conclude that thorough qualitative evidence is not yet available in order to holistically assess the net impact of market deregulation regarding primary producer welfare. The overwhelming focus on the economic impact of deregulation provides little assessment to the social impact on the policy paradigm shift on aspects such as the risk perceptions, satisfaction and innovation appetite of primary producers currently active within the industry. It is vital to examine these social aspects in order to accurately and holistically assess the impact of market deregulation on the overall triple bottom line equilibrium. As identified by Elkington (2004) and Zeng et al. (2016), it is only through the balance of environmental, social and economic aspects can the market maintain long-term functionality and sustainability.

36.6 Future Research

The ramifications of the sectoral policy paradigm shift experienced with the constraints of the Australian wheat market stretch further than the economic welfare of the market's constituents. The social impacts of the deregulation of the Australian Wheat Board, and greater grain industry, require further attention and analysis in order to accurately develop the understanding of the market regarding the net effect of deregulation.

References

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2018). *Agricultural commodities: March Quarter 2018.* Canberra: Australian Government Department of Agriculture and Water Resources.

Australian Government. (2015). *Science and research priorities*. Canberra: Australian Government.

Australia New Zealand Bank (ANZ). (2016). *The Grains Muster: Infocus March 2016.* Australia New Zealand Bank, retrieved on 10/05/2018 from: http://www.anzbusiness.com/content/dam/anz-superregional/AU20963_Grains_Newsletter_Mar_2016_13.pdf.

Boaitey, A. (2013). Grain market deregulation: A case study of the Canadian and Australian wheat boards. *Journal of Public Affairs, 13*(3), 282–287.

Botterill, L. (2011). Life and death of an institution: The case of collective wheat marketing in Australia. *Public Administration, 89*(2), 629–643.

Chang, H., Martel, W., & Berry, R. (2003). *Examining AWB's market power in the inter-national wheat market.* In Proceedings of the 47th Annual Conference of the Australian Agri-Cultural and Resource Economics Society, AARES, Fremantle. Retrieved 16 May 2018 from http://ageconsearch.umn.edu/bitstream/57843/2/2003_chang2.pdf.

Cockfield, G., & Botterill, L. C. (2007). From the Australian Wheat Board to AWB Limited: Collective Marketing and Privatisation in Australia's Export Wheat Trade. *Public Policy, 2*(1).

Coleman, W. D., Skogstad, G., & Atkinson, M. (1997). Paradigm shifts and policy networks: Cumulative change in agriculture. *Journal of Public Policy, 16,* 273–301.

Commonwealth of Australia (COA). (2015). Work undertaken by the Australian Federal Police's Oil for Food Taskforce. Legal and Constitutional Affairs References Committee. Retrieved 10 May 2018 from https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Legal_and_Constitutional_Affairs/AFP_Oil/Report.

De Landgrafft, T. (2015). West Australian wheat growers twice as likely to pool grain says national survey. *ABC Rural News.* Retrieved 12 May 2018 from: http://www.abc.net.au/news/rural/2015-07-16/wheat-grower-survey-shows-surprising-grain-marketing-results/6624998.

Elkington, J. (2004). Enter the triple bottom line. In A. Henriques & J. Richardson (Eds.), *The triple bottom line: Does it all add up?*. London, England: Earthscan.

Fulton, M., Larue, B., & Veeman, M. (2001). The impact of export state trading enterprises under imperfect competition: The small country case. *Canadian Journal of Agricultural Economic, 47,* 363–373.

Grain Growers Limited (GGL). (2016). State of the Australian grain industry 2016. Grain Growers Limited. Retrieved 15 May 2018 from: http://www.graingrowers.com.au/about/publications.

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78,* 1360–1380.

Hicks, P., & Ireland, I. (1997). Wheat Marketing Amendment Bill 1997. *Parliament of Australia: Parliamentary Library, Bills Digest, 43.*

Keogh, M. (2013).Global and commercial realities facing Australian grain growers. Grain Research and Development Corporation (GRDC) update papers. Retrieved 18 May 2018 from http://grdc.com.au/resources-and-oublications/grdc-update-papers/tab-content/grdc-update-papers/2013/02/global-and-commercial-realities-facing-australian-grain-growers.

Krezel, S. (2017). Economic sustainability of the Australian grain supply chain post market deregulation. *European Journal of Sustainable Development, 6*(4), 1–10.

MacAulay, T. G. (2011). *What the world wants from Australian wheat*, Presentation to Grain Research and Development Corporation (GRDC) Update, Clifton, Queensland, 23 Aug 2011.

Marshall, A. (2015). Grain deregulation doesn't pay. *Farm Weekly*. Retrieved 12 May 2017 from: http://www.farmweekly.com.au/news/agriculture/agribusiness/general-news/grain-deregulation-doesnt-pay/2737545.aspx.

McCorriston, S., & MacLaren, D. (2007). Deregulation as (welfare reducing) trade reform: The case of The Australian Wheat Board. *American Journal of Agricultural Economics, 89*(3), 637–650.

National Competition Council (NCC) (2004). *NCC Occasional Series: A review of the NCP grain market reforms,* Canberra: AusInfo. Retrieved 15 May 2018 from http://ncp.ncc.gov.au/docs/PCRevsub-003.pdf.

O'Keeffe, P., & Neave, M. (2017). Experiences of wheat growers in Australia's western Wimmera following deregulation of the export wheat market. *Rural Society, 26*(1), 1–17.

