

Springer Proceedings in Business and Economics

Agnieszka Bem ·
Karolina Daszyska-Zygadlo ·
Tatana Hajdíková · Erika Jáki ·
Bożena Ryszawska
Editors

Sustainable Finance in the Green Economy

The 3rd Finance and Sustainability
Conference, Wrocław 2019

 Springer

Springer Proceedings in Business and Economics

More information about this series at <https://link.springer.com/bookseries/11960>

Agnieszka Bem
Karolina Daszynska-Zygadlo
Tatana Hajdíkóvá • Erika Jáki
Bożena Ryszawska
Editors

Sustainable Finance in the Green Economy

The 3rd Finance and Sustainability
Conference, Wrocław 2019

 Springer

Editors

Agnieszka Bem
Corporate and Public Finance
Wrocław University of Economics
and Business
Wrocław, Poland

Karolina Daszynska-Zygadlo
Corporate and Public Finance
Wrocław University of Economics
and Business
Wrocław, Poland

Tatana Hajdíková
Department of Management
University of Economics in Prague
Jindřichův Hradec, Czech Republic

Erika Jáki
Institute for the Development of Enterprises
Corvinus University of Budapest
Budapest, Hungary

Bożena Ryszawska
Corporate and Public Finance
Wrocław University of Economics
and Business
Wrocław, Poland

ISSN 2198-7246

ISSN 2198-7254 (electronic)

Springer Proceedings in Business and Economics

ISBN 978-3-030-81662-9

ISBN 978-3-030-81663-6 (eBook)

<https://doi.org/10.1007/978-3-030-81663-6>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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

Preface

Finance and sustainability conference proceedings cover a variety of issues related to recent financial problems, among which are corporate finance, public finance, capital markets, monetary and fiscal policy issues, and risk management. Hence, this book covers sustainable finance, corporate sustainability, sustainable banking, and sustainable development in the sustainability field. It is a selection of the contributions presented at the conference and its satellite meetings. Its contents reflect the extent, diversity, and richness of research areas in the field, both fundamental and applied.

Europe's climate neutrality by 2050 is the primary goal of the European Union's new strategy, the European Green Deal. All EU actions and policies will have to contribute to the objectives of the European Green Deal. The EU budget and European funds will support this process and are allocated mainly to prevent and adapt to climate change, the low-carbon economy, and the circular economy.

The papers, presented during the "Finance and Sustainability" conference, focus on finance as an instrument of green economic transition supporting sustainable development, green economy, low carbon economy, adaptation, and climate change mitigation. The financial system is understood as the "central nervous system of the economy." New finance concepts have emerged in a public debate, such as green finance, sustainable finance, climate finance, and carbon finance. The new aim of sustainable finance is to improve the financial system's social, economic, and environmental performance.

The orthodox finance journals are failing to address finance and sustainability adequately. Several systematic reviews of highly ranked accounting and finance journals show that finance research focuses mainly on the post-2008 financial crisis, covering asset pricing, bankruptcy, credit issues, governance, and risk management. In scientific research contradictions exist between the global demand for sustainability and the structure of conventional finance. Academic finance needs to be diversified and situated within the broader spectrum of social sciences.

The Green European Deal's integral part is establishing an adequate European financing framework to meet the demands of the Green Deal. It is a large field for researchers to explore and identify the main challenges and new scientific issues.

The future of sustainable finance research is to identify and analyze private and public finance, shifting from brown to green. More complex issues recommended studying are mandatory and include ESG corporate reporting. In order to meet the EU's climate and energy targets and reach the objectives of the European Green Deal the Green Taxonomy has been introduced. It is a classification system for environmentally sustainable economic activities in sectors of energy, transport, construction, manufacturing, agriculture. For retail investors EU Ecolabel was implemented which supports individual investor to choose investment products labeled according to their degree of sustainability. Besides, new rules has been highlighted like reduction of short-termism in financial markets, consideration of systemic sustainability risk, and integration of ESG risks.

There is emerging importance in studying public finance's sustainability role, which means the greening budget issue and green fiscal policy also better identify climate and environmental financial risks. Public finance plays a crucial role in the Green Deal strategy. Investments from public funds of the European Union act as leverage for domestic public and private investments. Experts estimate that every 1,000 euros allocated for investment from the EU budget attract 13,000 euros of investment from private funds. European money sets the direction and priorities for investment, followed by banks, insurance companies, the stock exchange, pension funds, private investors, and consumers.

These proceedings' target audience includes researchers at universities and research and policy institutions, students at graduate institutions, and practitioners in economics, finance, and international economics in private or government institutions.

Wroclaw, Poland
Wroclaw, Poland
Jindřichův Hradec, Czech Republic
Budapest, Hungary
Wroclaw, Poland

Agnieszka Bem
Karolina Daszynska-Zygadlo
Tatana Hajdřková
Erika Jákı
Bořena Ryszawska

Contents

Capital Asset Prices in V4 Countries.	1
Gábor Bóta, László Nagy, and Mihály Ormos	
Corporate Social Responsibility Activities and Impact on Firm Value: The Case of the Technology Company Group	19
Marvin Enalpe	
Innovative Public Procurement: An Analysis of Surveys Conducted Among Contractors in Poland and the UK	47
Ma. Mateusz Halka	
Technology-Oriented Startups in the Intersection of Industry 4.0, Venture Capital Financing and Business Scaling – Empirical Examples from the Automotive Industry –	61
Erika Jáki and Péter Halmosi	
Key Competencies of Startup Teams Sought After by Investors	75
Erika Jáki, Fruzsina Major, and Endre Mihály Molnár	
Objective Assumptions for the Monte Carlo Simulation when Historical Data with a Desired Interval Have Limited Size	89
Jan Kaczmarzyk	
Financial Determinants of Development in the Process of Gmina Management in the Silesian Voivodeship in Poland.	103
Justyna Łukomska-Szarek	
Is the Situation of Polish Public Hospitals Healthy? Indebtedness Analysis	117
Katarzyna M. Miszczyńska and Piotr M. Miszczyński	
Trends and Recommendations of the Municipal Spending Policy in the Context of Social Assistance Benefits – Initial Analysis	127
Katarzyna M. Miszczyńska and Żaklina Jabłońska	

Procuring Socially Responsible Services Within Sustainability-Driven Thessaloniki	139
Fragkoulis Papagiannis, Patrizia Gazzola, Seng Kok, and Mauro Romanelli	
Insurance Business Cycles in Liability Insurance – The Case of the Polish Market	153
Ewa Poprawska	
Sustainable Business Models in Healthcare: A Scoping Review of the Quality and Quantity of Literature	167
Omar Rashdan and Gábor Csepy	
Inequality in the Distribution of Specialist Doctors: Evidence from Poland	177
Justyna Rój	
Sustainable Investments as Real Options	191
Elżbieta Rychłowska-Musiał	
Quantitative Easing and Green Bonds – Should a Central Bank Be Involved in Fostering Transition Towards Low-Carbon Economy?	201
Klaudia Zielińska-Lont	
Investment in the Polish Real Estate Market – Housing “Beta” Coefficient	213
Karolina Siemaszkiewicz	
Factors Affecting Bankruptcy Depending on the Size of the Company	225
Martina Sponerová, Miroslav Svoboda, and Miroslav Sponer	
The Competitiveness of Regions in Poland in 2009–2016	237
Agnieszka Wojtasiak-Terech and Ewa Majerowska	
Drivers of Market Cartelisation on the Example of Bid-Rigging – Case Study	249
Łukasz Ziarko and Justyna Wiktorowicz	
How Do Environmental, Social, and Governance (ESG) Factors Impact on Public Finance Performance? Risk, Efficiency, and Public Financial System Perspectives	261
Magdalena Zioło, Beata Zofia Filipiak, Iwona Bąk, and Katarzyna Cheba	

Capital Asset Prices in V4 Countries



Gábor Bóta, László Nagy, and Mihály Ormos

1 Introduction

We investigate the capital markets of the Visegrád four countries: the Czech Republic, Hungary, Poland, and Slovakia. Modern capital market trading restarted after the collapse of the communist regime in these countries after 1990; however, these countries and their economies fed from common roots of historical background; in the past decades, substantial differences have developed.

To have a better understanding of the development as a process, we compare our results with developed European economies as well: Austria, France, Germany, and the United Kingdom. In these developed countries, stock exchanges have a much longer history and have significant differences in the number of companies listed, market capitalization, and even the role of stock exchanges. We are about to find whether these characteristics have an impact on the price development and also what implications can be found for local and international investors. Our hypothesis

G. Bóta (✉)

Department of Finance and Accounting, Eötvös Loránd University, Institute of Business,
Budapest, Hungary
e-mail: bota@gti.elte.hu

L. Nagy

Faculty of Economic and Social Sciences, Department of Finance, Budapest University of
Technology and Economics, Budapest, Hungary
e-mail: nagyl@finance.bme.hu

M. Ormos

Department of Finance and Accounting, Eötvös Loránd University, Institute of Business,
Budapest, Hungary

Department of Economics, J. Selye University, Komárno, Slovakia

e-mail: ormosm@ujss.sk

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

A. Bem et al. (eds.), *Sustainable Finance in the Green Economy*, Springer

Proceedings in Business and Economics, https://doi.org/10.1007/978-3-030-81663-6_1

suggests that we can identify significant differences in asset pricing concerning the V4 countries for the last decade.

Price development in capital markets has been extensively examined in developed economies, but fewer lights shed on the developing countries. Bekaert et al. (2009) examine 23 developed economies, Gray and Johnson (2011) Australian, and Wang et al. (2015) Chinese equities. Morelli (2010) investigates 15, Bauer et al. (2010) investigate 16, and Papanastasopoulos (2017) also investigates 16 developed European countries. Hou et al. (2011) use monthly data of stocks from 49 countries including emerging ones.

Our dataset provides insights in the factors behind of the capital market returns on the period 2005–2018.

Our results underpin the rationale behind international diversification even in a single first-class geographical area. Daily data shows that V4 countries pay significant a size premium; however, the liquidity of these markets is comparable to that of developed markets.

2 Methodology and Data

Capital Asset Pricing Model (Sharpe 1964; Lintner 1965) gives the market as the sole factor behind price changes. Market in our case is the European market as defined by Kenneth French.

The Fama and French three-factor model (1993) extends the model by size (market capitalization, price times shares outstanding, small minus big factor) and the relation between average return and price ratios like book to market value (high minus low factor). Later they add profitability (robust minus weak) and investment-style (conservative minus aggressive) factors and get the Fama and French (2015) five-factor model. Carhart (1997) constructed a four-factor model, with the three factors used by Fama and French (market, size, and value) extended with a momentum factor as the returns of winner minus loser portfolios. Pastor and Stambaugh (2003) used liquidity measure as a new factor and extended the model used by Carhart (1997) using market, size, value, and momentum factors.

The source of the indices, individual equities, and foreign exchange rates are *Bloomberg Markets*. The factors we use to explain the price development of indices and individual stocks are available in the CRSP (Center for Research in Security Prices) and from the site of Lubos Pastor. The former is available both as daily and monthly readings, while the latter is only in monthly database.

For V4 countries we have a representative index being PX for the Czech Republic, BUX for Hungary, WIG20 for Poland, and SKSM for Slovakia while for the developed countries ATX for Austria, CAC for France, DAX for Germany, and UKX for the United Kingdom. We have not only the representative index but all its constituents at the end of our investigated period.

We run regressions for the market, size (small minus big), book to market value (high minus low), profitability (robust minus weak), investment style (conservative

minus aggressive), momentum (winners minus losers), and liquidity (traded liquidity).

All the data are in US dollars, we calculate the Euro prices, and where applicable the prices denominated in local currency as well.

3 Results and Discussion

For the whole investigated period, we receive mixed results. Slovakia is the only country with a very low determination coefficient (R^2), the explaining power of the models in EUR and USD, respectively: from 5.2% and 4.5% if we try to capture the return of the index only by the market proxy to 9.0% and 7.5% if we do this by size, book to market value, profitability, investment style, and momentum. For the other three countries of the V4, we receive results of R^2 ranging from 44% to 54%, while the developed countries show explaining power between 62% and 79% depending on the model and set of variables, as we can see in Table 1.

If we turn to the set of variables used by different models, we can see an interception between -0.0047 and -0.0050 with significant p-values very close to zero for all model settings.

Table 1 Adjusted R^2 of different models in daily settings

	One-factor	Three-factor	Four-factor	Five-factor	Six-factor
PX in EUR	50%	53%	54%	54%	55%
PX in USD	47%	50%	51%	51%	52%
PX in CZK	50%	53%	54%	54%	55%
BUX in EUR	47%	48%	48%	48%	48%
BUX in USD	44%	45%	45%	45%	45%
BUX in HUF	46%	47%	47%	47%	47%
WIG20 in EUR	51%	52%	52%	52%	52%
WIG20 in USD	48%	49%	49%	49%	49%
WIG20 in PLN	50%	51%	51%	51%	52%
SKSM in EUR	5.2%	8.3%	8.3%	9.0%	9.0%
SKSM in USD	4.5%	7.1%	7.1%	7.5%	7.5%
ATX in EUR	66%	68%	68%	68%	68%
ATX in USD	62%	64%	65%	65%	65%
CAC in EUR	79%	79%	79%	80%	80%
CAC in USD	76%	77%	77%	77%	77%
DAX in EUR	75%	75%	75%	76%	76%
DAX in USD	72%	73%	73%	73%	73%
UKX in EUR	69%	70%	70%	70%	70%
UKX in USD	70%	71%	71%	71%	71%
UKX in GBP	66%	68%	68%	68%	68%

Standard CAPM shows significantly positive market factors in all countries and exchange rates used; however, market is close to 1 only for the Czech Republic and the United Kingdom as presented in Table 2. This result underpins the rationale behind international diversification even in a single first-class geographical area. Although all of these indices represent well-diversified portfolios, their risks are significantly different from each other, while their returns are in equilibrium.

The Fama-French three-factor model shows that market betas are close to one in case of developed European markets, except for Austria where this result is 1.32 in EUR and 1.27 in USD as it can be seen in Table 3. Market factor is between 1.18 and 1.3 for the Czech Republic, Hungary and Poland (in EUR, USD and local currency as well). For Slovakia the market is 0.48 in EUR and 0.44 in USD.

The size factor is significantly positive for all the V4 countries and Austria and significantly negative for France, Germany, and the United Kingdom. These results show that by adding SMB and HML factors highlight the higher market-risk of the V4 countries. SMB factors for the V4 countries are positive which means these countries pay significant a size premium; however, the liquidity of these markets is comparable to that of developed markets.

Size factor is negative for all developed European markets, except Austria. HML factor is significantly positive for all V4 countries and for Austria and France contrary to the remaining developed European markets.

In the four-factor model, we expand the market, size, and value factors with momentum factor (winners minus losers: WML). In this model setting from among V4 countries, we receive negative results for WML factor; however, it is significant (at the 1% level) for the Czech Republic, only 5% and 10% level in case of Poland depending on the currency, in 10% level or insignificant for Hungary and insignificant for Slovakia.

For Austria and the United Kingdom, WML factor is significantly negative; for France it is negative but significant only in USD. For Germany WML factor is positive but at a significant level only if measured in EUR. Thus, the momentum effect is not that strong as we expected.

As Poterba and Summers (1988) show the mean-reverting nature of stock market prices is usually stronger in less sophisticated markets, it seems to be worthwhile to run a robustness test or even examine how the momentum factor sensitivity is changing over the period under investigation.

Results of the Fama-French five-factor model show that from among V4 countries, only the Czech Republic has significantly negative RMW factor, while Hungary has positive but not significant in either EUR, USD, or local currency (HUF). Poland has also positive but only significant at the 10% level RMW factor in local currency (PLN), and positive but not significant RMW factor in EUR and USD. Slovakia has positive and insignificant RMW factor in EUR and positive and significant in the 10% level in USD.

From among the developed countries, Austria and France have a significant and negative RMW factor, while Germany has positive and significant RMW factor both in EUR and USD. The United Kingdom has negative RMW factors in EUR, USD, and local currency (GBP) but only significant in USD.

Table 2 Estimates and their significance in the *CAPM* in daily settings

		est.	signif.
PX in EUR	int.	-0.0049	***
	Mkt	1.02	***
PX in USD	int.	-0.0049	***
	Mkt	0.99	***
PX in CZK	int.	-0.0049	***
	Mkt	1.02	***
BUX in EUR	int.	-0.0047	***
	Mkt	1.17	***
BUX in USD	int.	-0.0047	***
	Mkt	1.15	***
BUX in HUF	int.	-0.0047	***
	Mkt	1.16	***
WIG20 in EUR	int.	-0.0049	***
	Mkt	1.16	***
WIG20 in USD	int.	-0.0049	***
	Mkt	1.37	***
WIG20 in PLN	int.	-0.0049	***
	Mkt	1.15	***
SKSM in EUR	int.	-0.0046	***
	Mkt	0.27	***
SKSM in USD	int.	-0.0046	***
	Mkt	0.25	***
ATX in EUR	int.	-0.0049	***
	Mkt	1.21	***
ATX in USD	int.	-0.0049	***
	Mkt	1.19	***
CAC in EUR	int.	-0.0049	***
	Mkt	1.20	***
CAC in USD	int.	-0.0049	***
	Mkt	1.18	***
DAX in EUR	int.	-0.0047	***
	Mkt	1.15	***
DAX in USD	int.	-0.0047	***
	Mkt	1.22	***
UKX in EUR	int.	-0.0048	***
	Mkt	1.01	***
UKX in USD	int.	-0.0048	***
	Mkt	0.99	***
UKX in GBP	int.	-0.0048	***
	Mkt	1.00	***

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Table 3 Estimates and their significance in the Fama-French three-factor model

		est.	signif.
PX in EUR	int.	-0.0050	***
	Mkt	1.23	***
	SMB	0.84	***
	HML	0.27	***
PX in USD	int.	-0.0049	***
	Mkt	1.18	***
	SMB	0.76	***
	HML	0.29	***
PX in CZK	int.	-0.0049	***
	Mkt	1.22	***
	SMB	0.83	***
	HML	0.29	***
BUX in EUR	int.	-0.0048	***
	Mkt	1.28	***
	SMB	0.52	***
	HML	0.30	***
BUX in USD	int.	-0.0048	***
	Mkt	1.24	***
	SMB	0.45	***
	HML	0.30	***
BUX in HUF	int.	-0.0048	***
	Mkt	1.28	***
	SMB	0.52	***
	HML	0.29	***
WIG20 in EUR	Int.	-0.0050	***
	Mkt	1.31	***
	SMB	0.61	***
	HML	0.26	***
WIG20 in USD	int.	-0.0050	***
	Mkt	1.26	***
	SMB	0.54	***
	HML	0.26	***
WIG20 in PLN	int.	-0.0049	***
	Mkt	1.29	***
	SMB	0.56	***
	HML	0.24	***
SKSM in EUR	int.	-0.0047	***
	Mkt	0.48	***
	SMB	0.69	***
	HML	-0.08	
SKSM in USD	int.	-0.0047	***
	Mkt	0.44	***

(continued)

Table 3 (continued)

		est.	signif.
	SMB	0.62	***
	HML	-0.07	
ATX in EUR	int.	-0.0049	***
	Mkt	1.32	***
	SMB	0.59	***
	HML	0.42	***
ATX in USD	int.	-0.0049	***
	Mkt	1.27	***
	SMB	0.51	***
	HML	0.43	***
CAC in EUR	int.	-0.0048	***
	Mkt	1.08	***
	SMB	-0.37	***
	HML	0.10	***
CAC in USD	int.	-0.0048	***
	Mkt	1.04	***
	SMB	-0.44	***
	HML	0.10	***
DAX in EUR	int.	-0.0046	***
	Mkt	1.03	***
	SMB	-0.31	***
	HML	0.15	***
DAX in USD	int.	-0.0046	***
	Mkt	0.99	***
	SMB	-0.38	***
	HML	0.15	***
UKX in EUR	int.	-0.0048	***
	Mkt	0.98	***
	SMB	-0.25	***
	HML	-0.28	***
UKX in USD	int.	-0.0048	***
	Mkt	0.94	***
	SMB	-0.32	***
	HML	-0.28	***
UKX in GBP	int.	-0.0048	***
	Mkt	0.96	***
	SMB	-0.26	***
	HML	-0.27	***

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Table 4 Estimates and their significance in the Carhart four-factor model

		est.	signif.
PX in EUR	int.	-0.0049	***
	Mkt	1.20	***
	SMB	0.90	***
	HML	0.15	***
	WML	-0.26	***
PX in USD	int.	-0.0049	***
	Mkt	1.15	***
	SMB	0.83	***
	HML	0.16	***
	WML	-0.28	***
PX in CZK	int.	-0.0049	***
	Mkt	1.20	***
	SMB	0.89	***
	HML	0.17	***
	WML	-0.25	***
BUX in EUR	int.	-0.0048	***
	Mkt	1.28	***
	SMB	0.54	***
	HML	0.27	***
	WML	-0.06	
BUX in USD	int.	-0.0048	***
	Mkt	1.23	***
	SMB	0.48	***
	HML	0.26	***
	WML	-0.09	**
BUX in HUF	int.	-0.0047	***
	Mkt	1.27	***
	SMB	0.54	***
	HML	0.25	***
	WML	-0.07	*
WIG20 in EUR	int.	-0.0049	***
	Mkt	1.30	***
	SMB	0.63	***
	HML	0.23	***
	WML	-0.07	*
WIG20 in USD	int.	-0.0049	***
	Mkt	1.25	***
	SMB	0.56	***
	HML	0.22	***
	WML	-0.09	**
WIG20 in PLN	int.	-0.0049	***

(continued)

Table 4 (continued)

		est.	signif.
	Mkt	1.28	***
	SMB	0.58	***
	HML	0.21	***
	WML	-0.07	*
SKSM in EUR	int.	-0.0047	***
	Mkt	0.48	***
	SMB	0.68	***
	HML	-0.07	***
	WML	0.02	
SKSM in USD	int.	-0.0047	***
	Mkt	0.44	***
	SMB	0.63	***
	HML	-0.07	***
	WML	-0.01	
ATX in EUR	int.	-0.0049	***
	Mkt	1.31	***
	SMB	0.62	***
	HML	0.36	***
	WML	-0.14	***
ATX in USD	int.	-0.0049	***
	Mkt	1.26	***
	SMB	0.55	***
	HML	0.36	***
	WML	-0.17	***
CAC in EUR	int.	-0.0048	***
	Mkt	1.08	***
	SMB	-0.37	***
	HML	0.09	***
	WML	-0.03	
CAC in USD	int.	-0.0048	***
	Mkt	1.03	***
	SMB	-0.43	***
	HML	0.08	***
	WML	-0.06	***
DAX in EUR	int.	-0.0047	***
	Mkt	1.04	***
	SMB	-0.33	***
	HML	0.18	***
	WML	0.06	***
DAX in USD	int.	-0.0046	***
	Mkt	0.99	***
	SMB	-0.39	***

(continued)

Table 4 (continued)

		est.	signif.
	HML	0.17	***
	WML	0.03	***
UKX in EUR	int.	-0.0048	***
	Mkt	0.97	***
	SMB	-0.22	***
	HML	-0.33	***
	WML	-0.10	***
UKX in USD	int.	-0.0048	***
	Mkt	0.93	***
	SMB	-0.29	***
	HML	-0.34	***
	WML	-0.13	***
UKX in GBP	int.	-0.0048	***
	Mkt	0.95	***
	SMB	-0.24	***
	HML	-0.32	***
	WML	-0.11	***

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

These results explain that the nature of operating profitability is different in the V4 countries compared to developed European countries and strongly differs from the US markets. In these countries the difference between profitability characteristics of the firms does not convey a premium for the investors which is a striking result, which also suggest that standard accounting-based analysis of listed companies does not really give added value for risk decisions.