Pyburne P. (2008). Wheat export marketing bill 2008. *Parliament of Australia: Parliamentary Library, Bills Digest, 128.*

Skogstad, G. (1998). Ideas, paradigms and institutions: Agricultural expectionalism in the European Union and the United States. *Governance: An International Journal of Policy and Administration, 11*(4), 463–490.

Standing Committee on Agriculture and Industry (SCAI). (2016). *Smart farming: Inquiry into agricultural innovation*. Canberra: The Parliament of the Commonwealth of Australia.

Whitwell, G. (1993). Regulation and deregulation of the Australian wheat industry: The 'great debates' in historical perspective. *Australian Economic History Review, 33*(1).

Whitwell, G., & Sydenham, D. (1991). *A shared harvest—The Australian wheat industry 1939–1989*. Melbourne: Macmillan Education Australia.

Young, L., Abbott, P., & Leetmaa, S. (2001). Export competition: Issues and options in the agricultural negotiations. *International Agricultural Trade* Research *Consortium Commissioned Paper, 15*.

Zeng, H., Chen, X., Xiao, X., & Zhou, Z. (2016). Institutional pressures, sustainable supply chain management and circular economy capability: Empirical evidence from Chinese eco-industrial park firms. *Journal of Cleaner Production, 155,* 54–65.

Chapter 37
Effects of the Greek Financial Crisis to the Food Manufacturing Firms

Ourania Notta, Aspasia Vlachvei and Evita Grigoriou

Abstract The objective of this study is to draw conclusions about changes over the crisis period in firm performance, using accounting data for 331 food and beverage manufacturing firms in the period from 2005 until 2016. The present study aims to advance our knowledge in three distinct ways: first none of the studies investigated what happened after 2012, second, we split our data in three groups: before crisis (2005–2008), first period of crisis (2009–2012) and second period of crisis (2013–2016), and third taking into account that the implementation of the strict austerity program for Greece in 2010 caused a substantial decrease in demand for goods and services pushing the Greek firms to a deeper recession, we examine differences between the years before 2011 (2005–2010) where the real crisis for Greece started with the implementation of austerity measures, and after 2011 (2011–2016). Fixed effects results suggest that, during economic crisis the efficient and older firms are most profitable, indicating that older firms have the ability, the structure and the experience to achieve a higher profitability. Leverage is negatively related to profitability, which shows that large interest rates due to economic crisis associated with high debt levels result to lower profits while the results provide evidence for a non linear relationship between market share and profitability.

Keywords Economic crisis · Greece · Food and beverage industry
Firm performance

O. Notta (✉)
Department of Agricultural Technology (Agricultural Economics Program), Alexander Technological Institute of Thessaloniki, P.O. Box 141, 57400 Thessaloniki, Greece
e-mail: ournotta@farm.teithe.gr

A. Vlachvei
Department of International Trade, Western Macedonia University of Applied Sciences, Kastoria Campus, Fourka Area, 52100 Kastoria, Greece
e-mail: vlahvei@kastoria.teiwm.gr

E. Grigoriou
West Macedonia University of Applied Sciences, Kozani, Greece
e-mail: evitagrigoriou@gmail.com

N. Tsounis and A. Vlachvei (eds.), *Advances in Time Series Data Methods in Applied Economic Research*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-030-02194-8_37

37.1 Introduction

The last global debt crisis started in 2008–2009, following the collapse of the US sub prime mortgage market. According World Bank, the global GDP growth rate, which was around five percent during 2005–2007, declined to three percent in 2008 and turned negative in 2009. Furthermore, during the year 2008 alone approximately 43% in market capitalization was lost in the examined developed capital markets and another 58% was lost in the emerging ones. Therefore, it becomes clear that the 2008 recession had a severe impact across the global economy, slowing down global GDP. The subdued financial environment lead to profit redactions and consequently to lack of internal funding for SMEs. Simultaneously banks limed the external funding, in order to comply with Basel III capital and leverage ratio requirements (OECD 2014). During the period of 2007–2010, firms faced higher interest rates, shortened maturities and increased requests for collateral (OECD, 2012) thus the credit conditions for firms were tight resulting payment delays and bankruptcies. It becomes therefore clear that even in developed countries, a global economic shock, such as the 2008 recession, can bring about seismic effects to the conduct strategies, competitiveness and survival of the firms.

In Greece, in 2010, in light of the rapid worsening of the fiscal situation, the European Union (EU), the European Central Bank and the International Monetary Fund announced a major financial assistance package based on the Greek compliance with far-reaching economic reforms. The implementation of strict austerity program caused a substantial decrease in demand for goods and services pushing the Greek firms to a deep recession. Furthermore, the imposition of capital controls in June 2015, in Greece led to the suspension of investments by one in three local firms that had been planning to spend money on their expansion. On the other hand, the continuation of the capital controls had an impact on the companies' structural operations, and it is crucial they are lifted soon to avert any structural problems for SMEs—particularly very small ones—which appear to have exhausted their reserves. Domestic corporate deposits reached €12.6 billion in July 2015 versus €20.7 billion in July 2014, while corporate deposits stood at €16.1 billion in June 2016. According to Monokrousos et al. (2016) evidence suggests that: first large domestic firms have had contingency plans for bad scenarios, second, following imposition of capital controls, some large firms (but also SMEs) active in the external sector have been retaining funds abroad in order to better service their needs and thus circumvent lingering restrictions in the domestic banking system and third usual import credits were not available for Greek firms (especially SMEs) after the implementation of capital controls, with the exception of some larger firms that continue to enjoy goodwill due to long-term relationships with suppliers. Also, capital controls impose significant transaction costs to Greek firms active in the external sector.