The investment factor (conservative minus aggressive, CMA) is negative for three of the four V4 countries, the Czech Republic, Hungary, and Poland, and significant in all cases except for Hungary where only in USD and only in 10% level is significant.

From among the developed countries with developed capital markets, CMA factor is significantly negative for Austria and the United Kingdom, while for France and Germany, CMA factor is significantly positive in EUR, and insignificantly negative in USD for France and insignificantly positive for Germany.

These results presented in Table 5 suggest that V4-listed firms apply aggressive investment strategies which means they are high investment firms. This outcome will accommodate the hypothesis that these postcommunist economies required to have much higher and more aggressive investment policies compared to developed ones to converge their economic performance to those.

If we add the aforementioned momentum factor to the Fama-French five-factor model, we receive a six-factor model.

From among the V4 countries, only the WML factor is negative for all cases, but only for the Czech Republic is significant at the 1% level, and for Hungary and

Table 5 Estimates and their significance in the Fama-French five-factor model

		est.	signif.
PX in EUR	int.	-0.0048	***
	Mkt	1.18	***
	SMB	0.80	***
	HML	0.12	***
	RMW	-0.57	***
	CMA	-0.49	***
PX in USD	int.	-0.0048	***
	Mkt	1.11	***
	SMB	0.72	***
	HML	0.17	***
	RMW	-0.59	***
	CMA	-0.66	***
PX in CZK	int.	-0.0048	***
	Mkt	1.17	***
	SMB	0.79	***
	HML	0.14	***
	RMW	-0.57	***
	CMA	-0.51	***
BUX in EUR	int.	-0.0048	***
	Mkt	1.28	***
	SMB	0.53	***
	HML	0.37	***
	RMW	0.15	
	CMA	-0.03	
BUX in USD	int.	-0.0048	***
	Mkt	1.22	***
	SMB	0.45	***
	HML	0.37	***
	RMW	0.04	
	CMA	-0.21	*
BUX in HUF	int.	-0.0048	***
	Mkt	1.27	***
	SMB	0.52	***
	HML	0.33	***
	RMW	0.05	
	CMA	-0.09	
WIG20 in EUR	int.	-0.0050	***
	Mkt	1.28	***
	SMB	0.61	***
	HML	0.42	***
	RMW	0.24	**
	CMA	-0.25	**

(continued)

Table 5 (continued)

		est.	signif.
WIG20 in USD	int.	-0.0050	***
	Mkt	1.21	***
	SMB	0.53	***
	HML	0.42	***
	RMW	0.15	
	CMA	-0.44	***
WIG20 in PLN	int.	-0.0049	***
	Mkt	1.25	***
	SMB	0.56	***
	HML	0.39	***
	RMW	0.19	*
	CMA	-0.27	***
SKSM in EUR	int.	-0.0047	***
	Mkt	0.54	***
	SMB	0.72	***
	HML	-0.10	
	RMW	0.23	**
	CMA	0.53	***
SKSM in USD	int.	-0.0047	***
	Mkt	0.48	***
	SMB	0.65	***
	HML	-0.07	
	RMW	0.19	*
	CMA	0.36	***
ATX in EUR	int.	-0.0049	***
	Mkt	1.29	***
	SMB	0.56	***
	HML	0.38	***
	RMW	-0.26	***
	CMA	-0.31	***
ATX in USD	int.	-0.0048	***
	Mkt	1.22	***
	SMB	0.48	***
	HML	0.39	***
	RMW	-0.37	***
	CMA	-0.49	***
CAC in EUR	int.	-0.0048	***
	Mkt	1.10	***
	SMB	-0.37	***
	HML	-0.09	***
	RMW	-0.16	***
	CMA	0.18	***

(continued)

Table 5 (continued)

		est.	signif.
CAC in USD	int.	-0.0048	***
	Mkt	1.04	***
	SMB	-0.45	***
	HML	-0.01	***
	RMW	-0.26	***
	CMA	-0.00	
DAX in EUR	int.	-0.0047	***
	Mkt	1.06	***
	SMB	-0.28	***
	HML	0.36	***
	RMW	0.60	***
	CMA	0.22	***
DAX in USD	int.	-0.0047	***
	Mkt	0.99	***
	SMB	-0.36	***
	HML	0.36	***
	RMW	0.49	***
	CMA	0.04	
UKX in EUR	int.	-0.0048	***
	Mkt	0.96	***
	SMB	-0.26	***
	HML	-0.26	***
	RMW	-0.05	
	CMA	-0.22	***
UKX in USD	int.	-0.0048	***
	Mkt	0.89	***
	SMB	-0.34	***
	HML	-0.26	***
	RMW	-0.17	***
	CMA	-0.41	***
UKX in GBP	int.	-0.0048	***
	Mkt	0.93	***
	SMB	-0.28	***
	HML	-0.24	***
	RMW	-0.09	
	CMA	-0.30	***

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Table 6 Estimates and their significance in the six-factor model

		est.	signif.
PX in EUR	int.	-0.0048	***
	Mkt	1.17	***
	SMB	0.86	***
	HML	0.04	
	RMW	-0.44	***
	CMA	-0.34	***
	WML	-0.21	***
PX in USD	int.	-0.0048	***
	Mkt	1.11	***
	SMB	0.78	***
	HML	0.09	
	RMW	-0.47	***
	CMA	-0.51	***
	WML	-0.21	***
PX in CZK	int.	-0.0048	***
	Mkt	1.16	***
	SMB	0.85	***
	HML	0.07	
	RMW	-0.45	***
	CMA	-0.37	***
	WML	-0.21	***
BUX in EUR	int.	-0.0048	***
	Mkt	1.28	***
	SMB	0.55	***
	HML	0.35	***
	RMW	0.20	*
	CMA	0.02	
	WML	-0.07	*
BUX in USD	int.	-0.0048	***
	Mkt	1.21	***
	SMB	0.47	***
	HML	0.34	***
	RMW	0.10	
	CMA	-0.15	
	WML	-0.08	*
BUX in HUF	int.	-0.0048	***
	Mkt	1.26	***
	SMB	0.54	***
	HML	0.30	***
	RMW	0.10	
	CMA	-0.04	
	WML	-0.07	*

(continued)

Table 6 (continued)

		est.	signif.
WIG20 in EUR	int.	-0.0050	***
	Mkt	1.28	***
	SMB	0.63	***
	HML	0.40	***
	RMW	0.29	***
	CMA	-0.20	*
	WML	-0.07	*
WIG20 in USD	int.	-0.0049	***
	Mkt	1.21	***
	SMB	0.55	***
	HML	0.40	***
	RMW	0.21	*
	CMA	-0.38	***
	WML	-0.08	**
WIG20 in PLN	int.	-0.0049	***
	Mkt	1.25	***
	SMB	0.58	***
	HML	0.37	***
	RMW	0.26	**
	CMA	-0.22	**
	WML	-0.07	*
SKSM in EUR	int.	-0.0047	***
	Mkt	0.54	***
	SMB	0.73	***
	HML	-0.11	
	RMW	0.26	**
	CMA	0.55	***
	WML	-0.04	
SKSM in USD	int.	-0.0047	***
	Mkt	0.48	***
	SMB	0.66	***
	HML	-0.08	
	RMW	0.22	**
	CMA	0.40	***
	WML	-0.05	
ATX in EUR	int.	-0.0048	***
	Mkt	1.29	***
	SMB	0.59	***
	HML	0.35	***
	CMA	-0.18	**
		-0.23	***

(continued)

Table 6 (continued)

		est.	signif.
	WML	-0.11	***
ATX in USD	int.	-0.0048	***
	Mkt	1.22	***
	SMB	0.51	***
	HML	0.35	***
	RMW	-0.28	***
	CMA	-0.42	***
	WML	-0.12	***
CAC in EUR	int.	-0.0048	***
	Mkt	1.10	***
	SMB	-0.36	***
	HML	-0.02	
	RMW	-0.13	**
	CMA	0.20	***
	WML	-0.03	
CAC in USD	int.	-0.0048	***
	Mkt	1.04	***
	SMB	-0.44	***
	HML	-0.02	
	RMW	-0.23	***
	CMA	0.03	
	WML	-0.04	*
DAX in EUR	int.	-0.0047	***
	Mkt	1.06	***
	SMB	-0.28	***
	HML	0.36	***
	RMW	0.60	***
	CMA	0.22	***
	WML	0.00	
DAX in USD	int.	-0.0047	***
	Mkt	0.99	***
	SMB	-0.36	***
	HML	0.36	***
	RMW	0.49	***
	CMA	0.04	
	WML	-0.01	
UKX in EUR	int.	-0.0048	***
	Mkt	0.95	***
	SMB	-0.23	***
	HML	-0.28	***
	RMW	0.01	
	CMA	-0.15	**

(continued)

Table 6 (continued)

		est.	signif.
	WML	-0.09	***
UKX in USD	int.	-0.0047	***
	Mkt	0.89	***
	SMB	-0.31	***
	HML	-0.29	***
	RMW	-0.10	
	CMA	-0.34	***
	WML	-0.10	***
UKX in GBP	int.	-0.0048	***
	Mkt	0.93	***
	SMB	-0.25	***
	HML	-0.27	***
	RMW	-0.02	
	CMA	-0.24	***
	WML	-0.09	***

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Poland, this sixth factor is significant at 5% or 10% depending on the currency and insignificant for Slovakia.

WML factor is significantly (even at the 1% level) negative for Austria and the United Kingdom, negative for France but only significantly at the 10% level when measured in USD and insignificant when measured in EUR, while insignificantly positive when measured in EUR and insignificantly negative when measured in USD for Germany.

4 Conclusions

All of the V4 countries joined the European Union on the first of May in 2004; they exhibit common historical roots and similar social regime switch from a communist economy to market economy in the beginning of the 1990s.

We investigate how the stock markets accommodated to the developed European countries. We find that V4 countries' capital asset pricing behaves well concerning the standard asset pricing models with only slight surprising results.

Behaving well means in this context that the explanatory powers of the applied models are high and most of the explaining factors are significant. It is surprising that WML, i.e., the momentum factor, is not as strong as Poterba and Summers (1988) suggested. We also find that the investment style of V4 firms is aggressive which result is in line with our economic intuition.

It seems to be clear that our research should be extended with a rolling window regression analysis to visualize the process of asset pricing development.

Acknowledgments This research was supported by the Pallas Athéné Domus Educationis Foundation.

References

- Bauer R, Cosemans M, Schotman PC (2010) Conditional asset pricing and stock market anomalies in Europe. *Eur Financ Manag* 16(2):165–190
- Bekaert G, Hodrick RJ, Zhang X (2009) International stock return comovements. *J Financ* 64(6):2591–2626
- Carhart MM (1997) On persistence in mutual fund performance. *J Financ* 52(1):57–82
- Fama EF, French KR (1993) Common risk factors in the returns on stocks and bonds. *J Financ Econ* 33(1):3–56
- Fama EF, French KR (1996) Multifactor explanations of asset pricing anomalies. *J Financ* 51(1):55–84
- Fama EF, French KR (2015) A five-factor asset pricing model. *J Financ Econ* 116(1):1–22
- Gray P, Johnson J (2011) The relationship between asset growth and the cross-section of stock returns. *J Bank Financ* 35(3):670–680
- Hou K, Karolyi GA, Kho BC (2011) What factors drive global stock returns? *Rev Financ Stud* 24(8):2527–2574
- Lintner J (1965) Security prices, risk, and maximal gains from diversification. *J Financ* 20(4):587–615
- Morelli D (2010) European capital market integration: an empirical study based on a European asset pricing model. *J Int Financ Mark Inst Money* 20(4):363–375
- Papanastasopoulos GA (2017) Asset growth anomaly in Europe: do profits and losses matter? *Econ Lett* 156:106–109
- Pastor L, Stambaugh RF (2003) Liquidity risk and expected stock returns. *J Polit Econ* 111(3):642–685
- Poterba JM, Summers LH (1988) Mean reversion in stock prices: evidence and implications. *J Financ Econ* 22(1):27–59
- Sharpe WF (1964) Capital asset prices: a theory of market equilibrium under conditions of risk. *J Financ* 19(3):425–442
- Wang Y, Liu C, Lee JS, Wang Y (2015) The relation between asset growth and the cross-section of stock returns: evidence from the Chinese stock market. *Econ Model* 44:59–67

Corporate Social Responsibility Activities and Impact on Firm Value: The Case of the Technology Company Group



Marvin Enalpe

1 Introduction

According to *The CSR Journal*, the millennial generation globally helps boost brands toward social responsibility, with an emphasis on conducting business with firms that are engaged in sustainable sourcing, social topics, and ethical corporate practices: “Nielsen Holdings published its Annual Global Corporate Sustainability Report in 2017 contemplating on global responsibility as well as sustainability. Nielsen’s 2015 report showed that 66 percent of consumers will spend more on products that come from sustainable brands. Another 81 percent expect their preferred corporate organization to publicly disclose their statements about corporate citizenship” (Landrum 2017). “A firm can expect to experience sustainable growth through the trust placed in it by the society. Accordingly, if a firm performs trust-based entrepreneurial activities, it can maintain good relationships with various stakeholders, and ultimately expect improvement in economic performance” (Aupperle & Hatfield 1985).

Today, many large information technology (IT) companies are becoming an integral part of extended Internet connectivity via the Internet of Things (IoT), which is an advanced smart office/home ecosystem embedded with electronics, Internet connectivity, and hardware items that can communicate and interact, as they are monitored and controlled remotely. It is pivotal to understand the interactions of these three industries, as the software and IT services industry provides the computer, phone, and household electronics industry with software programs for its hardware to work, while telecommunication companies purchase the products and services provided by both types of firms and operate in the market of their

M. Enalpe (✉)

Global Business-Quality Manager, Kuehne+Nagel Poland, Wroclaw, Poland

e-mail: mrvnenalpe@gmail.com

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

A. Bem et al. (eds.), *Sustainable Finance in the Green Economy*, Springer

Proceedings in Business and Economics, https://doi.org/10.1007/978-3-030-81663-6_2

geographical–regional/national locations. The IoT concept faces prominent criticism with regard to privacy and security concerns. In addition to governance issues, these companies are also often criticized for the environmental impacts of their industrial waste (such as batteries and electronic equipment) and their high energy consumption, leading to high CO₂ emissions in comparison with other industries.

Strategic planning and execution of corporate social responsibility (CSR) activities by large IT companies may have significant impacts on the prosperity of their stakeholders. These CSR activities may also have powerful impacts in shaping society's future formation in some way. For example, it has been said that the South Korean firm and tech chaebol giant Samsung's revenue is "17% of the country's GDP [gross domestic product]" (Daniel 2013).

The purpose of this research was to understand CSR activities and their influence on the firm value of companies that operate in the technology and telecommunication sector within the three business industry groups of software and IT services; computer, phone, and household electronics; and telecommunication services.

The design of our study was structured as follows. We initially set out in detail what the context of CSR was and how CSR projects could help a firm to create value. We then developed a hypothesis for the three ESG (environmental, social, and corporate governance) pillars, which had a potentially significant link to their corporate financial performance (CFP). In this study, our main aim was to understand whether CSR activities influenced the firm value. Thus, we set out our hypothesis as described below.

Hypothesis: Do technology companies' corporate environmental, social, and governance activities have a significant influence on (or relationship to) their corporate financial performance on the basis of their industry group/region/country of domicile?

After that, we analyzed the valuation of a firm, and why and how the valuation was exercised. We then focused on the research methodology, the data collection and description, the analysis, the findings, and the results. In the last section of this paper, titled "Discussion and Conclusion", we show the contribution of the individual ESG pillar dimensions to value creation and the consequences of the outcomes for the firms' overall business strategy, management practices, and public policy, and we conclude with suggestions for future research.

2 Literature Review on CSR and Valuation of a Firm

2.1 Definition of CSR

The International Organization for Standardization (ISO) *Guidance on Social Responsibility* (ISO 26000) was issued in November 2010. There have been many disputes over the need for exact and impartial definitions of CSR and CSR activities. Section 2 of ISO 26000 states, "Social responsibilities is a responsibility of an organization for the impacts of its decisions and activities on the society and the

environment through transparent and ethical behavior that contributes to sustainable development, including health and the welfare of society; worth to note the expectations of stakeholders; is in compliance with applicable law and consistent with international norms of behavior; and is amalgamated throughout the organization and practiced in its relationships. Activities include products, services and processes while linkages refer to an organization's activities within its sphere of influence" (International Organization for Standardization 2010).

On the other hand, the Ten Principles of the United Nations Global Compact define CSR as "a platform for business and non-business actors to come on board in discussions around transnational policy issues such as global warming—greenhouse effect, human rights and anti-corruption" (Rasche et al. 2013).

2.2 *CSR Value for Stakeholders*

Firms do not exist in isolation. They are highly dependent on their stakeholder relationships—for example, with investors, customers, consumers, employees, communities, domestic institutions, and suppliers. Identification of who are the strategic stakeholders of a company that can drive the business toward sustainable growth with long-term partnerships is important not only for the firm's profitability but also for its stability, company reputation, building of social capital, and risk and crisis reduction. Depending on who the stakeholder is, the firm's CSR activities then become more specific and sometimes can be more sophisticated; hence, the firm should ensure that its CSR processes are robust and inclusive enough to gain the value and purpose of each and every activity it implements.

For instance, Organisation for Economic Co-operation and Development (OECD) green investment banks (GIBs) are expected to implement stronger policies and requirements toward the companies they invest in. A GIB is a public entity recognized specifically to expedite private investment in domestic low-carbon, climate-resilient (LCR) infrastructure. Using transaction-enabling techniques, innovative transaction structures, risk reduction, and local and market experience, GIBs transform private investment in low-carbon projects. A self-reinforcing process exists between responsible investment and CSR. The more that responsible investors can profit from investing in CSR, the more necessity for CSR activities there will be. "Most investors acting upon CSR information are so called responsible investors who consider the environmental or social criteria in their investment decision-making. The number and assets of these responsible investors appear important for CSR itself, since firms' CSR strategies are shown to be potentially reactive to the CSR demand from responsible investors" (Mackey et al. 2007).

Maruja Malik reveals the most common CSR areas in which firms usually practice and the values that firms experience when implementing CSR activities: "Firms can develop business models with basic value propositions designed for different stakeholders such as employees, customers, suppliers, regulators, the community, and investors. Protecting different stakeholder's interests results in different

benefits, such as product market benefits (e.g. loyal customers, product diversification, extended market share, and the creation of brand equity), capital market benefits (e.g. increased market returns, lowered cost of capital, and declined information asymmetry & risk), employee benefits (e.g. employee morale, job satisfaction, and employee productivity), regulatory benefits (e.g. reduced litigation costs, beneficial media coverage, and favorable treatment from regulators), and operational benefits (e.g. better managerial skills, boost operating efficiency, improved corporate branding, and reputation). All these benefits derived by superior quality CSR performance helps to improve firms' profitability as well as economic value both in the short run and in long run" (Malik 2015).

Consumers prefer to purchase from institutions that are well known for helping society to prosper. "Firms that announce and fulfill their commitment to various causes are perceived as more generous than companies who do not engage in CSR activities" (Malik 2015). Firms can boost their public image by supporting nonprofit organizations through donations, volunteerism, social environmental campaigns, and educational activities. Firms that are perceived by society as socially responsible also amplify their employees, suppliers and business partners, morale, trust, and engagement. They can also gain favorable treatment as role models with regulators and even with their competitors (Fig. 1).

2.3 CSR Limitations

Corporate social responsibility can mean greater scrutiny and dissection. As soon as a firm publishes its CSR goals and targets, it is susceptible to stakeholders' and critics' opinions, especially when those targets are not achieved, which can literally damage the company's reputation. A failed CSR plan means a failed promise and false commitment; it would be better than no CSR plan at all. CSR activities require a budget for resources in order to implement them; hence, most smaller firms are not able to extend their targets and lack or may miss several elements of CSR. CSR costs the firm to integrate it into their processes, and it takes time and effort to yield benefits from it and to master the specific strategy that will work effectively for the firm.

In many countries, there is not even clear legislation regarding the implementation of CSR activities. Therefore, there is a huge range of nonstandardized reporting of every single CSR activity, and firms that do not have any experience in CSR programs may find them difficult to implement at the beginning, as they lack the necessary expertise.

According to Hoepner et al. (2010) "Only in a few cases do CSR business processes result in tangible assets, for instance, eco-efficient production technologies (Fombrun et al. 2000; Gardberg and Fombrun 2006; Godfrey 2005). Notably, these intangible assets resulting from CSR are in the clear majority of cases not reflected on corporate balance sheets, as contemporary accounting standards tend not to recognize them. (The main exception would be the incorporation of an acquired firm's

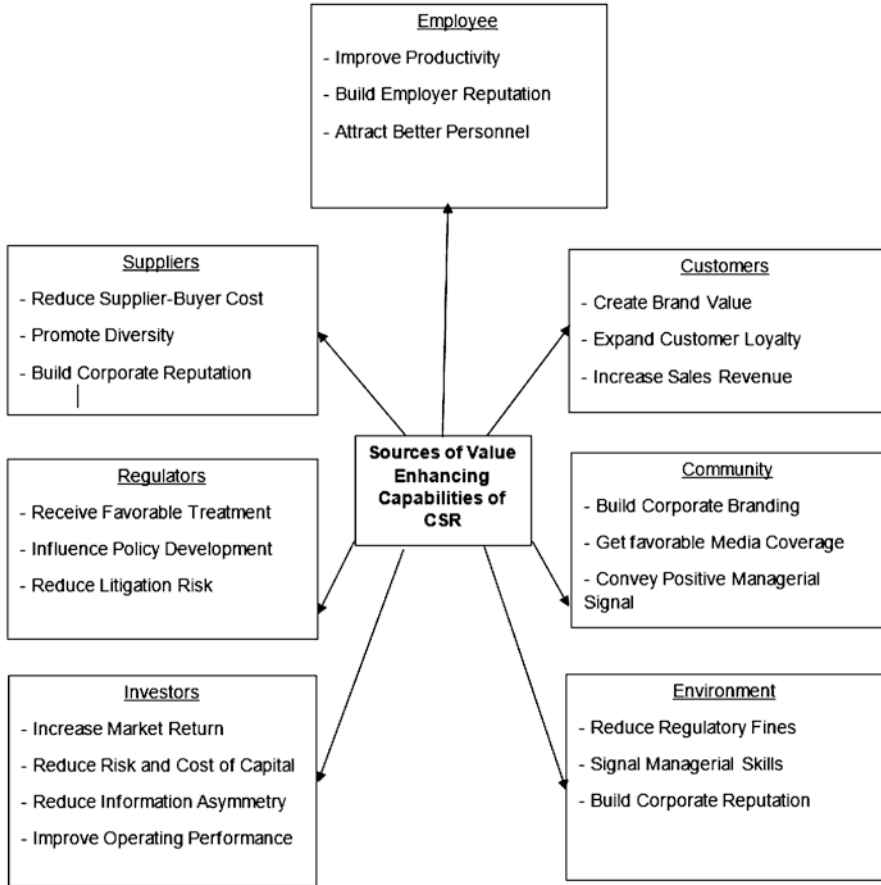


Fig. 1 Sources of value-enhancing capabilities of corporate social responsibility (CSR) (Malik 2015)

intangible assets, such as goodwill). As a result, most corporate investments of (cash) resources in CSR are considered expenses by current accounting standards.”

Hoepner et al. (2010) argue that “this expensing of corporate CSR investment could have created an *accounting illusion* of a positive link between corporate social and financial performance as found in the recent meta analyses (Allouche and Laroche 2005; Margolis et al. 2007; Orlitzky et al. 2003)” and that “the expensing of most corporate CSR investments leads to ad hoc reductions in the book value of a corporation’s equity and total assets. In contrast, the alternatives of not investing the respective corporate resources or investing them in tangible assets instead of CSR lead to no (immediate) expenses and hence these alternatives have no effect on book value of a corporation’s equity and total assets (apart from minor depreciation expenses). Consequently, . . . even if a firm’s investment in CSR has no effect on its earning, it will raise its short-term return on equity (ROE) and return on assets

(ROA), as it decreases denominators of these ratios. ROE and ROA are the most common accounting measures applied in analysis of the link between corporate social and corporate finance performance and an equivalent effect appears in the case of other (partially) accounting based measures like Tobin's Q."

Hoepner et al. (2010) suggest that "The found positive link between corporate social performance (CSP) and corporate financial performance (CFP), which is mainly driven by accounting based measures of financial performance, might represent an accounting illusion. . . . If a firm had the choice of investing in CSR, investing in tangible assets or not investing at all, the CSR investment would *ceteris paribus* [other things being equal] lead to the highest short-term ROE or ROA."

The accounting illusion rationalization mentioned by Hoepner et al. (2010) makes sense of why it looks premature to draw a conclusion that "there is a positive association between CFP and CSP across industries and across study contexts (Orlitzky et al. 2003: 423). There are at least two other reasons. First, if Orlitzky et al.'s (2003: 423) 'universally positive relationship' between CFP and CSP were to exist, corporations could maximize their financial performance by investing unlimited resources in any CSR business process. However, it appears impossible that unlimited investments in (most) CSR business processes would increase corporate financial performance. For instance, if a corporation invested multiples of its revenue in charitable donations or corporate social reporting, contemporary market mechanisms would be virtually unable to sufficiently compensate it financially. . . . Second, Orlitzky et al.'s (2003) attempt to identify one single type of relationship (positive, neutral, or negative) between any CSP indicator and CFP in any industrial context fails to recognize any contextual nature of the CSR concept. It implies, for instance, that eco-efficiency projects in manufacturing industries, microfinance activities of finance institutions, and donations of medicine supply in the healthcare sector are comparable activities with the same type of effect on CFP simply because they are conducted under the flag of CSR."

2.4 Impact of CSR on CFP

"Several studies has been done with different claims that CSR has either have positive, neutral, or negative effect in the corporate financial performance (Hoepner et al. 2010)". Results on the impact of CSR on CFP can differ depending on which perspective and point of view is considered. "Nevertheless, the growing number of articles claiming a positive trend the importance of CSR is undebatable and undeniable given the ascending trend, and new socio-political development in each country and region. Based on these research studies, including those conducted by Sang Jun Cho, Chune Young Chung, and Jason Young, a positive relationship exists between a firm's corporate social responsibility policies and corporate financial performance (Cho et al. 2019)."

CSR activities differ in how they affect CFP. Some CSR activities have a direct cost saving effect (e.g., eco-efficiency programs), other CSR activities aim to

improve employees’ long-term performance (e.g., employee relations), other CSR activities attempt to build reputation capital, and so on. “Different forms of CSR can fairly be expected to have non-identical effects on CFP in different application contexts. Similarly, CSR rating agencies tend to focus on a pool of largest companies” (Schäfer et al. 2006). Therefore, CSR programs are more likely to be adopted by many larger firms than by smaller firms, as larger firms can have higher exposure and public scrutiny.

Hoepner et al. (2010) state that “Firm characteristics, especially firm size and the level of a firm’s intangible assets, are thought of as factors that affect a firm’s ability to profit from CSR activities. Stakeholder activism tends to focus on larger firms as these attained more public attention (Clark et al. 2008)” and that “Drawing on prior conceptualizations (Rowley and Berman 2000; Ullmann 1985), Barnett (2007: 813) advocates a contingency perspective on the link between CSR and CFP and calls for future research to determine the contextual circumstances in which CSR pays.” Barnett (Barnett 2007) notes that “CSR cannot financially please all of the corporations all of the time, but it can please some of the corporations some of the time. Researchers should try to figure out which ones and when.” Hoepner et al. (2010) state that “Barnett’s contingency perspective is based on three main conditional dimensions: CSR form [which refers to specific CSR activities (e.g., carbon neutrality, charitable donations, and human rights policies)], firm characteristics and time. Following previous studies (Matten and Moon 2008; Rowley and Berman 2000), we add national framework and industrial characteristics as the fourth and fifth dimension to our contingency perspective” (Fig. 2).

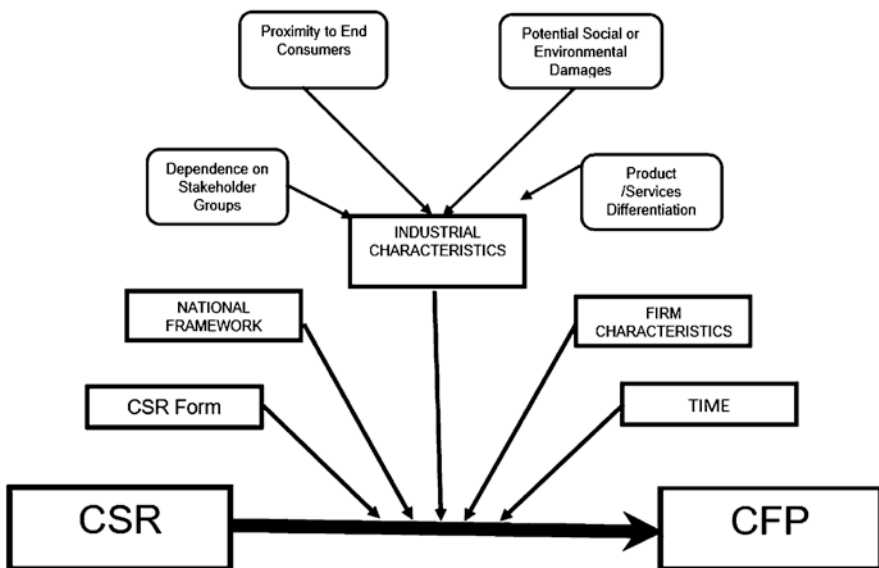


Fig. 2 Contingency perspective on the effect of corporate social responsibility (CSR) on corporate financial performance (CFP) (Hoepner et al. 2010)

Hoepner et al. (2010) also note that “Decades ago, Ullmann (1985) suggested that industries moderate the relationship between CSP and CFP. Subsequently, many researchers have reinforced calls for research on the potential heterogeneity of CSR’s impact on CFP across industries (e.g. Barnett 2007; Godfrey and Hatch 2007; Hart 1995).”

Most of these studies have controlled only for industry drivers of CFP; they did not control for industry drivers of CSR results or CSP indicators’ influence on CFP. These studies indirectly assumed that the CSR–CFP relationship is homogeneous across industries. In cases of a cross-sectional or panel regression of a CFP measure on a CSR measure and a set of control variables, many studies included stand-alone industry dummies to capture industry influence. While industry dummies adjust industry drivers of CFP, they do not control for industry drivers of CSR’s effects on CFP unless they are multiplied by the CSR variables.

2.5 *Valuation of a Firm*

A basic valuation method includes a relative valuation, which aims to correlate a company’s value with that of its competitors or industry peer group to assess the firm’s financial worthiness. The objective is to value an asset on the basis of how alike assets (guideline assets) are currently priced by the market. Consequently, there are two components to relative valuation. The first is that to value assets on a contingent basis, prices must be standardized, usually by transposition of prices into multiples of some common variable. This usually embodies earnings P/E (price to earnings) or P/Book Value (price to book value) or revenues for publicly traded stocks.

Every decision that a firm makes has financial implications, and any decision that affects the finances of a business is a corporate finance decision. These decisions may include financial analysis of pricing and product strategies, assessment of the financial payoff of creating and enlarging barriers to entry, such as in corporate strategy, evaluation and increases of the financial value of human capital and information for making better financial decisions, and operation or management of the financial consequences of production and operating decisions. For instance, the volume of cash that is invested in assets must be matched by an equal amount of cash raised by financing. When a firm sells mobile unit devices, the firm will generate cash, which is a basis for value creation. The purpose of the firm is to create value for the stakeholders. The value is reflected in a simple balance sheet model of the firm (Fig. 3).

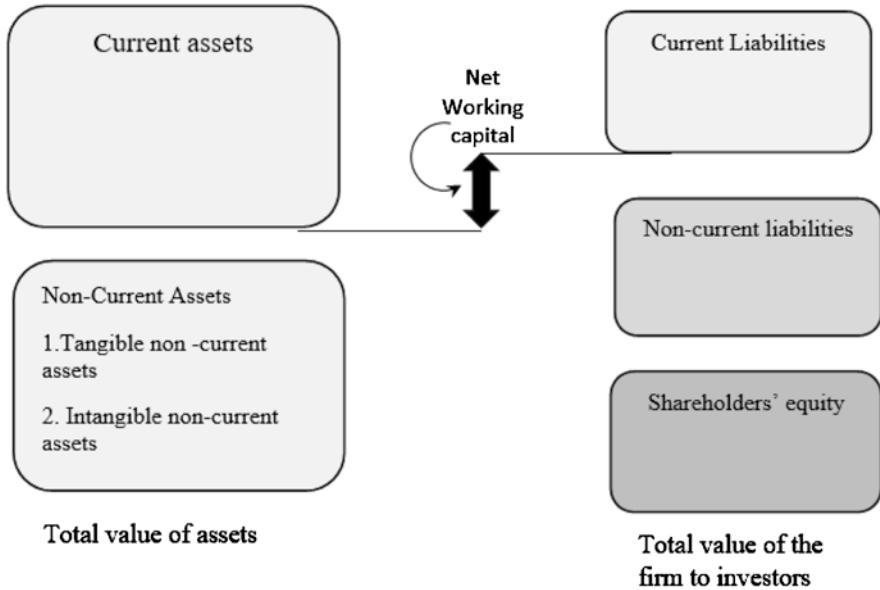


Fig. 3 Balance sheet model of a firm (McGraw Hills 2000)

2.6 Tobin's Q Ratio

This concept was first introduced by Nicholas Kaldor in 1966 in a paper titled “Marginal Productivity and the Macro-Economic Theories of Distribution: Comment on Samuelson and Modigliani” (Kaldor 1966). In 1977, James Tobin of Yale University (a Nobel laureate in economics) described it in two capacities and hypothesized that the combined market value of all companies on the stock market should be similar or equivalent to their replacement costs. The Q ratio is computed as the market value of a company divided by the replacement value of the firm's assets.

A low Q value ($1 > Q > 0$) means that the cost to replace a firm's assets is greater than the value of its stock. This implies that the stock is undervalued. Conversely, a high Q value greater than 1 denotes that a firm's stock is more costly than the replacement cost of its assets, which means that the stock is **overvalued**. This measure of stock **valuation** is the key factor in making an investment decision in the Tobin's Q model.

2.6.1 Q Ratio Formula and Example

The principle for Tobin's Q ratio considers the total market value of the firm and divides it by the overall total asset value of the company. Since the replacement costs of the total assets are difficult to estimate, another version of the formula is often used by analysts to estimate Tobin's Q ratio:

$$\text{Tobin's Q ratio} = \frac{(\text{Equity Market Value} + \text{Liabilities Market Value})}{(\text{Equity Book Value} + \text{Liabilities Book Value})}$$

Often, an assumption is made that the market value and the book value of a company's liabilities are equivalent. This simply translates this form of the Tobin's Q ratio into:

$$\text{Tobin's Q ratio} = \text{Equity Market Value} / \text{Equity Book Value}$$

An undervalued company, with a Q ratio of <1 , would be attractive to corporate traders or potential purchasers, as they may want to purchase the firm instead of creating a similar-scale company. This would likely result in increasing interest in the company, which would make its stock price surge, and this would, in turn, increase its Tobin's Q ratio.

As for overvalued companies (those with a ratio higher than 1), they may see greater competition. A ratio higher than 1 indicates that a firm is earning a rate higher than its replacement cost, which would cause individuals or other companies to create similar types of businesses to capture some of the profits. This would lower the existing firm's market shares, shrink its market price, and cause its Tobin's Q ratio to drop.

2.7 Data Description, Research Design, and Methodology

In this study, our main aim was to understand whether CSR activities influenced a firm's value, so we set our hypothesis as follows:

Hypothesis: Do technology companies' corporate environmental, social, and governance activities have a significant influence on (or relationship to) their corporate financial performance on the basis of their industry group/region/country of domicile?

To determine whether the association between the response and each term in the model was statistically significant, we compared the p -value for the term with our significance level to assess the null hypothesis. The null hypothesis was that the term's coefficient was equal to 0, which would entail that there was no linkage between the term and the response. Usually, a significance level connoted as α or alpha of 0.05 would work fine. A significance level of 0.05 would indicate a 5% risk

of deriving a conclusion that a linkage existed when there was no real relationship (Minitab 2019).

P-value $\leq \alpha$: The association is statistically significant

If the *p*-value is less than or equal to the significance level, you can conclude that there is a statistically significant relationship between the response variable and the expressed term. (Minitab 2019)

P-value $> \alpha$: The association is not statistically significant

If the *p*-value is greater than the significance level, you cannot conclude that there is a statistically significant association between the response variable and the term. You may want to refit the model without the term.

If there are multiple predictors without a statistically significant association with the response, you can reduce the model by removing terms one at a time. (Minitab 2019)

If, during the multiple regression analysis, we obtained a *p*-value of <0.1 , it would consequently mean a high probability that there was a significant relationship. Then, to redeem whether there was a positive or negative relationship, we would obtain the R^2 (correlation coefficient squared) value, which should usually be above 80%. Conversely, a larger (nonsignificant) *p*-value would indicate that the difference in the predictors was not related to changes in the response *Y*.

If (and only if) there was a significant CSR–CFP relationship, we would then need to dive deep and check which of the specific ESG pillar versus CSR data points/activities consequently had a significant influence in technology companies, using the same regression method, to determine whether there was heterogeneity between firms?

To analyze our hypothesis and later verify CSR heterogeneity in addition to our CSR contingency perspective discussion in our review of the literature, we would be looking for two dependent variables: the Tobin's *Q* value and the price-to-earnings ratio (PER) value. We would be comparing each controlled variable (the industry group, the region, and the country (C1, C2, and C3) where the companies were located), added as a categorical variable (control parameter).

The relationships between X1, X2, X3, C1, C2, C3, and Y1 or Y2 variables were tested quantitatively using Minitab statistical software, where:

X1 was the environmental score;

X2 was the social score;

X3 was the governance score;

Y1 was the Tobin's *Q* value;

Y2 was the PER (price-to-earnings ratio) value;

C1/C2/C3 was the industry/region/country, as a controlled categorical variable.

Depending on the outcome of our hypothesis, we planned to analyze whether there was a significant relationship between CSR and CFP in technology firms. We were interested to know which of the X variables would have the strongest relationship, and we then planned to do further regression analysis of the individual data points versus the most significant ESG score to identify the top CSR key drivers that could improve the firm values of technology companies.

2.7.1 Data Collection and Analysis with Minitab

We used statistical multiple regression to model the relationship between two or more variables (the environmental score, social score, and governance score), using the industry group, region, and country as categorical X variables and a response variable (Y1: Tobin's Q; Y2: PER).