With the ongoing economic recession in Greece and in view of the inherent heterogeneity of firms the question is which characteristics make some firms more resilient to crisis than others. The answer(s) to this question may contribute to more adequate policy measures for faster economic recovery. In this context, the objective of this paper is to identify those determinants of firms' performance which proved to help them resisting to crisis. This study investigates the performance of food and beverage manufacturing firms operating in Greece, for the period 2005–2016, in order to find out which are the main financial and non-financial determinants of profitability, especially during economic crisis. Also the study tries to investigate when the effects of the financial crisis are evident in Greek food manufacturing firms and split the sample first into three groups (taking 2008 as year of crisis): before recession, the first years of global recession and the next period of crisis and second into two groups (taking 2010 as year of crisis) before and after the implementation of austerity program.

The remainder of this work is organized as follows: In Sect. 37.2, a selective review of the literature about the effects of economic crisis on firm performance is presented. Section 37.3 provides description of the Greek food and beverage industry, the data set and the proposed research methodology, with information for the models used, using relevant financial data in terms of size, age, efficiency, leverage, liquidity and capital intensity. Section 37.4 presents the empirical results of the study, while in Sect. 37.5 concluding remarks are provided.

37.2 Literature Review

Recessions and their impact on firm performance have been the key point of discussion in a plethora of published works in the past. Some of them focus on the drop in GDP and consumer demand, shortage of resources, wage cuts, reduced efficiency and moral hazard problems in order to explain the poor firm performance (Greenwald and Stiglitz 1988; Pearce and Michael 2006; Richardson et al. 1998). A number of recent works have studied firms' performance during the 2008–09 crisis and how various factors propagated the shocks. Claessens et al. (2011) examine the performance of manufacturing firms in 42 countries and find that the crisis had a bigger negative impact on firms with greater sensitivity to aggregate demand and international trade. Also Bricongne et al. (2012) using a sample of French firms showed that the effect of crisis on large firms has been mainly at the intensive margin and has affected less the products being offered to export destinations. There is rich literature (Mitton 2002; Lemmon and Lins 2003; Baek et al. 2004; Aldamen et al. 2011; Chaston 2012; Erkens et al. 2012) that draw attention to attributes of corporate governance and their influence on the performance of firms during the crisis.

Other studies (Lucky and Minai 2012; Little et al. 2011; Opler and Titman 1994; Safieddine and Titman 1999; Jandik and Makhija 2005) examined the effects of firm characteristics and financial leverage on firm performance during crisis. Opler and Titman (1994) find that the relationship between firm performance and financial distress is negative and significant, while Asgharian (2003) tests the performance-distress relationship using Swedish firms and finds that highly leveraged firms in distressed industries face relatively lower stock returns.

Emilia Garcia-Appendini and Judit Montoriol-Garriga (2012) employ a differences-in-differences approach in which they compare the trade credit supplied by firms before and after the start of the crisis as a function of their liquidity positions. Their results prove that firms with high pre-crisis liquidity levels experienced higher performance as compared to ex-ante cash-poor firms. Research by Calomiris, et al. (1995) and Nilsen (2002) showed that during recessions, liquidity in the form of trade credit flows from firms having access to the markets for commercial paper or long-term debt to firms without access to these financial instruments. Burger et al. (2017), using a sample of Central and Eastern European countries (CEECs), prove that small old firms react more swiftly, whereas downward adjustment in employment is less severe in exporters and in foreign-owned firms, during recession. On the other hand, investment does not respond to demand shocks per se, but to free cash flow component of the business cycle. Bamiazi et al. (2016) examine 15,008 firms within 10 emerging and 10 developed countries, accounting for variations among countries of different economic development. They find that firm effects become stronger under adverse economic conditions while industry effects become weaker during recessions.

Concerning Greek data, Notta and Vlachvei (2014, 2015 and 2017) proved that there is a structural break between the two periods before and after crisis (2005–2008 and 2009–2012) in the estimation of profitability model, using data of Greek food manufacturing firms. The results for the period during crisis show that market share, liquidity and leverage have significant effect on profits and explains profitability differences among the firms. Lemonakis et al (2013) investigated the role of exports on the profitability of agri-firms, together with many other internal firm characteristics. They use pre crisis (2004–2007) and during crisis data (2008–2011) and they prove that the majority of Greek exporting firms were widely influenced by the economic crisis and the lack of sufficient liquidity and financing. The profit performance increases for agri-firms that place emphasis on increased fixed capital employed turnover, high labor productivity and low levels of Leverage and of course by the improvement in country's macro environment. In a recent research, Lemonakis et al. (2016) concluded that companies with IT investments present higher profitability than their rivals, especially during a financial crisis, until 2011. Agiomirgianakis et al. (2013) examines the impact of the recent economic crisis on the determinants of profitability in the Greek tourism sector. They prove that the age of a firm (credibility effect), a firm's size and low cost access to bank financing, are, indeed, factors that may influence positively and substantially the profitability of a firm operating in the tourism sector.