Then we randomly collected sample items and recorded their X values, or we could only sample items with predetermined X values that we set beforehand. We collected a random sample of items that were representative of the process. The sample needed to be large enough to obtain a precise estimate of the strength of the relationship and to avoid normality issues. If the number of data points was small and the residuals were not normally distributed, the p -values used to determine whether there was a significant relationship between the X variables and Y might not be accurate. (Use of at least 15 data points is recommended in Minitab software.)

We needed to have sufficient data to be able to estimate all of the terms needed to construct a model that adequately described the relationship between the X variables and Y. If we had multiple X variables, our model would contain more terms, such as interaction terms and possibly quadratic terms, and might require more data. Also, small samples would not provide a very precise estimate of the strength of the relationship, which was measured by R^2 and the adjusted R^2 . If a precise estimate was desired, a larger sample size (typically, $n = 40$ or more) should be utilized. Minitab checked that the load of the data was large enough for our specific model. To detect time-related patterns in the data that might indicate problems with the regression model, we made sure that we entered the data in the Minitab worksheet in the same order and in the same format in which we collected it. Each data set needed to be complete, with all parameters being validated and verified before the analysis was run; this meant that no blank values should be fed into the analysis.

To test our hypothesis, we set a p -value $\alpha = 0.1$. Using $\alpha = 0.1$ made the procedure much more selective than the step-by-step procedure in core Minitab, which would use $\alpha = 0.15$.

R^2 was used to indicate how well the regression model fitted the data. Specifically, it measured how much of the variation in the response Y was explained by the X variables in the regression model. The higher the R^2 was, the better the regression model fitted the data (Minitab 2017).

In the second part of our study, if we found that there was a significant relationship or if our p -value was less than $\alpha = 0.1$, we would need to identify which of the independent variables or predictors X1, X2, X3 had an incremental impact in our final model and select one of the X1, X2, and X3 variables to further run a deeper analysis of the specific CSR data points or CSR activities under a given CSR pillar.

Therefore, we also introduced a variance inflation factor (VIF), which was used to estimate how much the variance of the coefficient was inflated as a result of the correlations among predictors in the model. The VIF was calculated by Minitab to determine how much multicollinearity (correlation between predictors) existed in the regression analysis. Multicollinearity would be problematic because it could

expand the variance of the regression coefficients, making it arduous to assess the individual impact that each of the correlated predictors had on the response.

$$VIF = 1 \div (1 - R^2(x1))$$

A VIF value larger than 5 would suggest that the regression coefficient was estimated poorly as a result of severe multicollinearity. The rule of thumb was to aim for $VIF = 1$ or $VIF < 5$. $VIF > 10$ would not be good for the model. The VIF quantified the severity of collinearity. It could pick up when a regressor was correlated with a linear combination of other regressors. It was the fraction of variance with collinearity versus variance without collinearity.

Our research covered the nine consecutive years between 2009 and 2017, with 293 observations (after data purification, removal of outliers, and exclusion of some companies that has missing data set in all parameters). ASSET4 contains extensive, objective, quantitative, and qualitative ESG data on almost 6000 global companies and scores them on four pillars. Research analysts have collected more than 600 data points per company since the 2002 fiscal year. However, only the fiscal years from 2009 onward were considered in our study, as we wished to minimize the potential effects of the global financial crisis and the European debt crisis in 2007 and 2008 (Williams and Cuaron 2010) on our model during the earlier fiscal years.

The Thomson Reuters ESG comprehensive model includes environment, social, and governance pillars. Under each pillar are ten categories: resource use, emissions, innovation, workforce, human rights, community, product responsibility, management, shareholders, and CSR strategy. More than 70 key performance indicators are calculated from data point values and are fully transparent back to the source documents. Therefore, these are trusted and comparable data sourced from publicly available information.

Use of the Thomson Reuters data set made our study unique or distinct in several ways: the large size of the sample, the comprehensive measurement of each dimension of CSR on the basis of multiple ratios, currency expressed in USD standard conversion of financial data, the transparency and objective measurements of the data points used by ASSET4 to obtain the score, and the comprehensive reference data points under each ESG pillar. It also allowed us to understand the interrelationships of the three variables with the industry group, region, and country of domicile/national framework as categorical controlled variables.

2.7.2 Mathematical Model

$$\text{Value}_i = \pm_0 + \pm_1 \text{Environmental Score}_i + \pm_2 \text{Social Score}_i + \pm_3 \text{Governance Score}_i + \sum_{j=1}^5 \pm_j \text{National}_{i,j} + \pm_4 \text{Economic}_i + \pm_5 \text{Market Cap}_i + \pm_6 \text{RoE}_i + \pm_7 \text{Sales Growth}_i + \mu_i, \mu_i$$

where:

$Value_i$ was the valuation proxy for sector i ;
 Environmental Score $_i$, Social Score $_i$, Governance Score $_i$, and Economic $_i$ were the scores (ranging from 0 to 100) for particular pillars of the Thomson Reuters ASSET4 CSR ranking;
 RoE_i was the return on equity;
 $Market\ Cap_i$ was the natural logarithm of market capitalization;
 $Sales\ Growth_i$ was the 1-year revenue growth;
 $Region_{i,j}$ denoted three dummy variables distinguishing the country of registration of the company between North America, Europe, and Asia (region was later substituted with two other categorical variables—such as industry group and country—This is to integrate the CSR contingent perspective elements, whether a relationship increases as the firm characteristic tend to be heterogeneous);
 ϵ_i was the residual (Daszyńska-Żygadło et al. 2016).

For Tobin's Q and the PER, we used the values provided by the Thomson Reuters DataStream database. Following Barth et al. (1998), we assumed that the firm's value was influenced by the firm's profitability, the firm's size, and the sales growth. To enhance the model's robustness, we used a complete set of those variables. The ROE was used as a measurement of the firm's profitability; the firm's size was defined as a logarithm of the market capitalization; the sales growth was defined as the 1-year revenue growth. Sales growth was used as a proxy for the expansion rate, and market capitalization was used as a proxy for the firm's ability to seize growth opportunities and its overall risk exposure. Since the host country's legal regulations might interfere with our results, we introduced the region as a control variable. On the basis of ordinary least squares (OLS) regression, we estimated two models, both with dependent variables: model 1, using the simplified Tobin's Q; and model 2, using the PER. Following Guenster et al. (2011), we used trimmed dependent variables in logs (this procedure ensured a limited effect of outliers). The trimming procedure eliminated potential outliers in the extreme left and right 0.5% of the distribution (Daszyńska-Żygadło et al. 2016).

2.8 Data Description and Analysis/Findings/Results

The Tobin's Q mark multiple regression analysis results showed a strong relationship, with a p -value significantly less than our α . For all three categorical variables (industry group, regional location, and country of domicile), all results were <0.001 , which confirmed that our X and Y variables were significantly associated; therefore, the null hypothesis was rejected.

Since the p -value results for our variables were less than the significance level (α), our sample data provided enough evidence to reject the null hypothesis for the entire population. Our data favored the hypothesis that there *was* a nonzero correlation. Changes in the independent variables X1, X2, and X3 *were* associated with changes in the response Y Tobin's Q at the population level.

The Tobin's Q mark multiple regression analysis results showed a strong relationship, with an R^2 correlation coefficient of 87.04% between the three variables X1 (the environmental score), X2 (the social score), and X3 (the governance score). Given the strong linear correlation results of the statistical analysis, a prediction model or multiple regression model equation could be used to predict future Tobin's Q variables if the three variables X1 (the environmental score), X2 (the social score), and X3 (the governance score) were available, within a constant categorical countries.

The Minitab analytical results also showed that the social score had a dominant impact in all three ESG pillars where there was an incremental increase in the R^2 . In all models, both with Tobin's Q mark and with the PER value, the social score contributed significantly in the regression model.

Table 1 summarizes the results of our regression analysis. On the basis of the table, both Tobin's Q and the PER value had a significant relationship versus the three ESG pillars. All p -values were <0.001 , which was much different from $\alpha = 0.10$. The degree of the relationship differed on the basis of the Minitab-derived correlation coefficient R^2 . Looking at the coefficient variation on the 8th column position—the values show the goodness of fit of the regression line to the sample observations that is the relationship strength expressed in R^2 . The firm value had a high relationship when the ESG pillars and Tobin's Q mark were categorized under the national framework or country of domicile.

The coefficient of variation in the regression models reduced as we expanded to a larger group such as region or industry group. This could consequently affirm and support the findings of Hoepner, Mitchell, and Barnett, and many other studies claiming that CSR activities indeed can be heterogeneous and are likely not homogeneous. In our study, we controlled industry, region, time, and national framework.

Furthermore, Y1 represented our Tobin's Q dependent variable under different categorization, using 293 sample data points. The Minitab multiple regression resulted in a significant relationship between X and Y regardless of categorization by country—national framework, region, and industry. However, the strength of this relationship between Tobin's Q versus ESG scores may vary or differ depending on the categorization. If we refer to the R^2 values in Table 1, there was a strong relationship between the Tobin's firm value and ESG if we included country as a categorical variable. This further validated the previously discussed contingency theory, in which the national framework is an important contributing factor in establishing the CSR–CFP link.

The Minitab regression analysis also showed the relative impacts on the overall coefficients of variation between the individual X1 (environmental), X2 (social), and X3 (governance) scores. For Tobin's Q with country categorization, the social pillar was the largest contributor in the regression, with 29.6%, meaning that any change in the social performance of the company within the national framework would have the biggest impact on CFP in comparison with governance activities and environmental activities. We could therefore conclude that if technology companies heavily increased their activities and investment in improving their social scores, this would consequently have much more positive impacts on their CFP. This

was in line with all other regression results, including the PER value regression analysis, where the social score consistently contributed the most to the final regression model. The social score had the largest incremental impact in increasing the R^2 . Any decrease in attention to social activities of technology companies could have a much more detrimental impact in comparison with the other CSR–ESG pillars.

The PER value multiple regression analysis results showed a moderate relationship with the R^2 correlation coefficient of 46% between the three variables X1 (the environmental score), X2 (the social score), and X3 (the governance score). Given the moderate linear correlation results of the statistical analysis, a prediction model or multiple regression model equation could not be used to predict future PER variables if the variables X1 (the environmental score), X2 (the social score), and X3 (the governance score) were available, and vice versa by categorical countries. Although the relationship was significant, with a p -value of <0.001 , a correlation coefficient of 46% might not be accurate enough and we would need to reconsider investigating the 13 residuals in the model that could have dramatically influenced the outcome of the PER overall regression model. It is therefore recommended to pursue further research regarding the PER regression model and why the regression R^2 is not as perfect as Tobin's Q model. As the two variables measure different parameters, there could be different interdependencies and the PER might not ultimately link to CSR in our case.

The Chart 1 shows the multiple regression model equation report for Tobin's Q.

This regression model included 12 countries where the headquarters of the technology companies were located. Each country had a different national framework and follows different regulations, with different social and political structures. Therefore, it was a perfect fit for the Tobin's Q regression model as we established our CSR–CFP link.

Chart 2 shows a summary report of the multiple regression for Tobin's Q mark by country. The regression result R^2 was 87.04%, which indicated that there was a *significant relationship* between the CSR–ESG pillar and CFP (Tobin's Q). The p -value (highlighted in dark blue in the chart) was <0.001 , confirming that our X and Y variables had a significant relationship.

Chart 3 shows the incremental impact of the X variables. The long bars represent X variables that contributed the newest information to the model. We knew from Table 1 that the social score was the most commonly dominant and influential X variable in all regression analyses; therefore, we took a further dive into the ASSET4 database, took the social score's individual category indicators, and ran a fit regression analysis to check which of the 38 indicators had a significant influence on the firm's overall social score.

In the second level of our study, we substituted the most dominant pillar (the overall social score) as our response Y and replaced our X variables with the 38 individual CSR–social activities scores from Thomson Reuters from the same data points of the 50 technology companies. We cleaned the data set and assigned each indicator as X1 to X38 variables in the regression equation:

X1: value—employment quality/policy (inactive); X2: employee satisfaction percentage;
X3: value—employment quality/salaries (inactive); X4: value—employment quality/sala-

**Multiple Regression for Tobin Q Mark
Model Equations Report**

X1: Environmental X2: Social Score X3: Corporate Go X4: Country of D

Country of Domicile	Final Equations
CANADA Tobin Q Market	= 2.546 - 0.00988 X1 - 0.0465 X2 + 0.02528 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
FINLAND Tobin Q Market	= 7.95 - 0.0164 X1 - 0.1009 X2 + 0.0265 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
FRANCE Tobin Q Market	= 2.147 + 0.00585 X1 - 0.05548 X2 + 0.02160 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
GERMANY Tobin Q Market	= 3.433 - 0.0127 X1 - 0.0723 X2 + 0.06344 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
HONG KONG Tobin Q Market	= 0.873 - 0.00823 X1 - 0.0247 X2 + 0.01846 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
JAPAN Tobin Q Market	= 3.079 - 0.01043 X1 - 0.06047 X2 + 0.04763 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
NETHERLANDS Tobin Q Market	= 2.030 + 0.0360 X1 - 0.0630 X2 + 0.0010 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
RUSSIAN FEDERATIO Tobin Q Market	= -0.467 - 0.0169 X1 - 0.0459 X2 + 0.0641 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
SINGAPORE Tobin Q Market	= 0.681 - 0.0038 X1 - 0.0164 X2 + 0.01439 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
SOUTH KOREA Tobin Q Market	= 3.526 - 0.00194 X1 - 0.07558 X2 + 0.03322 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
SWEDEN Tobin Q Market	= 1.499 - 0.01038 X1 - 0.03996 X2 + 0.03119 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3
UNITED STATES Tobin Q Market	= 1.150 + 0.00897 X1 - 0.04869 X2 + 0.02629 X3 + 0.000264 X1^2 + 0.000938 X2^2 - 0.000716 X1*X2 + 0.000279 X1*X3 - 0.000629 X2*X3

Chart 1 Model equation report: multiple regression for Tobin’s Q mark by country

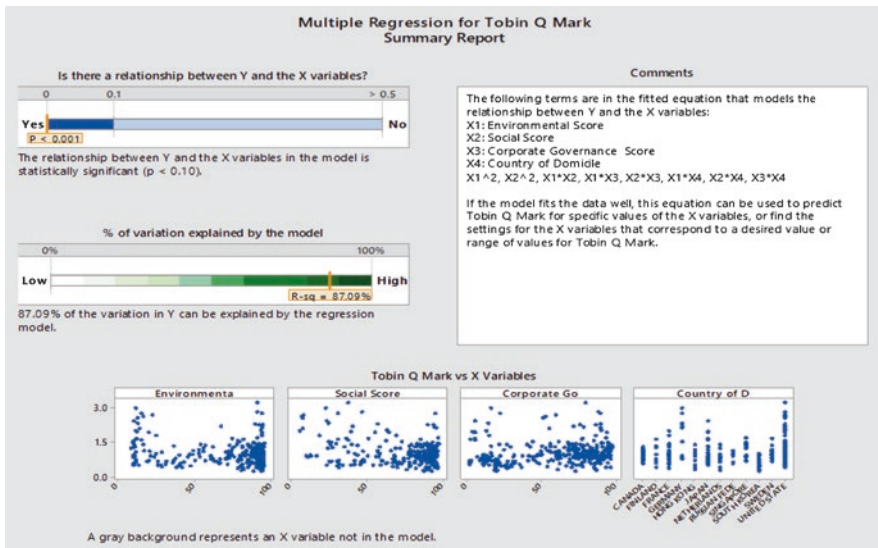


Chart 2 Summary report: multiple regression for Tobin’s Q mark by country

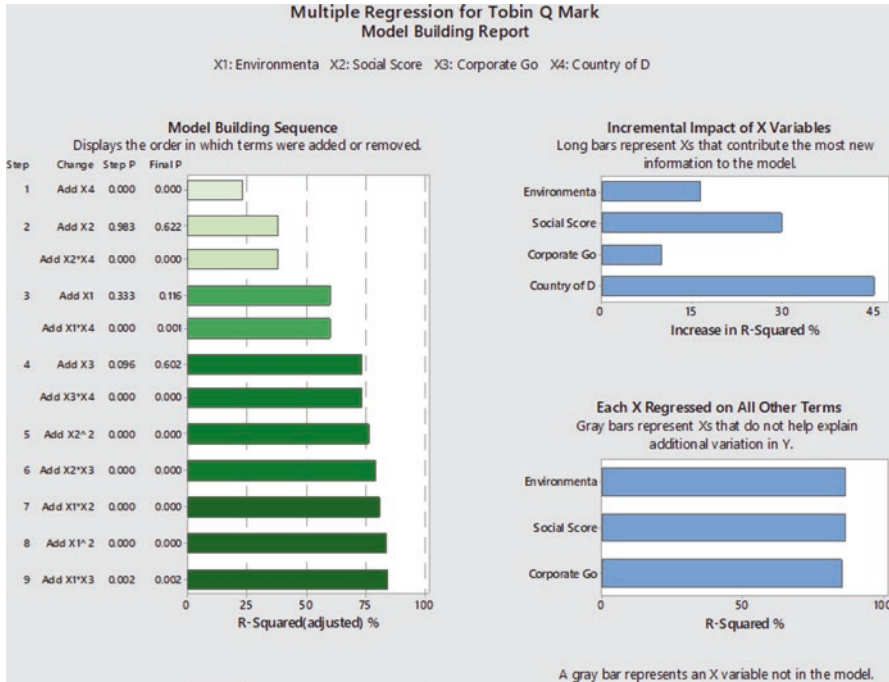


Chart 3 Model-building report: multiple regression for Tobin’s Q mark by country

ries distribution (inactive); X5: bonus plan for employees/employees (inactive); X6: generous fringe benefits (inactive); X7: value—employment quality/employment awards (inactive); X8: trade union representation; X9: employees leaving (inactive); X10: turnover of employees; X11: total injury rate; X12: lost time injury rate; X13: lost working days; X14: HIV–AIDS program; X15: value—training and development/policy; X16: average training hours; X17: training cost total; X18: internal promotion; X19: management training; X20: value—diversity and opportunity/policy (inactive); X21: women employees; X22: women managers; X23: positive discrimination (inactive); X24: flexible working schemes; X25: day care services; X26: value—human rights/policy; X27: human rights suppliers; X28: human rights breaches suppliers; X29: value—community/policy (inactive); X30: donations total; X31: cash donations (inactive); X32: in-kind donations (inactive); X33: donations (inactive); X34: crisis management systems; X35: value—product responsibility/policy (inactive); X36: customer satisfaction percentage; X37: product access low price; X38: healthy food or products.

The final social score versus categorical indicators regression analysis model showed a correlation coefficient R^2 of 96.54% and a p -value of <0.001, affirming the very strong relationship and interaction of each of the 38 indicators with the social score pillar (Chart 4).

Table 2 summarizes the fit multiple regression analysis of the overall social score fitted versus the 38 social score indicators. The ranking was based on the analytical

Regression Equation

Social Score = -25.68 - 4.51 Value - Employment Quality/Poli + 0.0172 Employee Satisfaction Percentag + 0.000020 Value - Employment Quality/Sala + 1.37 Value - Employment Quality/Sa_1 + 6.32 Bonus Plan for Employ.nees/Empl + 4.18 Generous Fringe Benefits (Inact - 2.21 Value - Employment Quality/Empl + 0.0509 Trade Union Representation + 0.000086 Employees Leaving (Inactive) - 0.027 Turnover of Employees - 0.232 Total Injury Rate + 0.061 Lost Time Injury Rate + 0.00319 Lost Working Days + 2.91 HIV-AIDS Program + 28.17 Value - Training and Developmen - 0.0003 Average Training Hours + 0.000000 Training Costs Total + 1.15 Internal Promotion + 0.00 Management Training + 26.74 Value - Diversity and Opportuni + 0.3343 Women Employees - 0.0274 Women Managers + 2.60 Positive Discrimination (Inacti - 1.85 Flexible Working Schemes - 3.08 Day Care Services + 12.74 Value - Human Rights/Policy + 2.06 Human Rights Suppliers - 0.48 Human Rights Breaches Suppliers + 20.74 Value - Community/Policy (Inact - 0.000000 Donations Total - 0.000000 Cash Donations (Inactive) + 0.000000 In-Kind Donations (Inactive) - 10.03 Donations (Inactive) + 2.82 Crisis Management Systems + 15.78 Value - Product Responsibility/ + 0.0379 Customer Satisfaction Percentag + 4.06 Product Access Low Price - 6.52 Healthy Food or Products

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
4.18032	96.54%	95.31%	92.88%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-25.68	5.14	-5.00	0.000	
Value - Employment Quality/Poli	-4.51	2.33	-1.94	0.055	4.91
Employee Satisfaction Percentag	0.0172	0.0186	0.92	0.358	3.94
Value - Employment Quality/Sala	0.000020	0.000011	1.90	0.061	3.14
Value - Employment Quality/Sa_1	1.37	4.21	0.33	0.745	3.92
Bonus Plan for Employ.nees/Empl	6.32	2.35	2.69	0.008	6.54
Generous Fringe Benefits (Inact	4.18	1.77	2.37	0.020	3.46
Value - Employment Quality/Empl	-2.21	1.24	-1.79	0.076	2.46
Trade Union Representation	0.0509	0.0209	2.44	0.016	4.27
Employees Leaving (Inactive)	0.000086	0.000153	0.56	0.574	8.13
Turnover of Employees	-0.027	0.130	-0.21	0.837	7.29
Total Injury Rate	-0.232	0.504	-0.46	0.646	3.02
Lost Time Injury Rate	0.061	0.408	0.15	0.882	2.60
Lost Working Days	0.00319	0.00191	1.67	0.098	1.67
HIV-AIDS Program	2.91	1.39	2.10	0.038	3.04
Value - Training and Developmen	28.17	4.23	6.65	0.000	10.43
Average Training Hours	-0.0003	0.0246	-0.01	0.991	4.14
Training Costs Total	0.000000	0.000000	0.39	0.698	6.78
Internal Promotion	1.15	1.34	0.85	0.395	3.33

Chart 4 Regression analysis: social score versus X1 to X38 indicators by technology company

Table 2 Minitab fit multiple regression analysis of the overall social score fitted versus 38 social score indicators

P Value Results of Social Pillar Score vs Categories/Indicators			
Term	P-Value	VIF	Color Coding
Constant	0	0	
Value – Training and Development	0	10.43	p-value:
Value – Diversity and Opportunity	0	4.34	Green: < 0.05 (has significant Relationship between X & Y variables)
Women Employees	0	4.6	Yellow: >0.05 < 0.1 (Moderate Relationship between X & Y variables)
Value – Human Rights/Policy	0	4.38	Red: >0.1 (has no significant relationship between X & Y variable)
Cash Donations (Inactive)	0	3.3	
Value – Community/Policy (Inactive)	0.001	3.84	VIF value:
Product Access Low Price	0.004	3.58	Green: =1 or <5 (Low severity on multicollinearity issues)
Bonus Plan for Employees/EmpI	0.008	6.54	Yellow: > 5, <10 (Moderate severity on multicollinearity issues)
Value - Product Responsibility	0.01	6.06	Red: ≥10 (Severe multicollinearity issues) Risk of high error.
Customer Satisfaction Percentage	0.013	2.34	
Trade Union Representation	0.016	4.27	
Generous Fringe Benefits (Inactive)	0.02	3.46	
Day Care Services	0.02	3.29	
Donations Total	0.037	6.94	
HIV-AIDS Program	0.038	3.04	
Crisis Management Systems	0.047	2.95	
Value - Employment Quality/Policy	0.055	4.91	
Donations (Inactive)	0.059	9.08	
Value - Employment Quality/Sala	0.061	3.14	
Value - Employment Quality/EmpI	0.076	2.46	
Healthy Food or Products	0.088	1.62	
Positive Discrimination (Inactive)	0.095	4.11	
Lost Working Days	0.098	1.67	
Human Rights Suppliers	0.235	4.52	
Flexible Working Schemes	0.337	6.69	
Employee Satisfaction Percentage	0.358	3.94	
Internal Promotion	0.395	3.33	
In-Kind Donations (Inactive)	0.421	2	
Employees Leaving (Inactive)	0.574	8.13	
Women Managers	0.603	3.2	
Total Injury Rate	0.646	3.02	
Training Costs Total	0.698	6.78	
Value - Employment Quality/Sa_1	0.745	3.92	
Human Rights Breaches Suppliers	0.764	3.8	
Turnover of Employees	0.837	7.29	
Lost Time Injury Rate	0.882	2.6	
Average Training Hours	0.991	4.14	
Management Training	1	4.2	

result of the p -value difference versus our $\alpha = 0.10$. Since we used several variables, in the third column, we also had to consider the VIF result (the variable inflation factor) of the social score pillar’s regression model. As we explained earlier, the VIF quantified the severity of collinearity. It could pick up when a regressor was correlated with a linear combination of other regressors. In other words, the greater the VIF value was, the less reliable the regression results would be. We therefore concluded that value—training and development is critically important, as the p -value was <0.001; hence, a relationship to the social score exists. However, given its high VIF result, even if it was significant in terms of the X–Y relationship, the regression result for value—training and development might not be fully reliable.

On a positive note, value—diversity and opportunity had a very low p -value of <0.001 and a VIF value of less than 5; therefore, it perfectly fitted our regression model and could be used as a key driver to improve the social score, similarly to the other indicators highlighted items in green in the first column of Table 2. We also concluded that for technology firms that were start-up companies and would like to implement CSR in their organizations, they could start to prioritize the 16 activities listed as factors to significantly step up their social scores and consequently gain higher social scores in technology firms, to significantly influence the firms' values. They could then continue to develop their CSR activities so that all three pillars—environmental, social, and governance—had a significant influence on the firms' values, and the regression itself was derived not just from one variable but from a collective result of the three CSR pillars.

As our study covered only three industries and 12 countries, it is recommended that future studies look at other technology industry groups and include other countries/national frameworks, which might demonstrate different behavior. In addition, future studies could investigate the key driver or other indicators under the other two pillars (the environmental and governance pillars) to better understand synergy effects of CSR activities on firms' values (Chart 5, 6 and 7).

As the sample size was large enough with 293 data points, with a minimal number of residuals, the estimation of the relationship was precise enough. Since there were more than 15 data points, normality was not an issue. The large cluster for the

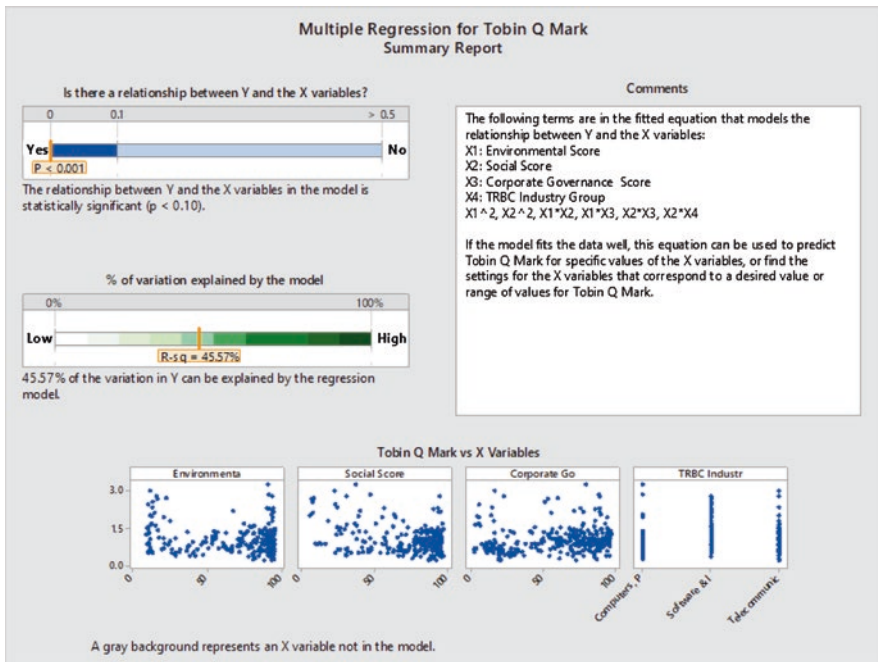


Chart 5 Summary report: multiple regression for Tobin's Q mark by industry. The Tobin's Q-ESG pillar relationship was significant, with a p -value of <0.001 , and the R^2 coefficient of variation was equal to 45.57%, which was moderate. Please see the green horizontal bar graph where the position of R^2 coefficient of variation is indicated by the orange line at 45.57%

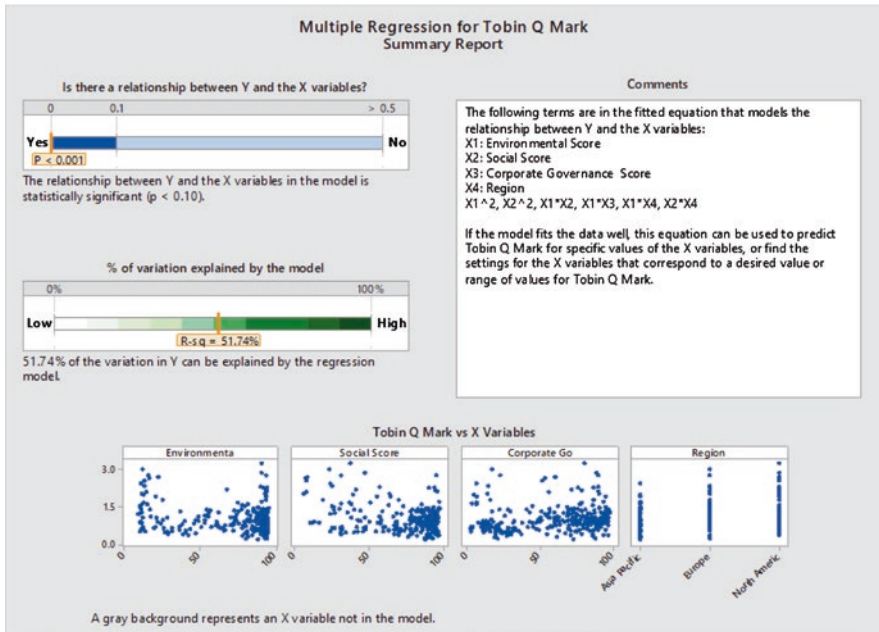


Chart 6 Summary report: multiple regression for Tobin’s Q mark by region
 The Tobin’s Q mark–ESG pillar relationship was significant, with a p -value of <0.001 , and the R^2 coefficient of variation was equal to 51.74%, which is moderate. Please see the green horizontal bar graph where the position of R^2 coefficient of variation is indicated by the orange line at 51.74%.

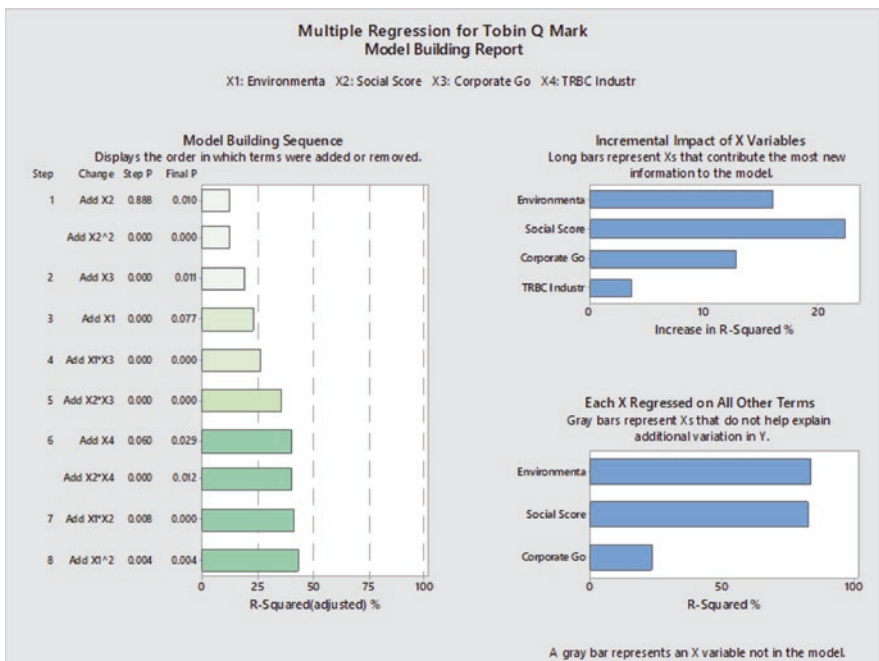


Chart 7 Model-building report: multiple regression for Tobin’s Q mark by industry group
 (The social score had the largest incremental impact, contributing the most new information to the model.) (Chart 8)

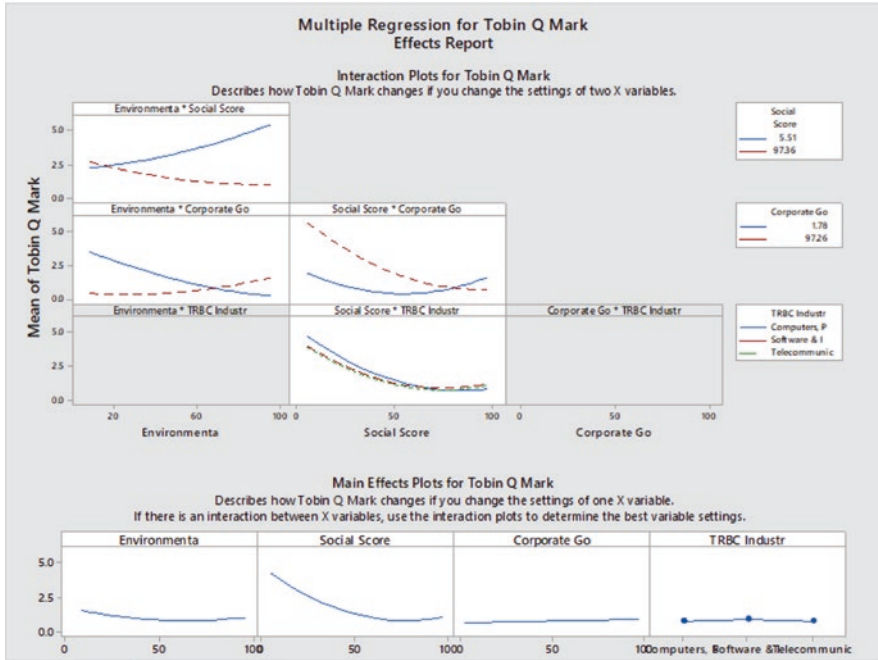


Chart 8 Effect report: multiple regression for Tobin’s Q mark by industry group

In Chart 8, we observed the effects and interaction for Tobin’s Q mark and how it changed if we changed two X variables. A lower social score consequently resulted in a lower Tobin’s Q value. The social and corporate governance scores overlapped at a Tobin’s Q score between 0 and 2.5. Opposite effects happened for the environmental score versus the corporate governance score. There was an interaction between the three industry groups (computers, software, and telecommunications) (Chart 9 and 10).

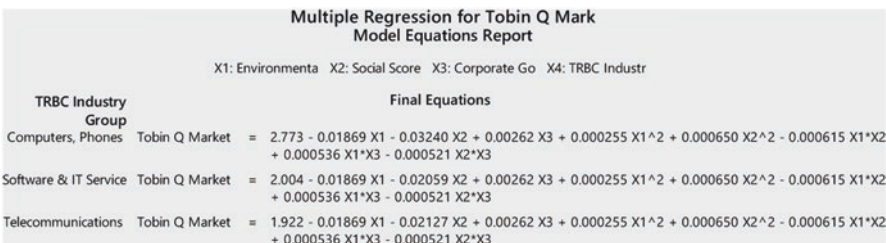


Chart 9 Model equation report: multiple regression for Tobin’s Q mark by industry group

Tobin’s Q mark was concentrated at a Tobin’s Q value equal to 1. The chart was quite dispersed and random. There were a few residuals in the model, which could have been the reason why the R^2 was not perfectly linear and was not equal to 99.9%. Further research is necessary to understand the reason for each residual and if those should be included in or removed from the model, which is a subject for future studies to build the perfect model.

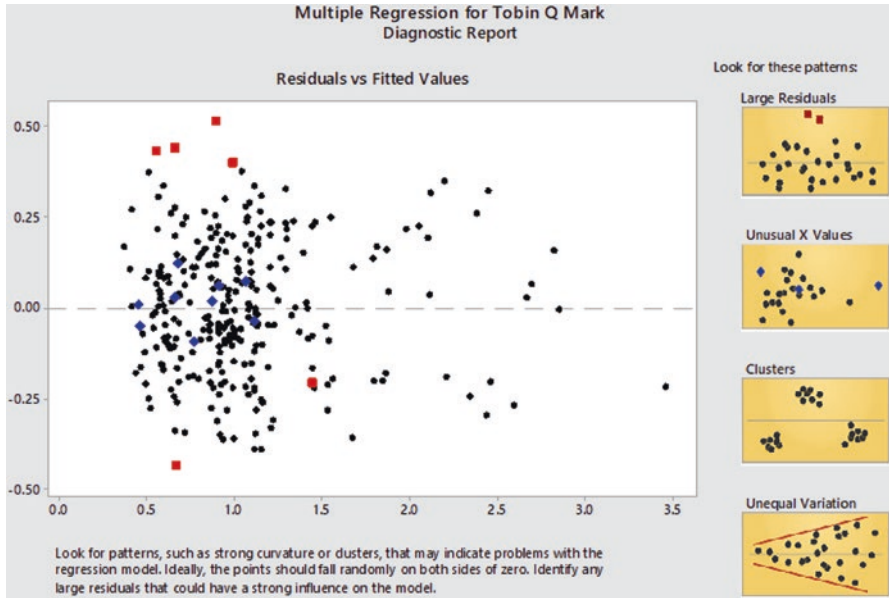


Chart 10 Diagnostic report: multiple regression for Tobin’s Q mark by country

3 Discussion and Conclusion

A total of 293 data points were used and collected for analysis. Multiple regression analyses were run using Minitab v18 software. Hypothesis testing was done using Tobin’s Q mark as output Y with three variables: X1 (the environmental score), X2 (the social score), and X3 (the governance score). Multiple regressions were used to test the hypothesis as to whether there was a significant relationship between the Y and X variables, first using C1 (the industry group) categorical controlled variables, then C2 (the region) categorical variables, and, finally, since the national framework had a large influence on our CSR–CFP link, we substituted C3 (the country of domicile) of each technology firm.

The Tobin’s Q mark multiple regression analysis results showed a strong relationship, with a *p*-value significantly less than our α value. For all three categorical variables (industry group, regional location, and country of domicile), all results were <0.001 , which confirmed that our X and Y variables were significantly associated; therefore, the null hypothesis was rejected. Since the *p*-value result for our variables was less than the significance level (α), our sample data provided enough evidence to reject the null hypothesis for the entire population. Our data favored the hypothesis that there was a nonzero correlation. Changes in the independent variables X1, X2, and X3 were associated with changes in the response Y Tobin’s Q at the population level.

As we mentioned in the results section, the Tobin's Q mark multiple regression analysis results showed a strong relationship with the R^2 correlation coefficient of 87.04% between the three variables X1 (the environmental score), X2 (the social score), and X3 (the governance score). Given the strong linear correlation results of the statistical analysis, a prediction model or multiple regression model equation could be used to predict a future Tobin's Q variable if the three variables X1 (the environmental score), X2 (the social score), and X3 (the governance score) were available, and vice versa by categorical countries.

The Minitab analytical results also showed that the social score had a dominant impact on all three ESG pillars where there was an incremental increase in the R^2 . In all models, with both Tobin's Q mark and the PER value, the social score contributed significantly in the regression model.

4 Summary and Future Recommendations

The hypothesis for our study was:

Do technology companies' corporate environmental, social, and governance activities have a significant influence on (or relationship to) their corporate financial performance on the basis of their industry group/region/country of domicile?

The Tobin's Q mark by country regression result R^2 was 87.04%, which indicated that there was a significant relationship between the CSR–ESG pillar and CFP (Tobin's Q). The p -value (highlighted in dark blue in Chart 2) was <0.001 , confirming that our X and Y variables had a significant relationship.

According to our findings, we observed that the value of companies did not increase as a direct influence of environmental, social, or governance activities individually but did increase with an amalgamation of all three pillars assessed categorically on the bases of country, region, and industry classifications, and this was dependent on the firm's characteristics. In general, not all CSR components might have the same degree of significant impact on technology firms, which might depend on the national framework and firm characteristics. The key takeaway from this assessment was that investment in CSR is not only good for benignity with customers and consumers; it can also help amplify a firm's share value, specifically for individual firms in each national market, which has its own individual levels of products and services, with different stakeholders. Our recommendation to these companies is to improve their social, governance, and environmental aspects (in this order of priority) and extend their CSR reach not just at the global–regional level but also within their national framework. Technology firms should pay attention to diversity and opportunity, women employees, human rights, cash donations, community, product access low price, bonus plan for employees, product responsibility, customer satisfaction percentage, trade union representation, crisis management systems, and employment quality in their organization, in order of significance, versus improving their overall CSP scores, and use them as key drivers to influence

firm valuation growth if they are starting their CSR activities. It is recommended to further explore the contributing factors under the environment and governance pillars, as there are potential activities that could relatively influence the overall CSR performance of the company greatly.