The present study aims to advance our knowledge in three distinct ways: first none of the studies investigated what happened after 2012 which is some more years after the crisis, which for Greece also means after the first years of the implementation of the strict austerity program, second we split our data in three groups: before crisis (2005–2008), first period of crisis (2009–2012) and second period of crisis (2013–2016), and third we investigate also the behavior of food manufacturing firms and differences between two periods: before and after the implementation of the strict austerity program (2005–2010) and (2011–2016).

37.3 Data and Methodology

The food and beverage sectors in Greece are consistently the major parts of the secondary sector of Greek economy and one of the main motors of Greek manufacturing. The Greek Food and beverage Industry is a dynamic, competitive and outgoing sector, with significant investments, and business in Greece, in Balkans and across Europe. Food industry has been maintaining all these years, even in the long period of recession for the Greek economy, its fundamental role for the development of Greek manufacturing.

The sector employs 28% (2015) of the total employees in secondary sector and ranked first in the share of total manufacturing value added in 2015, contributing 26% to the total Manufacturing. In terms of turnover, the food and beverage sector in 2015 covering 23% of the total turnover of the manufacturing sector (18.4% Food and 4.57% in the Drinks), making a total value of sales €11.66 billion, a fact that ranked the industry in the second place. In 2009, when started the recessionary course in the domestic economy, the industry received strong blow in terms of employment, value added, sales, gross value production and investments, recording a substantial drop in these sizes. However, this fall, stems not so much from larger companies (over 10 people) but mostly by smaller businesses (under 10 people), which also constitute the overwhelming majority both in the food sector (95%) and in the beverage industry (87%) (IOBE 2015). However, in 2016 the number of employees increased more than 4% in food industry and it is important to note that 36% of sales of food and 57% of sales of beverage industry are generated by firms with more than 250 employees.

The annual financial data used in our empirical estimates were obtained from the balance sheets and income statements provided by the proprietary service companies ICAP Hellas (2006–2016) and HELLASTAT (2008–2016). The data consist of detailed financial statements of the firms, which allow us to calculate the selected financial indicators. The final dataset includes 331 food and beverage firms operating for the whole period from 2005 to 2016. The sample consists of all food and beverage firms with size greater than 10 employees and with active presence of the business through the whole period 2005–2016. So, we use panel data for manufacturing firms over the period 2005–2016 of ten (10) food and beverage industries: firms with oils and fats (19% of total sample), meat poultry and sausages (17.8% of the total sample), water and soft drinks (14.5%), wine firms (12.7%), dairy firms (9.6%), alcoholic beverages (8.7%), preserving of fruits and vegetables (3%), brewery (2%), and firms with miscellaneous products (6%) (bread, cakes, chocolate and sugar confectionery, tea and coffee, prepared meals etc.).

Table 37.1 presents the descriptive data for 2005–2016. According to Table 37.1, profitability (gross profits over turnover) increases until 2009 and then decreases substantially from 32.5% in 2009 to 26.7% in 2012 and to 21.5% in 2016. Liquidity (current assets over current liabilities) decreases too with value less than 1 from 2012 to 2016. Leverage (liabilities to assets) is at the higher level in 2009 and then there is a substantial decrease. The variable that denotes the equity coverage of fixed assets is decreasing in the whole period, while the capital intensity ratio value (assets to sales) decreases from 2005 to 2012, while from 2012 to 2016 is increasing. It is interesting to note that GDP value reaches its lowest value (−9.1) in 2011, which is the first year after the implementation of austerity programme.

The following model has been formulated to identify and quantify the factors that explain profitability of food manufacturing firms operating in Greece:

$$\mathrm{PR} = a_0 + a_1\mathrm{MS} + a_2\mathrm{MS}^2 + a_3\mathrm{KS} + a_4\mathrm{LIQ} + a_5\mathrm{LEV} + a_6\mathrm{EQ} + a_7\mathrm{LAGE} + a_8\mathrm{GDP} \tag{37.1}$$

where PR is Profit performance measured as Gross profits to turnover

MS is Market share, measured as annual firm's sales over industry sales

KS is Capital intensity index, measured as total assets to total sales. It shows the level of financing which is a determinant factor for the activity of the company

LIQ is Liquidity index measured as Current assets to Current liabilities. It's an indicator of a company's ability to meet its short-term obligations with its most liquid assets

LEV is Leverage index, measured as Liabilities to Total assets. It shows the degree in which a company depends on foreign capital

Table 37.1 Mean values of variables per year (TOTAL)

Year	PR	KS	LIQ	LEV	EQ	GDP
2005	0.307	1.487	1.057	0.207	0.808	
2006	0.317	1.440	1.161	0.195	0.837	5.7
2007	0.319	1.376	1.062	0.194	0.819	3.3
2008	0.311	1.386	1.044	0.204	0.778	−0.3
2009	0.325	1.360	1.115	0.229	0.754	−4.3
2010	0.302	1.358	1.114	0.170	0.791	−5.5
2011	0.270	1.352	1.134	0.174	0.758	−9.1
2012	0.267	1.338	0.895	0.132	0.743	−7.3
2013	0.242	1.494	0.981	0.108	0.720	−3.2
2014	0.250	1.501	0.874	0.102	0.679	0.7
2015	0.214	1.538	0.876	0.183	0.605	−0.3
2016	0.215	1.494	0.896	0.202	0.574	−0.2

[a]The figures are estimated for the group as a whole. E.g. The figures of the first column show the ratio of gross profits over sales

EQ is Equity coverage of fixed assets, which is measured as Networth over Fixed assets
AGE is Firm's age, measured as the Logarithm of the years a firm is operating
GDP is annual growth of Gross Domestic Product.