References

- Aupperle KE, Carroll AB, Hatfield JD (1985) An empirical examination of the relationship between corporate social responsibility and profitability. *Acad Manag J* 28:446–463
- Allouche J, Laroche P (2005) A meta-analytical investigation of the relationship between corporate social and financial performance. *Revue de Gestion des Ressources Humaines* 57(3):18–41
- Barnett ML (2007) Stakeholder influence capacity and the variability of financial returns to corporate social responsibility. *Acad Manag Rev* 32(3):794–816
- Barnett ML, Salomon RM (2006) Beyond dichotomy: the curvilinear relationship between social responsibility and financial performance. *Strateg Manag J* 27(11):1101–1122
- Barth ME, Beaver WH, Landsman WR (1998) Relative valuation roles of equity book value and net income as a function of financial health. *Journal of Accounting and Economics* 25(1):1–34
- Cho SJ, Chung CY, Young J (2019) Study on the relationship between CSR and financial performance. *Sustain For* 11(2):343. <https://doi.org/10.3390/su11020343>
- Clark GL, Salo J, Hebb T (2008) Social and environmental shareholder activism in the public spotlight: US corporate annual meetings, campaign strategies, and environmental performance, 2001–2004. *Environ Planning A* 40(6):1370–1390
- Daszyńska-Żygadło K, Słoński T, Zawadzki BM (2016) The market value of CSR performance across sectors. *Eng Econ* 27(2):230–238. <https://doi.org/10.5755/j01.ee.27.2.13480>
- Fombrun CJ, Gardberg NA, Barnett ML (2000) Opportunity platforms and safety nets: corporate citizenship and reputational risk. *Bus Soc Rev* 105(1):85–106
- Gardberg NA, Fombrun CJ (2006) Corporate citizenship: creating intangible assets across institutional environments. *Acad Manag Rev* 31(2):329–346
- Godfrey PC (2005) The relationship between corporate philanthropy and shareholder wealth: a risk management perspective. *Acad Manag Rev* 30(4):777–798
- Godfrey PC, Hatch NW (2007) Researching corporate social responsibility: an agenda for the 21st century. *J Bus Ethics* 70(1):87–98
- Guenster N, Bauer B, Derwall J, Koedijk K (2011) The Economic Value of Corporate Eco-Efficiency. *European Financial Management* 17(4):679–704
- Słoński T, Ilbasmis G (2020) Corporate social responsibility activities and the firm's value: the case of containers and packaging industry sector. In: Daszyńska-Żygadło K, Bem A, Ryszawska B, Jáki E, Hajdúková T (eds) *Finance and sustainability*. Springer, Cham, pp 335–347. https://doi.org/10.1007/978-3-030-34401-6_27
- Hart SL, Christensen CM (2002) The great leap: driving innovation from the base of the pyramid. *MIT Sloan Manag Rev* 44(1):51
- Hart SL (1995) A natural-resource-based view of the firm. *Acad Manag Rev* 20(4):986–1014
- Hoepner AG, Yu PS, Ferguson J (2010) Corporate social responsibility across industries: when can who do well by doing good? *SSRN Electron J*. <https://doi.org/10.2139/ssrn.1284703>.
- International Organization for Standardization (2010) ISO 26000:2010: guidance on social responsibility [pp 1–5, clause 2:18, clause 3.3.5]. Geneva: International Organization for Standardization. <https://www.iso.org/iso-26000-social-responsibility.html>. Accessed
- Kaldor NC (1966) Marginal productivity and the macro-economic theories of distribution: comment on Samuelson and Modigliani. *Rev Econ Stud* 33(4):309–319
- Landrum S (2017) <https://www.forbes.com/sites/sarahlandrum/2017/03/17/millennials-driving-brands-to-practice-socially-responsible-marketing/?sh=19c2f84f4990>

- Mackey A, Mackey T, Barney J (2007) Corporate social responsibility and firm performance: investor preferences and corporate strategies. *Acad Manag Rev* 32(3):817–835
- Malik M (2015) Value-enhancing capabilities of CSR: a brief review of contemporary literature. *J Bus Ethics* 127(2):419–438
- Margolis JD, Elfenbein HA, Walsh JP (2007) Does it pay to be good? An analysis and redirection of research on the relationship between corporate social and financial performance [working paper]. Harvard University, Cambridge
- Matten, D., Moon, J. (2008) “Implicit” and “explicit” CSR: a conceptual framework for a comparative understanding of corporate social responsibility. *Acad Manag Rev*, 33 (2): 404–424.
- McGraw Hill (2000) Introduction to Corporate Finance Textbook, Chapter 1, Online Version <https://www.mheducation.co.uk/he/chapters/9780077121150.pdf>
- Minitab (2000) Minitab statistical software, release 13. Minitab, State College
- Minitab (2017) Multiple regression [Minitab Assistant white paper]. State College: Minitab.
- Minitab (2019) Minitab 18 support. Variance inflation factor. <https://it.minitab.com/en-us/search/default.aspx>. Accessed
- Orlitzky M, Schmidt FL, Rynes SL (2003) Corporate social and financial performance: a meta-analysis. *Organ Stud* 24(3):403–441
- Rasche, A., Waddock, S., McIntosh, M. (2013) The United Nations global compact: retrospect and prospect. *Bus Soc*, 52(1): 6–30.
- Rowley TJ (1997) Moving beyond dyadic ties: a network theory of stakeholder influences. *Acad Manag Rev* 22(4):887–910
- Rowley T, Berman S (2000) A brand new brand of corporate social performance. *Bus Soc* 39(4):397–418
- Schäfer H, Beer J, Zenker, J., Fernandes P (2006) Who is who in corporate social responsibility rating? A survey of internationally established rating systems that measure corporate responsibility. Bertelsmann Foundation, Gütersloh
- Daniel, J. (2013) Shell, Glencore, and other multinationals dominate their home economies: some corporate giants’ revenues are massive in relation to their countries’ GDP. *Bloomberg Businessweek*. <https://www.bloomberg.com/news/articles/2013-04-04/shell-glencore-and-other-multinationals-dominate-their-home-economies>. Accessed
- Ullmann AA (1985) Data in search of a theory: a critical examination of the relationships among social performance, social disclosure, and economic performance of US firms. *Acad Manag Rev* 10(3):540–557
- Williams M, Cuaron A (2010) *Uncontrolled risk: lessons of Lehman Brothers and how systemic risk can still bring down the world financial system (general finance & investing)*. McGraw-Hill, New York

Innovative Public Procurement: An Analysis of Surveys Conducted Among Contractors in Poland and the UK



Ma. Mateusz Halka 

1 Introduction

The use of public procurement (PP) as an instrument to stimulate growth of private sector innovativeness is increasingly debated, especially in the context of demand-oriented innovation policies in particular Member States of the European Union (European Parliament and the Council 2014). The participants of such debates agree that the process of spending public funds through PP can be oriented towards achieving several objectives simultaneously. The primary objective is to acquire a PP contract, while secondary effects may consist in developing mechanisms to support socially and economically important tasks (Rolfstam 2009).

Public procurement law offers tools that can be skilfully used to achieve innovative outcomes of public procurement. These solutions may involve many aspects of the procedure of awarding a PP contract, such as the appropriately specified requirements in the description of the subject of the contract, the use of non-price criteria for evaluating the tender, the use of appropriate procedure (particularly one based on negotiation) and the use of technical dialogue (The Act of 29 January 2004). All these factors depend on the decision and action of the contracting authority. The contractor, on the other hand, may achieve an innovative solution as a result of their own research and development activity or as a result of the purchase. It is possible to acquire knowledge and technology, purchase equipment, software or services (Ziarniak 2016).

The issue of innovativeness in public procurement is a relatively new concept and requires plenty of research. The majority of studies focus on the supply side of a contract, considering in detail the perspective of the contracting authority or

M. M. Halka (✉)
Maria Curie-Skłodowska University, Lublin, Poland
e-mail: mateusz.halka@poczta.umcs.lublin.pl

describing the current and planned legal solutions. Very few studies address the issue of contractors' innovativeness, especially in the context of the functioning of the public procurement market.

The aim of this study is to attempt to characterise factors resulting from procedures, competition and the very mechanisms of the functioning of public procurement, which may affect the potential and innovative capacity of companies potentially performing a public procurement contract. For this purpose, logistic regression models, developed for the purpose of another study, will be presented. These are based on the results of surveys conducted on groups of contractors from Poland and the UK.

The study is based on the Polish and EU legislation, the subject literature, the reports of the Public Procurement Office and the results of the analyses of logistic regression models carried out for Poland and Great Britain.

2 Innovativeness in the Polish Public Procurement System: Current State

Data on the functioning of innovative public procurement (IPP) in Poland are presented in the annual reports of the Public Procurement Office (PPO [2017](#), [2018](#), [2019](#)) only since mid-2016, when the public procurement law was amended, obliging the contracting authorities to inform the PPO about the proceedings on innovative public procurement (The Act of 16 December [2016](#)). It is worth noting that data on innovative public procurement is published in the same category together with green public procurement. Information on the number and value of such contracts in comparison with total contracts is presented in [Table 1](#).

As can be seen from [Table 1](#), the volume and value of the whole market, including contracts taking into account environmental and innovative aspects, are characterised by a significant increase over the period considered. However, the percentage

Table 1 Data on the number and value (in billion PLN) of total public procurement contracts awarded and the number of green and innovative procurement contracts awarded

Description	2016 ^a	2017	2018
Number of public procurement contracts completed during the year (total)	129,776.00	139,133.00	143,881.00
Value of (total) public procurement contracts completed during the year (in billion PLN)	107.40	163.20	202.10
Number of public procurement contracts taking into account environmental or innovative aspects	646.00	1212.00	1469.00
Value of public procurement contracts taking into account environmental or innovative aspects (in billion PLN)	n.d.a. ^b	3.23	9.83

Source: Own study based on the PPO ([2017](#), [2018](#), [2019](#))

^aData from 22.06.2016 to 31.12.2016

^bNo data in reports

Table 2 Number and value (in million PLN) of innovative public procurement contracts in Poland in years 2016–2018 in the statistics of the PPO

Description		2016 ^a	2017	2018
Public procurement contracts in which the description of the contract's subject refers to aspects related to innovativeness within the requirements related to the realisation of the contract	Number	12	20	27
	Value (in million PLN)	n.d.a. ^b	77.4	554.1
Public procurement contracts in which innovation-related aspects are taken into account in the criteria for evaluating tenders	Number	13	27	34
	Value (in million PLN)	n.d.a. ^b	116.6	562.7

Source: Own study based on the PPO (2017, 2018, 2019)

^aData from 22.06.2016 to 31.12.2016

^bNo data in reports

of innovative and ecological contracts compared to all contracts does not change significantly and oscillates around 1%. On the other hand, the share of the value of the discussed contracts increases from about 2% to 4.9%. This is due to the growing popularity of environmental and innovative initiatives, as well as financial support for so-called green contracts from numerous earmarked funds.

When analysing data on strictly innovative contracts, a narrow range of meaning should be applied. In its reports, the Public Procurement Office presents contracts in which innovativeness appears as a criterion for evaluation of a tender or as one of the elements required in the description of the contract subject. Details on this subject for the period 2016–2018 are presented in Table 2.

Based on Table 2, over the period considered, one can observe a growing interest in innovative public procurement contracts. This is particularly evident in the case of values of contracts. In 2018, compared to the previous year, the value of contracts characterised by innovative aspects in the description of the contract's subject increased more than sevenfold, while in the case of contracts where innovativeness was one of the criteria for evaluating tenders, this increase was almost fivefold. Due to data gaps and reporting only from mid-2016 onwards, only 2018 and 2017 can actually be compared.

3 Description of the Method Used

The analyses presented in this paper have been prepared on the basis of existing models built by teams of researchers from the University of Lodz and the University of Manchester. However, in order to properly interpret the results, the method, the assumptions and the characteristics of the variables have been described. The author's own study included justification of the method used, selection of models, comparative analysis of the data, interpretation of the results from the sources used and recommendations made.

When making a multidimensional assessment of the chances for engaging into, e.g. innovative activity by enterprises, the logistic regression model may be applied. The variable described in this process is in binary form – zero-one – and takes the value 1 in case of engaging into the described activity. Explanatory variables are both quantitative and qualitative (after conversion to zero-one variables) (Kufel 2011).

The symbol at the value of parameter (b) evaluates the direction of influence of the independent variable on the dependent variable. Positive values increase the probability of occurrence; negative values decrease the probability (Kufel, 2011). At the same time, the assessment of the significance of odds ratio ($\exp(b)$) allows to indicate which of the adopted factors significantly affect the chance of success – i.e. engaging into the analysed activity (e.g. innovative) by enterprises. Moreover, on the basis of odds ratio assessments, it is possible to indicate which of the factors have a stimulating effect and which of them have a destimulating effect on the probability of success. The chance quotient expresses a multiple of changes in the estimated probability under the influence of the increase of a given factor by a unit (with other assumptions remaining unchanged). As a result from this fact, the odds ratio greater than 1 indicates a stimulating effect of a given factor, whereas if $0 < \exp(B) < 1$, a destimulating effect of a given factor can be observed. It is also worth mentioning that the conclusions from the regression analysis concern the relations between the analysed variables. Therefore, the assessment of classification properties of the model and the assessment of matching were omitted (Bedyńska and Brzezicka 2007).

In the development of the models, factors considered statistically significant have been indicated in column p . The correlation is considered statistically significant if the test probability p is less than the assumed level of significance α . The symbol present in this column depended on the significance level of the factor and was applied as follows:

- “*” for the significance level α of 0.1
- “**” for the significance level α of 0.05
- “***” for the significance level α of 0.01

4 Data Sources and Methodology of Surveys Conducted Among Enterprises

4.1 Assumptions of the Surveys Conducted

From August to September 2011, a team of researchers from the University of Lodz conducted a survey among 685 enterprises (Starzyńska and Wiktorowicz 2012). The survey was conducted using the CAWI (computer-assisted web interviewing)

method, mainly among enterprises from the SME sector. The objectives of the survey were focused, among other things, on assessing the innovativeness of enterprises and the degree of their involvement in the public procurement market.

The tool for verifying the assumed objectives was a survey questionnaire, which consisted of 47 questions divided into thematic blocks assigned to the assumed objectives.

Another survey took place from May to July 2011 – it was conducted in Great Britain by a team of employees from the University of Manchester (Edquist et al. 2015). The survey was conducted among 788 company managers using the CATI (computer-assisted telephone interviewing) method. The objectives of the survey were focused, inter alia, on the issues of assessing the innovative activity of enterprises and identifying innovativeness barriers and stimulants for enterprises in the public procurement procedure.

By comparing the above-mentioned surveys, one can observe numerous similarities. Both surveys have a similar thematic scope, as well as a group of respondents. The timespan of the conducted surveys is also similar. However, the place of the survey and the structure of the sample are different. In the British survey, a greater participation of large companies (over 250 employees) and medium-sized companies (between 50 and 250 employees) is noticeable. On the other hand, in the survey conducted in Poland, small enterprises (10–29 employees) and microenterprises (less than 10 employees) are predominant. A significant number of common features in both surveys can be used to make a comparison between Poland and the UK in the characteristics of contractors in the public procurement market. A general description of the two surveys is presented in Table 3.

Table 3 General characteristics of the survey of employees of the University of Lodz and the University of Manchester

Description	Survey conducted by the employees of the University of Lodz	Survey conducted by the employees of the University of Manchester
Sample size	685 enterprises	788 enterprises
Territorial scope	Poland (nationwide survey)	UK (nationwide survey)
Period of the survey	August to September 2011	May to July 2011
Method of surveying	CAWI	CATI
General characteristics of the sample	4% – Large enterprises 20% – Medium enterprises 48% – Small enterprises 28% – Microenterprises	24% – Large enterprises 28% – Medium enterprises 37% – Small enterprises 11% – Microenterprises

Source: Own elaboration based on Starzyńska and Wiktorowicz (2012) and Edquist et al. (2015)

4.2 *Characteristics of the Variables Used in Modelling*

The respondents of these surveys were asked various questions. Most often these were close-ended questions with a predetermined set of answers. Some of the close-ended questions had a dichotomous (two-variant) form. Such questions give a binary set of possible answers, e.g. yes, 1, and no, 0. Other questions referred to the five-point Likert scale. Such questions were most often used to assess the agreement with a given statement, where 1 marked a strong objection to the statement and 5 marked full agreement. On this scale, “3” marks a neutral assessment in support of the submitted opinion.

When studying the impact of individual factors on the nature of the phenomenon, it is necessary to adequately prepare the variables used. If the variable to be described is written in the Likert scale, it may be necessary to switch to a binary type. Then, the values “4” (e.g. “I agree to some extent”) and “5” (“I fully agree”) should be assigned to variant “1” – an option that indicates the occurrence of the phenomenon. The remaining variants of the answers should be treated as “0” – the phenomenon does not occur. This technique is used for, e.g. logistic regression (Bedyńska and Brzezicka, 2007).

Based on a survey conducted by the University of Lodz, two models of logistic regression were used for the current analysis. As dependent variables (variables described by the model), the company’s participation in public procurement (model 1) and engagement in innovative activities by the company (model 2) were used. The dependent variables are dichotomous (zero-one). “1” means that the company participates in public procurement (model 1) or implements innovations (model 2). “0” should be understood as the opposite of these situations. The variables influencing the phenomenon (independent variables), on the other hand, were the characteristics of enterprises, due to individual characteristic features. In model 1, each of the influencing variables was used in a separate detailed model. This allowed to determine the significance of the different variants of the variable. The independent variables that were used in the survey of the University of Lodz are the following:

- Employment size (variants: small or microenterprises)
- Period of activity (quantitative variable given in years)
- Location (variable variants by the number of inhabitants in thousands)
- Revenue (variable variants by the annual revenue in million PLN)
- Main recipient (variants by the type of main recipient)
- Coverage (variants by company’s coverage)
- Capital structure (variants: domination of domestic capital; balanced structure; or domination of foreign capital)
- Innovation value (variants: below 500,000 PLN and 500,000 PLN and more)
- Number of proceedings in which the enterprise participated (quantitative variable)
- Staff responsible for public procurement (variants: one-person position, partial duties of one employee, external consultancy, own staff and external expertise)

Slightly different assumptions have been applied in the survey conducted at the University of Manchester. Many dichotomous dependent variables were used, which were built by transforming variables on the Likert scale. In order to maintain as high level of similarity as possible to the survey conducted by the team of scientists from Łódź, the author of the article chose only two variables, for which separate impact models were described. These variables are (Uyarra et al. 2014):

- Lack of cooperation with the contracting authority during the proceedings of a public procurement contract (“1”, if the attribute has been described as “significant” or “very significant”; otherwise, “0”) (model 3)
- Lack of innovative needs (“1”, if the attribute has been described as “significant” or “very significant”; otherwise, “0”) (model 4)

Certain company properties are listed as independent variables. These determine to which group a company falls into. Besides the size of the company, the main type of economic activity, *inter alia*, was taken into account. Based on the official UK classification (DCLG/PwC, 2006), the authors of the survey distinguished the following groups of activities: facilities management, professional/specialist services, IT and office equipment suppliers and providers of healthcare goods and services. Another type of variable was intended to classify whether the central administration is the main recipient of the enterprise’s activities. Variables that broadly describe the innovative activity of an enterprise were also used in the model. In this group there were commitment to R&D, introduction of product innovation in 2008–2010 and introduction of innovations in the services market in 2008–2010. Independent variables are listed below, together with a brief description of the possible response variants within the variable:

- Employment size (variants: large, medium, small and microenterprise).
- “Facilities management services” – a type of services related to the broadly understood service of facilities in companies. These services include cleaning services, waste management, security services and catering (zero-one variable: 1 means that the core business of the company falls within this group).
- Professional/specialist services – type of services requiring special licences, e.g. architectural services, legal services and medical services (zero-one variable: 1 means that the core business of the enterprise falls within this group).
- IT services and office services (zero-one variable: 1 if the company’s core activity falls within this group).
- Healthcare services (zero-one variable: 1 if the company’s core activity falls within this group).
- Central administration (zero-one variable: 1 if the company’s main public client is central administration).
- R&D (zero-one variable: 1 if the company carried out R&D activities in years 2008–2010).
- Product innovations (zero-one variable: 1 if the company introduced product innovation in years 2008–2010).

- Service innovations (zero-one variable: 1 if the company introduced service innovation in years 2008–2010).

4.3 Estimation of Models in the Survey

For the purpose of assessing the probability of enterprises' participation in public procurement, logistic regression equations were estimated, where the broadly understood potential of the enterprise was assumed as explanatory variables. When none of the variants of the explanatory variable was significant, the model was omitted. The results of the estimation for model 1 are presented in Table 4.

The following conclusions can be drawn from the results of model estimation:

- The probability of participating in public procurement contracts increases with the size of the company.
- The period of company's activity is a significant destimulant for participation in public procurement.
- The chances for the execution of the contract are related to the location of the company. In relation to the reference group, locating a company in a city of 100–500 thousand inhabitants increases the probability of participation in public procurement more than threefold.
- The probability of a company being included in public procurement increases with its turnover.
- Companies that are oriented towards cooperation with the public sector are more open to the execution of public procurement contracts.

The influence of particular factors on innovative activity of enterprises is also worth noting. On the basis of the results of the survey carried out by the employees of the University of Lodz, a model of logistic regression was created in order to determine which factors influence the engagement into innovative activities by enterprises (model 2). The analysis included employment size, location and participation of the company in public procurement and staff involved. Both models are based on the answers of the same group of respondents. The results of model 2 estimation are presented in Table 5.

On the basis of model 2, the following patterns can be observed:

- The size of employment has a significant impact on the level of innovativeness, and with the increase in the number of employees, the percentage of enterprises involved in innovative activity also increases.
- Companies with a specialised group of employees responsible for public procurement are more innovative than all other groups.
- The increase in the number of public procurement proceedings does not have a positive impact on the innovativeness of an enterprise.
- Locating an enterprise in larger cities increases the chance of engaging into an innovative activity.

Table 4 Influence of factors on participation in public procurement (model 1) – model estimation results (n = 656)

Model no.	Independent variable	Group	Parameter (b) value	exp(b)	p
1	Employment size (reference group – micro)	x	x	x	0.002 ***
		Small	0.531	1.701	0.006 ***
		Medium	0.791	2.206	0.001 ***
2	Period of the enterprise's activity	x	-0.015	0.985	0.016 **
3	Location (reference group – rural areas)	x	x	x	0.001 ***
		Town with up to 20,000 inhabitants	0.306	1.359	0.325
		Town with 20,000–50,000 inhabitants	0.965	2.625	0.004 ***
		City with 20,000–50,000 inhabitants	0.797	2.219	0.013 **
		City with 100,000–500,000 inhabitants	1.215	3.370	0.0***
		City with more than 500,000 inhabitants	0.519	1.680	0.073 *
4	Revenue (reference group – below 1.5 million PLN)	x	x	x	0.0***
		1.5–ten million PLN	0.751	2.118	0.0***
		10–30 million PLN	0.999	2.717	0.0***
		30–100 million PLN	1.586	4.882	0.002 ***
		More than 100 million PLN	1.553	4.724	0.154
5	Main recipient (reference group – individual customers)	x	x	x	0.0***
		Business clients	-0.096	0.909	0.706
		Public sector	2.895	18.088	0.0***
		Balanced portfolio	2.384	10.853	0.002 ***
6	Dominant coverage of activity (reference group – local coverage)	x	x	x	0.001 ***
		Regional coverage	0.567	1.764	0.081*
		Several neighbouring provinces (voivodeships)	0.207	1.230	0.634
		Nationwide coverage	-0.326	0.722	0.439
		International coverage	-2.414	0.089	0.0***
		Balanced	-0.486	0.615	0.174
7	Capital structure	Insignificant correlation			
8	Value of innovation (reference group: no investment in innovation in 2009)	x	x	x	0.0***
		Less than 500,000 PLN	1.183	3.263	0.0***
		500,000 PLN or more	-0.272	0.762	0.427

***p<0.01; **p<0.05; *p<0.10. Source: Own elaboration based on Kornecki et al. (2012)

Table 5 Influence of factors on innovativeness of enterprises – results of model 2 estimation (n = 656)

Independent variable	Group	Parameter (b) value	exp(b)	p
Employment size (reference group – micro)	x	x	x	0.008***
	Small	1.901	6.692	0.045**
	Medium	2.398	10.998	0.017**
	Large	6.523	680.518	0.001***
Location (reference group – rural areas)	x	x	x	0.001***
	Town with up to 20,000 inhabitants	-2.795	0.061	0.069*
	Town with 20,000–50,000 inhabitants	-1.531	0.216	0.253
	City with 20,000–50,000 inhabitants	-2.726	0.065	0.046**
	City with 100,000–500,000 inhabitants	-2.513	0.081	0.065
	City with more than 500,000 inhabitants	0.299	1.348	0.795
Staff responsible for public procurement (reference group – qualified team)	x	x	x	0.062*
	One-person position	-2.240	0.106	0.0***
	Partial responsibilities of one employee	-2.294	0.101	0.005***
	External consultancy	-22.058	0	0.999
	Own staff and external consultancy	-3.325	0.036	0.045**
Number of proceedings in which the enterprise participated		-0.011	0.989	0.005***
Const.		1.154	3.171	0.367

***p<0.01; **p<0.05; *p<0.10. Source: Own elaboration based on Borowicz et al. (2012)

A different approach has been presented in the British survey. While in the case of survey carried out in Poland, the investigated subject was the impact on the occurrence of the phenomenon, researchers from the University of Manchester focused on identifying barriers. The roles of the dependent variables are characterised by the following features: the existence of a barrier in relations with the contracting authority in public procurement (model 3) and the existence of a barrier in the form of lack of need for companies to engage in innovative activities (model 4). The independent variables are the same for both models and refer to different criteria for the classification of enterprises. Both models were created on the basis of the responses of the same group of respondents, which makes them comparable. The results of both models' estimation are presented in Table 6.

Based on the estimation of model 3, it can be concluded that the barrier of lack of integration with the contracting authority within the public procurement procedure appears most frequently in enterprises investing in R&D and enterprises introducing service innovations. The correlation with the employment size has also

Table 6 The results of the estimation of two logistic regression models describing the barrier of interaction between entities and the barrier of lack of innovative needs in public procurement (n = 787)

Independent variables	Model 3			Model 4		
	<i>b</i>	exp(<i>b</i>)	<i>p</i>	<i>b</i>	exp(<i>b</i>)	<i>p</i>
Employment size	0.098	1.103	0.054*	0.053	1.054	0.051*
Facilities management services	0.21	1.234	0.185	0.613	1.846	0.007***
Professional services	0.174	1.190	0.155	0.055	1.057	0.142
IT and office services	-0.135	0.874	0.204	-0.02	0.978	0.195
Healthcare	-0.096	0.908	0.169	0.150	1.162	0.157
Central administration	-0.108	0.898	0.087*	0.266	1.305	0.031**
R&D	0.345	1.412	0.001***	0.313	1.368	0.005***
Product innovations	-0.201	0.818	0.106	-0.20	0.816	0.048**
Service innovations	0.222	1.249	0.031**	0.031	1.031	0.096*
Const.	0.107	1.113	0.181	-0.15	0.856	0.173

****p*<0.01; ***p*<0.05; **p*<0.10. Source: Own elaboration based on Uyarra et al. (2014)

proved to be significant, which means that with the increase in employment, the barrier of non-cooperation with the contracting authority becomes a larger barrier in business activity. Model 4, on the other hand, indicates that the barrier of lack of innovative needs is most burdensome in enterprises engaged in R&D and in enterprises applying innovations in production and service sectors.

Moreover, one can observe an important correlation between the barriers and the enterprises performing public procurement contracts for the government administration. The impact of the employment size on the lack of innovation needs is also noticeable. This barrier has the strongest impact on the larger companies performing public procurement contracts.

When analysing the column exp(*b*), it can be observed that in both models, R&D activity strengthens the described barriers (exp(*b*) > 1). The situation is similar in terms of employment size and innovative service activities. On the other hand, the only statistically significant factors (exp(*b*) < 1) limiting the occurrence of barriers are the predominant share of central administration as the main recipient in model 3 and engaging in innovative activities in production in model 4.

5 Conclusion

Innovative public procurement is a promising, but still not very popular form of contracting. One of the reasons for this is the low innovative activity of contractors, especially in Poland. In the light of surveys conducted in 2011, as much as 68% of all surveyed enterprises did not engage in any innovative activity. In the same period, there were only 33% of such companies in the UK. This is due to the significantly higher level of development of the British market, which has been operating in a

market economy for several centuries, while Poland has only been gaining experience in this field since 1989.

On the basis of the presented models and their results, it was possible to identify the factors determining innovativeness and contractors' involvement in the public procurement market. In Poland, this phenomenon is present in companies with a large number of employees, with significant revenues, located in larger urban agglomerations, with their own specialised staff handling public procurement. Such companies perform relatively fewer contracts than competitors, but they are more specialised. The problem is that the number of such contractors in the sample structure amounted only to 4%. The most dominant group are the SMEs.

Much greater involvement in innovation and public procurement can be observed among British entities. The presented models showed that conducting R&D activity and innovative involvement in the market of products and services eliminate barriers of the lack of innovative needs and integration with the contracting authority to a greater extent. This can also be understood in such a way that the particular group of entities is prone to participation in innovative public procurement.

Although the survey was conducted in 2011, there have been no comparable studies in this field since then. The current extent of the use of innovative public procurement in Poland is very low, due to the lack of needs or the lack of opportunities due to the profile of the activity. In general, there has been an increase in awareness of the need for innovation, both among contracting authorities and enterprises engaging in public procurement, but they are still not reaching a satisfactory level (PPO, 2018). In order to improve this situation, it is necessary to reorient contracting authority, which must become a customer able to correctly define the objectives of the contract and then use the optimal paths available in the public procurement. As a result of cooperation, contractor may share the expertise, e.g. as a part of a technical dialogue. A positive effect should also be ensured by the admission of equivalent offers – the company's own interpretation of the target is stimulating the innovation, and, combined with the use of advance payments, the company will be able to finance larger undertakings (Ziarniak, 2016). Furthermore the procedures of public procurement should be streamlined to increase latitude entities in public contracts.

References

- Bedyńska S, Brzezicka A (eds) (2007) *Statystyczny drogowca. Praktyczny poradnik analizy danych w badaniach społecznych na przykładach z psychologii*, Warsaw
- Borowicz A et al (2012) *Determinanty proinnowacyjnego oddziaływania zamówień publicznych*. In: Starzyńska W, Wiktorowicz J (eds) *Zamówienia publiczne a innowacyjność przedsiębiorstw – stan obecny i perspektywy*, Łódź
- DCLG/PwC (2006) *Developing the local government services market to support the long term strategy for local government*. Department of Communities and Local Government, London
- European Parliament and the Council (2014) Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, OJ L 94, 28.3.2014

- European Parliament and the Council (2014) Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC, OJ L 94, 28.3.2014
- Edquist C et al (eds) (2015) *Public procurement for innovation*. Edward Elgar Publishing, Northampton, Cheltenham
- Kornecki J et al (2012) Szanse i bariery wdrażania nowego podejścia do zamówień publicznych w Polsce z perspektywy innowacyjności i włączenia MSP. In: Starzyńska W, Wiktorowicz J (eds) *Zamówienia publiczne a innowacyjność przedsiębiorstw – stan obecny i perspektywy*, Łódź
- Kufel T (2011) *Ekonometria. Rozwiązywanie problemów z wykorzystaniem programu GRETL*, Warsaw, pp 141–150
- Public Procurement Office (PPO) (2017, 2018, 2019) *Sprawozdanie Prezesa UZP o funkcjonowaniu systemu zamówień publicznych w 2016, 2017, 2018 roku*. Warsaw
- Public Procurement Office (PPO) (2018) *Raport z funkcjonowania systemu zamówień publicznych*, Warsaw
- Rolfstam M (2009) Public procurement as an innovation policy tool: the role of institutions. *Science and Public Policy* 36(5):349–360. <https://doi.org/10.3152/030234209X442025>
- Starzyńska W, Wiktorowicz J (eds) (2012) *Zamówienia publiczne a innowacyjność przedsiębiorstw – stan obecny i perspektywy*, Łódź
- The Act of 16 December 2016 – Rozporządzenie Ministra Rozwoju i Finansów w sprawie informacji zawartych w rocznym sprawozdaniu o udzielonych zamówieniach, jego wzoru oraz sposobu przekazywania. (Journal of Laws of 2016, item 2038)
- The Act of 29 January 2004 – Public Procurement Law (Journal of Laws of 2018, item 1986, 2215).
- Uyara E, al. (2014) Barriers to innovation through public procurement: a supplier perspective. *Technovation* 34(10):631–645. <https://doi.org/10.1016/j.technovation.2014.04.003>
- Ziarniak I (2016) Innowacyjne zamówienia publiczne. *Przetargi Publiczne*. Monthly magazine nr 5/126, Wrocław, pp 8–13

Technology-Oriented Startups in the Intersection of Industry 4.0, Venture Capital Financing and Business Scaling – Empirical Examples from the Automotive Industry –



Erika Jáki and Péter Halmosi

1 Conceptual Framework

The term Industry 4.0 has been first used at the Hannover Fair in 2011 to summarize changes that will revolutionize global value chains in the manufacturing industry (Schwaab 2016). Revolutionary changes will appear in sectors with shorter product investment cycles, a high level of production plant investment, and a rich flow of data regarding production. The automotive industry, the medical device sector, and the electronic equipment industry are good examples.

Though Industry 4.0 has an important organizational challenge for all sizes of business entities, multinational companies can adapt more efficiently to changes as opposed to domestic micro-, small-, and medium-sized companies by their R&D capacities and business culture.

In the venture capital literature, companies are classified by their size or by their stage of development, separating early- and late-stage companies. Formers – usually called “startups” – have a role to bridge the technology, knowledge, and business gap among multinational companies and SMEs. A higher level of risk tolerance of technology-oriented companies establishes a “transmission” function between multinational companies and domestic SMEs.

Technology-oriented companies were inspired by the spread of the Internet during the 1990s. It has been gaining venture capital investment since the end of the decade. In Hungary, the importance of technology-oriented investments has gained an upswing by the JEREMIE Program of Hungary launched in 2009.

E. Jáki (✉)
Corvinus University of Budapest, Budapest, Hungary

P. Halmosi
University of Szeged, Szeged, Hungary

The development of the venture capital ecosystem along with Industry 4.0 pathway is gaining importance both in a national and international context since 2011. We argue that there is a need for an exchange of best practices to identify and understand organizational changes that will completely redefine the scope of enterprises under Industry 4.0.

1.1 The Research Problem

Our paper aims to shed light on the importance of the intersection of technology-oriented startups, venture capital market, Industry 4.0, and business scaling theoretically and empirically in the automotive industry. This segment is an interesting and important research area due to the transformation of global value chains in all industries. Technology-oriented startups are a significant issue especially in CEE countries where the value is created mostly in outsourced manufacturing than domestic innovation. They are the driving force of innovation and important members of the ecosystem facing relocation decisions, standardization, and vertical specialization as well. Recent papers also highlight the importance of core-periphery relations in economic integration areas along the value chain. Technology-oriented startups – receiving investment from venture capital funds – target international and global markets to prove their viability in business and technology stack.

Traditional and technology-oriented startups are usually financed by venture capital funds due to their lack of access to other external financings (Colombo et al. 2010). Some of them are facing challenges of Industry 4.0 which will reshape the operation of business entities along the value chain. Some of them will be able to perform intense growth stimulated by technology like Google or Facebook.

It is, however, a crucial question whether these vulnerable startups will find their best way to manage the operation in this environment. The target area in the segment of the investigated terms is shown in Fig. 1.

It can be seen that there is an intersection of scalable startups financed by venture capital, with technologies falling under Industry 4.0. We argue that this intersection is already existing in industries.

1.2 Methodology and Database

The paper is based on both a literature review and database analysis of startups in the automotive industry.

We defined theoretically the conceptual sections of terms as startup, venture capital, Industry 4.0, and scalability based on literature. As a first step, we defined the notion of startup and Industry 4.0. Secondly, we investigate those startups that are operating under Industry 4.0. This is commenced by investigating the financiers of startups highlighting the importance of venture capital. Finally, the notion of

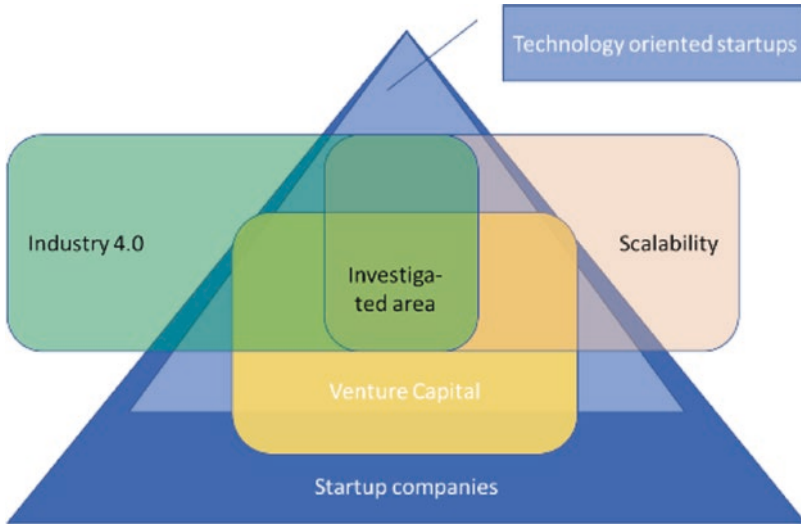


Fig. 1 The investigated terms and in their intersection the investigated area

scaling was defined concerning the sections of the startups and their financial problems and Industry 4.0. The aim of the first part of the paper is to study these sections from a theoretical point of view.

Secondly, using [crunchbase.com](https://www.crunchbase.com) as a database, we prove that the defined sections of notions exist in the automotive industry with ever-increasing importance. We look for startups receiving VC financing after the defined beginning of the period of Industry 4.0 in 2011 with business relations to the automotive industry. To tap their connection to business scaling, we further investigate available information on startup websites and business portals. Crunchbase is containing information on more than 100.000 VC funding rounds and acquisitions worldwide in all sectors of the economy. The site is well-known both among startups and investors which adds creditworthiness to shared public information.

1.3 Startups

Startups or early-stage companies are the most vulnerable small enterprises. Founders have usually a vision for becoming a big company in the future (Vecsenyi 2011). On the other hand, they might be only entities seeking reproducible and scalable business models (Blank 2013) disappearing after a short period of operation. They have higher risk potential but also a chance for being successful in business by their new ideas, products, and services.

Generally, three stages of the life cycle can be defined for the startup companies. In the *seed stage*, the company possesses merely the product or service idea and

need funds to finalize their idea. In the *growth stage*, the enterprise has already developed an operational prototype. Companies already realizing some revenue are a beloved target of venture capital financiers. *Expansion stage* enterprises need to be financed to cover the marketing expenses to expand further, but they have already an established manner of operation (Jáki and Molnár 2017). A small portion of these companies is technology oriented with a strong commitment to producing new technological solutions, methods, or pathways (Halmosi 2019).

1.4 Industry 4.0

The term “Industry 4.0” was first introduced by the German Industry-Science Research Alliance (Forschungsunion) in 2011 (Buhr 2015): “*It is usually perceived as the combination of digitalization and the interconnection of products, value chains, and business models. It also aims to support research, the networking of industry partners and standardization*” (Digital Transformation Monitor Germany 2017, p. 3). According to Nagy, Industry 4.0 is placing companies in the focus of the economy (Nagy 2017, 2019) as opposed to the fourth industrial revolution incorporating a wider effect.

The use of new data storage devices makes companies transform the value production process inside the company. It is not the Internet itself that makes smart connected products fundamentally different but the changing nature of operations (Porter and Heppelmann 2014). This is meant by how the capacities and functions of these devices are extended and how data is collected combined with the rise of productivity (Halmosi 2019).

Most experts agree that the core element of Industry 4.0 relates to the redefinition of the value chain. Therefore, Industry 4.0 is strongly connected to other factors of the value chain, e.g., supplier networks, manufacturing of products and services, and distributing to customers. In Fig. 2, we collected evidence from the literature without aiming to give an exhaustive list.

Automated data connection along the value chain initiated by the digitalization of operation is a precondition for an efficient Industry 4.0 company (Posada et al. 2015; Roblek et al. 2016; Zezulka et al. 2016). Sharing of information with business partners raises concerns with flexibility, service orientation, and real-time availability (Perales et al. 2018; Horvath-Szabó 2019). Companies with strategic goals under Industry 4.0 can only succeed if they manage to go far beyond: they need to embed functionality of products and services, handle interdependency of technologies, and develop a monitoring-controlling-optimization-autonomy of operation to have a strong, strategic business connection to suppliers and customers. These changes may in the long run reshape the entire business climate.