We expect firm size to affect positively profitability, even in recessions (Miller and Toulouse 1986; Mintzberg 2003). Given that large firms may have strategic and competitive advantages they may realize superior profits. (Majumdar 1997; Singh et al. 2007). Larger firms can better withstand external shocks and shield themselves against prolonged declines in sales or price wars due to their strategic advantages (economies of scale, access to capital, broader investment options, increased bargaining power etc.). The most successful strategies for countering the recessionary periods are the aggressive ones. These include innovation, continuous investment on new product development and focus on quality (DeDee and Vorhies 1998; Geroski and Gregg 1997). Also, difficulty to get external financing is one of the main reasons that smaller firms have more problems in recession than larger firms. On the other hand, small firms may be able to compensate their cost differentials by adopting more flexible managerial organizations and methods of production responding more rapidly to changes in the competitive environment and obtaining larger than average profits.

Firm age is a basic variable included in empirical analyses of firm's performance determinants. A positive relationship between firm age and profitability may be expected if older firms benefit from dynamic economies of scale by learning from experience. They may also benefit from reputation effects, which allow them to earn higher profits. At the same time, an older firm may have a more rigid organizational structure not in line with changes in market conditions that can negatively affect firm performance (Notta et al. 2010). The predominant finding is that there is a negative relationship between firm age and performance (Glancey 1998; Geroski and Gugler 2004) although some analyses do not confirm this (Das 1995; Barron et al. 1994). Fort et al. (2013) specifically analyse the role of firm's age and size in business cycles, using UK data collected in mid-2010. They find that young/small businesses are more cyclically sensitive so that the relative decline in performance during the 2007–2009 recessions is greater for young and small businesses than for large and mature businesses. There is recent evidence according to Burger et al. (2017) that age plays a larger role in firm responses to cyclical shocks.

The literature suggests that firms with lower level of indebtedness and those which are less dependent on external sources of financing have better chances to resist the pressures of economic recession; i.e. financial limitations, which are typical for periods of crises, are one of the main factors that restrain firms' performance in economic recession (Kroszner et al. 2007; Braun and Larrain 2005; Bugamelli et al. 2009; Desai et al. 2004; Manova et al. 2009; Bricogne et al. 2010; Luzzi 2006). The empirical results of Giroud and Mueller (2017) suggest that firms with higher leverage not only appear to be more financially constrained, but they also act like financially constrained firms in the recession period.

37.4 Results

Notta et al. (2014) used the model presented in Table 37.2 and split the sample into two groups: the first group includes the years before the official start of global economic crisis in 2008, while the second group includes the four years after 2008. However, this work goes further and is unique since we use one more group which includes years from 2013 to 2016 in order to find out, for the first time, what happened after 2012, and which determinants influence the performance of Greek food manufacturing from 2013 to 2016. Furthermore we test whether significant profitability differences between 2009 and 2012 which denotes the beginning of the crisis and 2013–2016 exist in the case of Greek food firms.

Table 37.2 summarizes the regression results for the model used by Notta et al. (2014) for the three time periods, pre-crisis (2005–2008), first period of crisis (2009–2012) and second period of crisis (2013–2016). In order to examine whether the respective coefficients obtained from the two groups after the crisis are statistically different, we applied Chow-test. The estimated value for the Chow-test is found F* = 2.86 while the theoretical value of F for v1 = 7 and v2 = 2148

Table 37.2 Determinants of profitability in Greek food and beverage firms in three periods 2005–08, 2009–12 and 2013–16

	2005–2008	2009–2012	2013–2016
Variables	Fixed effects estimates of profitability		
MS	−0.28 (−0.48)	1.67 (4.14)**	−0.85 (−3.25)**
KS	−0.001 (−3.64)**	0.47 (1.19)	0.02 (7.17)**
LIQ	0.002 (0.82)	0.002 (2.16)*	−0.0005 (−0.002)
LEV	−0.0003 (−0.12)	−0.21 (−3.64)**	0.003 (0.17)
EQ	0.001 (0.47)	−0.61 (−0.04)	−0.001 (−0.32)
LAGE	0.06 (1.94)*	−0.18 (−2.85)**	0.39 (2.86)**
SSR	49.84536	463.2622	61.2694
F* test (Chow Test)		2.86	
F* test (Chow Test)	5.20		
Hausman Test	38.65 6df (0.00)	81.93 6df (0.00)	56.73 6df (0.00)
R^2	0.63	0.95	0.62
Adj. R^2	0.48	0.92	0.45
No of observations	1030	1117	860

[a]t-ratios in parentheses
[b]* and ** denote statistical significance at 5 and 1% level, respectively

−(2 × 7) = 2136 degrees of freedom is 2.90. Thus, F* > F.01 shows that, the coefficients of the variables are different in the two groups.

When looking at differences between the two last periods, during crisis, we observe that the statistically significant variables either change their sign or become insignificant, with some contradicting conclusions. Interestingly, a closer look across the two groups provides some unexpected insights. In the first period of crisis the coefficient of market share is positive and significant, which shows that larger firms are more profitable than smaller ones, while in the last period the coefficient of size is again significant but negative, while during 2013–16 capital intensity variable is positive and statistically significant which explains profitability differences. Another interesting result has to do with age. In the second period of crisis the older firms are most profitable, which is strongly supported by the relevant literature. It is evident that in periods of recession, firms will have to rely more on their own resources and capabilities.

Taking into account that, first, there is no empirical evidence so far (at least to our knowledge) that test the performance differences for period years after 2012, second, the fact that the implementation of the strict austerity program for Greece in 2010 caused a substantial decrease in demand for goods and services pushing the Greek firms to a deeper recession and third, the above contradicting empirical evidence for different behaviors of firms between the two periods of crisis, we examine differences between the years before 2011 where the real crisis for Greece started with the implementation of austerity measures, and after 2011. The sharp increase in transaction costs with a contemporaneous decline in firm resources especially after the capital controls in 2015 lead according to the literature to declines in productivity and competitiveness, job and wage cuts, reduced efficiency, lower profit margins.

Table 37.3 summarizes the regression results for the model (1) presented in the previous section, for the two time periods, pre-crisis (2005–2010) and during crisis (2011–2016). First, in order to examine whether the respective coefficients obtained from the two groups are statistically different, we applied Chow-test. The null hypothesis in this case is structural stability; if we reject the null hypothesis, it means we have a structural break in the data. The estimated value for the Chow-test is found F* = 201.15 while the theoretical value of F for v1 = 9 and v2 = 3031 −(2 × 9) = 3013 degrees of freedom is 2.62. Thus, F* > F.01 shows that, the coefficients of the variables are different in the two groups and we do have a structural break in the data. Then, the application of Hausman test (see Greene 2008, Chap. 9) for fixed effects or random effects (it basically tests whether the unique errors (ui) are correlated with the repressors, the null hypothesis is they are not) in the case of the two groups (pre-crisis and during crisis) shows that the fixed effect model is the appropriate estimation method for the model (H = 27.21, d.f. = 8, p = 0.00 and H = 111.93, d.f. = 8, p = 0.00), respectively.

The results of the econometric analysis suggest that, during economic crisis market share, capital intensity, leverage and age have significant effect on profitability and explain profits differences among the firms. The above results are in line with our previous study for Greek dairy firms (Notta et al. 2014). The

Table 37.3 Determinants of profitability 2005–10 & 2011–16

	2005–2010	2011–2016
Variables	Fixed effects estimates of Profitability	
MS	2.7 (1.97)*	−1.90 (−3.75)**
MS^2	−5.20 (−1.35)	2.03 (2.84)**
KS	0.002 (6.10)**	0.16 (7.84)**
LIQ	0.09 (27.82)**	0.0001 (0.05)
LEV	−0.0001 (−0.12)	−0.10 (−2.52)**
LAGE	0.032 (0.56)	0.14 (2.16)*
EQ	−0.001 (−0.51)	−0.0004 (−0.42)
LGDP	−0.001 (−0.29)	−0.001 (−0.28)
SSR	270.44510	94.7938
F* test (Chow Test)	201.15	
Hausman Test	27.21 8df (0.00)	111.93 8df (0.00)
R^2	0.72	0.58
Adj. R^2	0.64	0.45
No of observations	1453	1578

[a]t-ratios in parentheses
[b]* and ** denote statistical significance at 5 and 1% level, respectively

coefficient of market share is negative and significant, while the square value of the variable is positive and significant. The results provide evidence for a non linear relationship between market share and profitability. As market share increases, profitability declines until the point where market share is equal to 0.465. After that point an increase in market share is associated with an increase in profitability. It is worth noting that market share higher than 46.5% corresponds to about 40% of the sample firms. Overall, large firms have both the power to control large parts of the industry output, but also a greater incentive to engage in practices that enable them to retain control over the market, especially during crisis. Our results show that firms with increased capital intensity index are more efficient and have the ability to achieve higher profitability.

Leverage is negatively related to profitability. The large interest rates due to economic crisis associated with high dept levels result to lower profits. Age was also found significant, only in case of crisis period, indicating that older firms have the ability, the structure and the experience to achieve a higher profitability, in periods of generalised economic adversity. As this global economic recession has its roots in the financial sector, our findings show that credit constraints at the firm level will inhibit a firm's ability to generate profits. The effect of capital availability on business performance is consistent with the traditional view that entrepreneurial activity, and the growth of small businesses, can be seriously constrained by limited access to financial resources.

These results show that, during crisis, the large and efficient food and beverage firms with low borrowing levels are more profitable than the other firms. Our findings confirm that in periods of generalised economic adversity, the firm's own resources and capabilities become even more important for firm performance. Managers will need to make the best use of the limited resources available, in order to over-perform the market and survive.

37.5 Conclusions

Global financial crisis of 2008, and especially the implementation of the strict austerity program for Greece in 2010, caused a substantial decrease in demand for goods and services pushing the Greek firms to a deeper recession for the last ten years. The present study aims to examine the effects of this long lasting crisis over time on the profitability of Greek food manufacturing firms and to investigate which firm characteristics make some firms more resistant to this economic shock than the others. We test for the following factors which may impact a firm's resistance to crisis and which we explore in our model: market share, firm age, leverage, liquidity index, and capital and efficiency index. We apply panel fixed effects method with firm level data for 2005–2016 for 331 food and beverage manufacturing firms with at least ten employees and with active presence of the business through the whole period 2005–2016.

The novelty of this research is that for the first time (at least to our knowledge) a work give emphasis to the year of the implementation of strict austerity program (2010) as real year of crisis for Greece, and also since the crisis has not ended, for the first time a work examine factors that affect the profitability of firms after 2011 (2011–2016). The application of Chow test in order to examine whether the respective coefficients obtained from the two groups 2005–2010 and 2011–2016 are statistically different, prove that, the coefficients of the variables are different in the two groups and we do have a structural break in the data.

Fixed effects results suggest that, business characteristics (e.g. size and capital intensity) are important either in pre-recession performance or within recession performance. However, during economic crisis the efficient and older firms are most profitable, indicating that older firms have the ability, the structure and the experience to achieve higher profitability especially in difficult situations. Also our results prove that large interest rates due to economic crisis associated with high debt levels result to lower profits. The results provide evidence for a nonlinear relationship between market share and profitability, which can be explained since only firms that can achieve large market share and control the market, may achieve also better performance.

References

Agiomirgianakis, G. M., Magoutas, A. I., & Sfakianakis, G. (2013). Determinants of profitability in the Greek tourism sector revisited: The impact of the economic crisis. *Journal of Tourism and Hospitality Management, 1*(1), 13.

Aldamen, H., Duncan, K. Kelly S. & McNamara, R. (2011). Performance of family firms during the global financial crisis: Does governance matter? Available at SSRN website: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1976789%23%23. Accessed June 2012.

Appendini Emilia Garcia and Judit Montoriol-Garriga. (2012). Firms as liquidity providers: Evidence from the 2007/2008 financial crisis. Available at website: http://www2.unine.ch/files/content/sites/irene/files/shared/documents/s%C3%A9minaires/Montorriol.pdf.

Asgharian, H. (2003). Are highly leveraged firms more sensitive to an economic downturn? *The European Journal of Finance, 9,* 219–241.

Baek, J., Kang, J., & Park, K. (2004). Corporate governance and firm value: Evidence from the Korean financial crisis. *Journal of Financial Economics, 88,* 499–533.

Bamiatzi, V., Bozos, K., & Cavusgil, S. T. (2016). Revisiting the firm, industry, and country effects on profitability under recessionary and expansion periods: A multilevel analysis. *Strategic Management Journal, 37*(7). 1448–1471. ISSN 0143-2095.

Barron, D. N., West, E., & Hannan, M. T. (1994). A time to grow and a time to die: Growth and mortality of credit Unions in New York, 1914–1990. *American Journal of Sociology, 100*(2), 381–421.

Braun, M. & Larraín B. (2005). Finance and the business cycle: International, inter-industry evidence. *Journal of Finance, LX*(3), 1097–1128.

Bricongne, J.-C., Fontagné, L., Gaulier, G., Taglioni, D., & Vicard, V. (2012). Firms and the global crisis: French exports in the Turmoil. *Journal of International Economics, 87,* 134–146.

Bricongne, J-C., Fontagne, L., Gaulier, G., Taglioni, D., & Vicard, V. (2010). 'Firms and the global crisis: French exports in the turmoil', Banque de France Documents de travail No. 265. Banque de France: Paris.

Bugamelli, M., Cristadoro R., & Zevi G. (2009). 'La crisi internazionali e il sistema produttivo italiano: un'analisi su dati a livello di impresa', Questioni di Economia e Finanza (Occasional papers), No. 58. Banca d'Italia: Roma.

Burger, A., Damijan, J. P., Kostevc, Č., & Rojec, M. (2017). Determinants of firm performance and growth during economic recession: The case of Central and Eastern European countries. *Economic Systems, 41*(4), 569–590.

Calomiris, C. W., Himmelberg, C. P., & Wachtel, P. (1995). Commercial paper, corporate finance, and the business cycle: A microeconomic perspective. In Carnegie Rochester Conference Series on Public Policy, vol. 42, pp. 203–250.

Chaston, I. (2012). Recession and family firm performance: An assessment of small U.K. family-owned hotels. *Journal of CENTRUM Cathedra, 5,* 60–69.

Claessens, S., Djankov, S., & Xu, L. C. (2011). Corporate performance in the East Asian financial crisis. *World Bank Research Observer, 15,* 23–46.

Das, S. (1995). Size, age and firm growth in an infant industry: The computer hardware industry in India. *International Journal of Industrial Organization, 13,* 111–126.

DeDee, J. K., & Vorhies, D. W. (1998). Retrenchment activities of small firms during economic downturn: An empirical investigation. *Journal of Small Business Management, 36*(3), 46–61.

Desai, M., Foley, C., & Forbes, K. (2004). Financial constraints and growth: Multinational and local firm responses to currency crisis, NBER Working Paper No. 10545. NBER: Cambridge, MA.

Erkens, D. H., Hung, M., & Matos, P. (2012). Corporate governance in the 2007–2008 financial crisis: Evidence from financial institutions worldwide. *Journal of Corporate Finance, 18,* 389–411.

Fort, T. C., Haltiwanger J., Jarmin R. S., & Miranda J. (2013). How firms respond to business cycles: The role of firm age and firm size, NBER Working Papers 19134.

Geroski, P. A., & Gregg P. (1997). Coping with recession: UK company performance in adversity. Cambridge University Press.

Geroski, P. A., & Gugler, K. (2004). Corporate growth convergence in Europe. *Oxford Economic Papers, 56,* 597–620.

Giroud, X., & Mueller, H. M. (2017). Firm leverage, consumer demand, and employment losses during the great recession. *The Quarterly Journal of Economics, 132*(1), 271–316.

Glancey, K. (1998). Determinants of growth and profitability in small entrepreneurial firms. *International Journal of entrepreneurship behaviour and research, 4*(1), 18–27.

Green, W. H., (2008). *Econometric analysis*. New Jersey: ed. Prentice Hall.

Greenwald B., & Stiglitz J. E. (1988). Information, finance constraints, and business fluctuations. In Proceedings of the Proceedings of Taipei) Symposium on Monetary Theory, Institute of Economics, Academia Sinica.

HELLASTAT. (2008–2016). Annual Balance Sheet Data for the Greek Manufacturing Companies, Athens (series).

ICAP HELLAS. (2006–2016). Annual balance sheet data for the Greek manufacturing companies, Athens (series).

IOBE. (2015). Food and beverage industry: Facts & figures. Foundation for Economic & Industrial Research.

Jandik, T., & Makhija, A. K. (2005). Leverage and the complexity of takeovers. *The Financial Review, 40*(1), 95–112.

Kroszner, R. S., Laeven, L., & Klingebiel, D. (2007). Banking crises, financial dependence, and growth. *Journal of Financial Economics, 84,* 187–228.

Lemmon, M. L., & Lins, K. V. (2003). Ownership structure, corporate governance, and firm value: Evidence from the East Asian Financial Crisis. *Journal of Finance, 58,* 1445–1468.

Lemonakis, C., Vassakis K., Garefalakis, A., & Papa, P. (2016). SMEs Performance and subsidies in IT investments: A vis-à-vis approach. *Journal of Theoretical and Applied Information Technology, 88*(2), 266–275.

Lemonakis, C., Voulgaris, F., Christakis, S., & Vassakis, K. (2013). Profit performance of exporting and non-exporting agricultural manufacturing firms: The case of Greece. In *8th NHIBE International Conference New Horizons in Industry and Education, Chania Greece* (pp. 29–30).

Little, P. L., Mortimer, J. W., Keene, M. A., & Henderson, L. R. (2011). Evaluating the effect of recession on retail firms' strategy using DuPont method: 2006–2009. *Journal of Finance and Accountancy, 7,* 1–7.

Lucky, E. O. I., & Minai, M. S. (2012). Re-investigating the effect of individual determinant, external factor and firm characteristics on small firm performance during economic downturn. *African Journal of Business Management, 6,* 229–237.

Luzzi, A. (2006). Do liquidity constraints matter in explaining firm size and growth? Some evidence from the Italian manufacturing industry. *Industrial and Corporate Change, 15*(1), 1–39.

Majumdar, S. K. (1997). The impact of size and age on firm-level performance: Some evidence from India. *Review of Industrial Organization, 12*(2), 231–241.

Manova, K., Wei, S.-J. & Zhang Z. (2009). Firm exports and multinational activity under credit constraints (December 15, 2009). Available at SSRN: http://ssrn.com/abstract=1534905.

Miller D., & Toulouse J.-M. (1986). Chief executive personality and corporate strategy and structure in small firms. *Management Science, 32*(11): 1389–1409. Mintzberg, 2003.

Mintzberg, H. (2003). The strategy process: Concepts, contexts, cases. Pearson Education.

Mitton, T. (2002). A cross-firm analysis of the impact of corporate governance on the East Asian financial crisis. *Journal of Financial Economics, 64,* 215–241.

Monokroussos, P., Dimitriadou, A., Gkionis, I., Gogos S., Petropoulou, P., & Stamatiou, Th. (2016). One year capital controls in Greece Impact on the domestic economy & lessons from the Cypriot experience. Eurobank Economic Research, August, 2016.

Nilsen, J. H. (2002). Trade credit and the bank lending channel. *Journal of Money, Credit, and Banking, 34,* 226–253.

Notta, O., & Vlachvei, A. (2015). Firm Performance Changes in Light of the Recent Greek Financial Crisis. Book of Proceedings published by International Organization for Research and Development—IORD ISSN: 2410-5465. Book of Proceedings ISBN: 978-969-7544-00-4.

Notta, O., & Vlachvei, A. (2014). The impact of financial crisis on firm performance in case of Greek food manufacturing firms. *Procedia Economics and Finance, 14,* 454–460.

Notta, O., & Vlachvei, A. (2017). Assessing the impact of economic crisis on food firms performance. In *Advances in Applied Economic Research* (pp. 873–881). Springer, Cham.

OECD (2012). OECD economic outlook, vol. 2012/2, Paris: OECD Publishing. Doi: http://dx.doi.org/10.1787/eco_outlook-v2012-2-en.

OECD (2014), Financing SMEs and entrepreneurs 2014: An OECD scoreboard. Paris: OECD Publishing. Doi: http://dx.doi.org/10.1787/fin_sme_ent-2014-en.

Opler, T. C., & Titman, S. (1994). Financial distress and corporate performance. *The Journal of Finance, 49*(3), 1015–1040.

Pearce, J. A., II, & Michael, S. C. (2006). Strategies to prevent economic recessions from causing business failure. *Business Horizons, 49*(3), 201–209.

Richardson, F. M., Kane, G. D., & Lobingier, P. (1998). The impact of recession on the prediction of corporate failure. *Journal of Business Finance & Accounting, 25*(1–2), 167–186.

Safieddine, A., & Titman, S. (1999). Leverage and corporate performance: Evidence from unsuccessful takeovers. *The Journal of Finance, 54*(2), 547–580.

Singh, M., Nejadmalayeri, A., & Mathur, I. (2007). Performance impact of business affiliation: An analysis of the diversification-performance link in a developing economy. *Journal of Business Research, 60*, 339–347.