Factors of Industry 4.0 along the value chain				
Suppliers Network	Manufacturing and service provision	Customer		
		Purchase „experience“	After-sales service	Database of customers
Digitalization and integration of networks (Posada et al.; 2015 and Roblek et al.; 2016) Automatic data exchange and communication (Posada et al.; 2015 and Roblek et al.; 2016) Digitalization and integration of networks (Zezulka et al.; 2016); Cyber-physical systems (Hermann et al.; 2016); Interoperability (Perales et al., 2018); New services via integration (Porter , 2014); Real-time integration (Porter , 2014)	Digitalization, optimization and customization of production (Posada et al.; 2015 and Roblek et al.; 2016); Automation and adaptation (Posada et al.; 2015 and Roblek et al.; 2016); Human-machine interaction (Posada et al.; 2015 and Roblek et al.; 2016); Digitalization of products (Zezulka et al.; 2016); Smart factories (Hermann et al.; 2016); Real-time availability (Perales et al., 2018); Automation, energy efficiency (Perales et al., 2018); Work without human intervention (Horvath & Szabo; 2019); ;Traceability of production (Horvath & Szabo; 2019); Machine-to-machine communication (Horvath & Szabo; 2019); Optimization of the production process (Horvath & Szabo; 2019); Monitoring - controlling - optimization - autonomy (Porter , 2014); Embedded functionality (Porter , 2014); Maximized value production (Porter , 2014); Interdependency of technologies (Schwaab, 2016); New economic structures (e.g. sharing economy, big data, AI solutions) (Schwaab, 2016)	Value-added stores (Posada et al.; 2015 and Roblek et al.; 2016); Intelligent warehousing and logistics (Horvath & Szabo; 2019); Smart products and connections (Porter , 2014)	Value-added services (Posada et al.; 2015 and Roblek et al.; 2016); Digitalization of services (Zezulka et al.; 2016); Internet of Services (Hermann et al.; 2016); Service orientation (Perales et al., 2018); Product sharing, predictive maintenance (Porter , 2014); Satisfaction of unmet demands, efficient management of externalities (Schwaab, 2016)	New markets model (Zezulka et al.; 2016); Flexibility (Perales et al., 2018); Flexibility (Perales et al., 2018); Product R&D and validation (Porter , 2014); User charging (Schwaab, 2016)

Fig. 2 Factors of Industry 4.0 based on literature review

1.5 The Role of Technology-Oriented Startups in the Era of Industry 4.0

In the era of Industry 4.0, a new segment of companies emerges, the so-called technology-oriented startups. These startups are important driving forces of innovation next to multinational companies obtaining significant R&D capacities (Makra 2009). The common feature of early-stage technology-oriented startups is their orientation to technical, scientific, and business success, which makes them an important element of the Industry 4.0 ecosystem. These companies establish new forms, methods, and channels of knowledge transfer. Their development and integration into traditional economic systems will be more and more important in the future from the point of value-added operation.

The major competitive edge is their innovation potential by which they can develop and bring new products to the market. The reason why young technology companies play a key role in technological changes lies in the so-called creative destruction phenomenon which can be described as the dismantling of long-standing practices to make way for innovation. Concentrating on customers’ demand has not been satisfied, or finding a “niche” role next to a market-leading company makes startups stay alive and spread the use of new technologies later on. They have a “provoking role” by developing new technological solutions and a “technology transfer role” by adjusting and bringing innovation to customers (Halmosi 2019).

Industry 4.0 makes a new borderline between technology-oriented startups. Some of them remain “traditional” startups without any close connection to Industry 4.0, while others become “evolutionary” startups facing challenges of Industry 4.0. The borderline is not traced by sectors but rather by their value proposition.

For example, a Hungarian technology-oriented startup, GD Photonics Ltd., has currently acquired Hungarian, EU, and US final patent for its revolutionary UV

photo spray technology, which is to be utilized under existing business models to the pharma industry which is not part of Industry 4.0.

However, a well-known car-sharing service provider, Uber, revolutionized public transport by offering a new business model that belongs to Industry 4.0.

New ventures with software solutions are more likely to be associated with Industry 4.0 and revolutionize a particular sector.

1.6 The Financiers of Startups

Many authors have pointed out that the lack of financial resources can significantly hinder startups in development projects (e.g., Kocsis 2012; McMahon 2001; Mittal et al. 2018; Horváth and Szabó 2019). Early funds and in-kind contributions from family members enable a certain level of daily operations, investments, deductible value-added tax pre-financing, and other general operating costs which are further challenging these companies.

The existence and development of startups are also strongly correlated to grant programs initiated by the state (Halmosi 2019). The European Committee together with the European Investment Fund launched the Jeremie I. program in 2009 in Hungary supporting micro-, small-, and medium-sized companies. The Hungarian venture capital investments get a new impulse from this capital inflow (Jáki and Molnár 2017).

The state plays two roles in the venture capital market. On the one hand, it is a venture capital investor, and on the other hand, there were and there are still many state-owned capital fund managers in Hungary managing only state-owned funds (Jáki and Molnár 2017).

Hungary invested the most public funds to its VC ecosystem of CEE countries since the launch of the JEREMIE VC program in 2007 (Karsai 2017). It is also a crucial investment criterion for venture capital managers to invest in projects with scalable products and services.

1.7 Business Scaling

The notion is that scaling is well-known in the world of information and technology; currently, it is also commonly used in business where it can be interpreted concerning applied technology in form of data procession, sales in form of targeting more customers, or employee skills. All these scaling activities shall support the organization to adapt to new challenges in case of fast growth (Zajko 2017).

Growth strategies of startups are earmarked by the development and validation of new products which helps them reach new and new geographical markets. Utilizing networks has the potential not only for product development but to gain new knowledge, market, and developing business processes (Zajko 2017).

The ability of a business to grow in a way it will not lose customers, deteriorate quality, or modify the core competencies of the business entity is called scalability. It is also referred to as the development of products or services at a lower cost level in large quantities (Dudnik 2010). Scalability is also “a stage of a system to adapt to the growing numbers of users without endangering the targeted performance level.” Kumar (2010) admits that scalability is performed by addressing the following arguments: customer value proposition (CVP), business attribute analysis, change capacity, and market analysis.

Matheisel (2015) found that scaling (or scalability) is the unique challenge of new small ventures. While larger companies have already established their best practices and cultures, new ventures’ brands and cultures may still be transforming, so the quality of their products and services could change when they increase. Not all entities shall be scaled because they might change their core businesses and suffer losses.

The scaling of a small company may also be connected to the scaling of multinational companies (MNE) when the former becomes mature for it. Hungarian startup, Solvo Biotechnology Inc., the leading clinical research organization (CRO) specializing in drug transporter research, was acquired in early 2018 by CitoxLab Group (France) to establish an efficient value chain integration in preclinic services. CitoxLab Group was in early 2019 then acquired by Charles River Laboratories (USA) to further support global scaling within the pharma industry. The acquisition process has been prepared for years.

Technology-oriented startups specialized in Industry 4.0 solutions face a challenge to scale their business. To meet this challenge, they have to find sector-specific answers on what, how, and when to scale to get a sustainable business model. Kumar (2010) has also found that certain business models are easy, but others are hard to scale even if the product is welcomed by customers. Companies offering tangible products can more easily scale their business model than those with intangible products.

Scaling requires a high level of responsibility from technology-oriented startups to get the most benefit from it by the company. The phenomenon is often combined with a business strategy to grow internationally to gain new investors. Jáki and Molnár (2019) found that the single most important quality is the scalability of the business. “In VC jargon, a scalable project can sustainably increase the sales volume, while keeping the marginal cost low, thus retaining a high-profit margin.”

To sum up, scaling is thus a crucial factor of small companies involving the following: capacity building, development of new products or reaching a new target group or geographical area, establishing networks with partners, licensing of results, building franchise collaborations, establishing new joint ventures, imitation of competitors, or lobbying (Halmosi 2019). Managers of technology-oriented startups have a responsibility in choosing the right time and right management of scaling business activities. Sutton and Rao (2014) found that many companies scale their business “too big” and “too early” instead of establishing the new culture of the company.

We believe that Industry 4.0 is going to raise the importance of scalable business models since companies are targeting new customer groups or looking for a new “niche” market. A Hungarian startup aims to establish new cooperation between private health clinics in different countries by increasing digitalization, decreasing fragmentation of praxis management services, and extending the use of private healthcare funds. The need for the development of a new business model is obvious; however, it depends to a large extent on country-specific information.

Mathaisel et al. (2009) found that sustainable entities have the characteristics of availability, dependability, capability, affordability, and marketability. *Availability* means the sustained source of inputs needed to operate the business, e.g., supply chain availability, can be defined as integration in the network, collaboration with suppliers, and trust. *Dependability* is described as high and constant quality of products and services. *Capability* is the performance management evaluating the effectiveness of the service or product. *Affordability* refers to the costs involved throughout the life of the product including also the estimated capital needs of the growth in the long run. *Marketability* is much more than just selling. It relates also to identifying the target market and motivating the change. Based on the literature review, Mathaisel (2015) added *scalability* as a new factor to these five characteristics. The author highlighted that being scalable affects multinational large companies (MNEs) and newly established small- and medium-sized companies (SMEs) in a different way and manner. MNEs have well-shaped practices and business culture, while SMEs are only developing their cultural heritage which, however, may result in the loss of their unique value proposition. Multinational companies visualize their strategies by growth which is usually not an attainable short-term goal for newly established companies.

Mathaisel (2015) found that although scaling is important, indeed, a conservative strategy for growth shall be performed in some cases. Agreeing with Blumberg and Hindi (2013), we argue that all businesses are scalable, given careful growth management considering environment effects under Industry 4.0 for startups (see Fig.3.).

2 Empirical Cases: Scalable Technology-Oriented Startups in the Era of Industry 4.0 Financed by Venture Capital in the Segment of Startup, Financiers, Industry 4.0, Scaling

The automotive industry is nowadays facing a revolution. In January 2020, new emission standards came into effect. The industry has not only arrears in environmentally friendly technologies but in intelligent, connected software solutions.

General Motors and BMW have established their own venture capital fund; however, the strongest technology competition is currently perceived not in Europe but in the USA. European automotive companies offer new solutions to premium

Fig. 3 The six abilities of a sustainable entity based on Mathaisel (2015)



category cars that have not penetrated the market at all. The involvement of the telecommunication sector and other sectors is in progress. Revolutionary solutions are to wait in the mid-run. The development of innovative new technologies is taking place in every automotive company in separate ways. This calls for a change in order to revolutionize the value chain operating in the era of Industry 4.0 and support startups as well.

For all that more than 1.700 technology-oriented startups have been established globally; in the Industry 4.0 era, examples are electric cars, artificial intelligence supported driving, mobility business models, machine learning ICT solutions, and self-driving cars.

Table 1 presents basic data for ten technology-oriented startups gathered from the Crunchbase database. All companies are forerunners of connected car services which is a recent phenomenon and has a connection to Industry 4.0 since connectivity of cars is a value chain collaboration among manufacturers, suppliers, and customers by artificial intelligence services. Most of these technology-oriented startups have received several rounds of early-stage venture capital investment in recent years. Although most of the companies were founded in the USA, they have recently been active in global markets, and most of them have relevant partnerships not only in the automotive industry but in the supplying sector – e.g., telecommunication, oil, or rubber industry – as well. All companies have at least ten different software products that collect and analyze data regarding driving. This software helps automotive companies like Jaguar, Mercedes, or Honda to build up a life cycle connection to car users. Even if scalability is not easy to measure the state of a company, the new

Table 1 Technology-oriented startups connected to the automotive industry

Startup companies	Year of founding	VC stage	Amount of VC raised (million USD)	Number of products	Number of employees	Number of VC rounds	Connection to Industry 4.0	Significant partners in the automotive and connecting industries	The role of scaling detected in the strategy of the startup
Zubie www.zubie.com	2012	Early stage	25.9	29	11–50	6	Providing consumers and businesses relevant vehicle health, location, and safety information	Mazda, BP, Castrol, Michelin	<u>Targeting new client groups with service</u>
Mojjo www.mojjo.io	2012	Early stage	80.7	25	11–50	5	Secure and scalable aftermarket connected car services	Bosch, Telekom	<u>Developing products by intense data transformation</u>
Airbiquity www.airbiquity.com	1997	Late stage	80.4	15	51–100	7	Integrating advances in software, communications technology, and wireless services with vehicles	Toyota, Shell	<u>Developing products by intense data transformation</u>
CarVi www.getcarvi.com	2014	Early stage	5	10	11–50	1	Increasing safety through real-time data to avoid dangerous situations while driving	Goodyear	<u>No relation has been detected</u>
CloudCar www.cloudcar.com	2011	Early stage	26.5	18	51–100	3	Providing driver-centric intuitive experience, control of data	Jaguar	<u>Developing products by intense data transformation</u>
Automile www.automile.com	2013	Early stage	47.3	17	11–50	4	Providing frictionless tracking software for fleets and assets	MAN., Scania, Volvo, DAF	<u>Performing organizational growth</u>

Startup companies	Year of founding	VC stage	Amount of VC raised (million USD)	Number of products	Number of employees	Number of VC rounds	Connection to Industry 4.0	Significant partners in the automotive and connecting industries	The role of scaling detected in the strategy of the startup
Drivemode www.drivemode.com	2014	Merger (late stage)	9.2	17	11–50	3	Connection to Industry 4.0 A connected driving experience by voice-to-text messaging, music player overlay on navigation	Honda, Panasonic	Developing products by intense data transformation
Vinli www.vin.li	2014	Early stage	20	30	11–50	2	Vehicle data computing platform, cooperating with telecom and automotive partners	Continental	Targeting new client groups with service
Otonomo www.otonomo.io	2015	Late stage	53	10	51–100	5	Data transformation for predictive maintenance, emergency services, on-demand fueling	Mercedes, Dell	Targeting new client groups with service

Source: Crunchbase.com

ecosystem built up together with venture capital funds and business partnerships in the automotive industry enables technology-oriented startups to grow without losing customer value proposition. This is equal to the original definition of scaling.

From Table 1 we can establish that the intersection of the targeted area exists in the automotive sector indeed. All investigated startups have at least one well-known business partner in the automotive industry and have declared some kind of business scaling perspective. Available data suggests that startups aim to scale their business to reach new clients, develop their organization, and to gather data to use for product development. CarVi – which is the youngest startup in the sample – is currently revealing no rumors on any type of business scaling; however, this will possibly change as it gets into higher-level VC round financing.

It is a question to be addressed how these companies can confront and manage challenges of business scaling.

3 Limitation of the Paper

Our study aimed to investigate whether the fast-evolving technology in the era of Industry 4.0 and the increasing number of startup companies supported by VC funds could arise as a new scientific research issue.

One of the limitations of the study is that we concentrated only on startups gained VC fund not considering startups receiving other forms of funding like crowdfunding or support from family members or friends or fools (FFF). To prove empirically the existence of the intersection of the research areas, legally funded companies had to be investigated. This is not a criterion in the case of crowdfunding or FFF financing. On the other hand, scaling is also a required investment criterion for VC financing, and this information is available in official databases of existing companies.

It is a limitation of our investigation, that we took only nine examples from the automotive industry to prove the empirical existence of the intersection. Although crowdfunding exists also in the automotive industry, the intersection in the investigated area is a rather narrow segment.

4 Discussion and Conclusion

This paper has proved that the intersection of startups, venture capital markets, Industry 4.0, and business scaling is a new area to be addressed in scientific researches in every sector of the economy. Revealing the target area, however, raises new questions to be investigated on large-scale samples verified by in-depth interviews with experts in the intersection area.

Based on the investigation, we defined the following research questions: How do startups make decisions on the timing and scope of business scaling? How is scaling to be interpreted in the intersection of sectoral characteristics (e.g., value chain

transformation), VC expectations (next round funding, exit, etc.), and technology slacks triggered by Industry 4.0? How is the startup ecosystem supporting the scaling of startups? Can startups help not only their clients but other startups also to scale up? The business scaling of the sector is scarcely analyzed, and we have found no information on international comparisons in this field. Our prior belief is that there are no unique attitudes to scaling the business.

Finally, our paper also did not investigate secular stagnations which is a prolonged period in which satisfactory growth can only be achieved by unsustainable financial conditions (Kovács 2020, Teulings–Baldwin 2014). The intersection discussed in our study may help economies to overcome secular stagnations which should be investigated by academic researchers.

References

- Blank S (2013) Why the lean startup changes everything. *Harvard Business Review* 2013. May <https://hbr.org/2013/05/why-the-lean-startup-changes-everything>
- Blumberg M, Hindi H (2013) *Startup CEO: a field guide to scaling up your business*, Wiley. ISBN 9781118683279. September
- Buhr D (2015) Social innovation policy for industry 4.0. Friedrich-Ebert-Stiftung, Division for Social and Economic Policies, Bonn
- Colombo MG, Luukkonen T, Mustar P, Wright M (2010) Venture capital and high-tech startups. *Ventur Cap* 12(4):261–266. <https://doi.org/10.1080/13691066.2010.486153>
- Digital Transformation Monitor Germany (2017) *Industrie 4.0* https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Industrie%204.0.pdf. Download: 08.11.2019
- Dudnik, N. (2010) Social Entrepreneurs' tricky Issues of Sustainability and Scale [online] *Harvard Business Review*. Available at: <https://hbr.org/2010/10/socialentrepreneurstricky-is> (Accessed: 26 Sept. 2016).
- Halmosi P (2019) A technológiaorientált start-up cégek lehetőségei és korlátai az ipar 4.0 korszakában–kérdőíves felmérés alapján/the possibilities and limits of technology-oriented startups under industry 4.0—a survey-based study. *Vezetéstudomány–Budapest Manag Rev* 50(9):40–48
- Horváth D, Szabó RZ (2019) Driving forces and barriers of industry 4.0: do multinational and small and medium-sized companies have equal opportunities? *Technol Forecast Soc Chang* 146:119–132
- Jáki E, Molnár EM (2017) Model of the state and EU involvement in the venture capital market. In: *Proceedings 31st European conference on modelling and simulation ECMS 2017*. ECMS-European Council for Modelling and Simulation, Nottingham, pp 120–126. ISBN 978-0-9932440-4-9
- Jáki E, Molnár EM, Kádár B (2019) Characteristics and challenges of the Hungarian startup ecosystem. *Vezetéstudomány–Budapest Manag Rev* 50(5):2–12
- Karsai J (2017) Az állam kockázatotóke-piaci részvételének átláthatósága Magyarországon. *Közgazdasági Szemle* 64(12):1316–1342
- Kocsi A (2012) A multinacionális vállalatok szerepe a hazai klaszterekben. *Vezetéstudomány* 43:24–35
- Kovács O (2020) Gazellák az iparpolitika tükrében, II. *Közgazdasági szemle*, LXVII. ÉVF., 2020. Február (181–205. o.). <https://doi.org/10.18414/KSZ.2020.2.181>
- Kumar D (2010) *Enterprise growth strategy: vision planning and execution*. Ashgate Publishing Group, Surrey

- Makra ZS (2009) A technológiai vállalkozások létrejötte, növekedése és gazdasági szerepe a szakirodalom tükrében. *Közgazdasági Szemle* 56(2):176–186
- Mathaisel DFX (2015) Is scalability necessary for economic sustainability? *Eur J Sustain Dev* 4(2):275–282
- Mathaisel DFX, Manary J, Comm CL (2009) *Enterprise sustainability*. CRC Press, Taylor and Francis
- McMahon RGP (2001) Growth and performance of manufacturing SMEs: the influence of financial management characteristics. *Int Small Bus J* 19:10–28. <https://doi.org/10.1177/0266242601193001>
- Mittal S, Khan AM, Romero D, Wuest T (2018) A critical review of smart manufacturing & industry 4.0 maturity models: implications for small and medium-sized enterprises (SMEs). *J Manuf Syst* 49:194–214. <https://doi.org/10.1016/j.jmsy.2018.10.005>
- Nagy J (2017) Az Ipar 4.0 fogalma, összetevői és hatása az értéklánra. Budapest Corvinus Egyetem műhelytanulmány. HU ISSN 1786-3031 <http://unipub.lib.unicorvinus.hu/3115/>. Downloaded: 2018. december 12
- Nagy J (2019) Az Ipar 4.0 fogalma és kritikus kérdései – Vállalati interjúk alapján. *Vezetéstudomány* 50(1):14–26. <https://doi.org/10.14267/VEZTUD.2019.01.02>. http://unipub.lib.uni-corvinus.hu/3869/1/VT_2019n1p14.pdf Letöltve: 2019. március
- Perales DP, Valero FA, García AB (2018) Industry 4.0: a classification scheme. In: Viles E, Ormazábal M, Lleó A (eds) *Closing the gap between practice and research in industrial engineering*, Lecture Notes in Management and Industrial Engineering. Springer, Cham, pp 343–350
- Porter ME, Heppelmann JE (2014) How smart, connected products are transforming competition. *Harv Bus Rev* 92(11):64–88. Downloaded: 2018. december 12
- Posada J, Toro C, Barandiaran I, Oyarzun D, Stricker D, Amicis de R, Pinto BE, Eisert P, Döllner J, Vallarino I (2015) Visual computing as a key enabling technology for Industrie 4.0 and industrial internet. *IEEE Comput Graph Appl* 35:26–40
- Roblek V, Mesko M, Krápez A (2016) A complex view of industry 4.0. *Sage Open*, 6(2), 2158244016653987. <https://doi.org/10.1177/2158244016653987>
- Schwaab K (2016) *The fourth industrial revolution*. World Economic Forum. Crown Publishing, New York. ISBN-13: 978-1-944835-01-9
- Sutton R, Rao H (2014) *Scaling up excellence: getting to more without settling for less*. Crown Publishing Group
- Teulings C, Baldwin E et al (2014) *Secular stagnation: facts, causes and cures*. Vox/CEPR Book, <https://voxeu.org/content/secular-stagnation-facts-causes-and-cures>
- Vecsenyi J (2011) *Kisvállalkozások indítása és működtetése*. Perfekt Kiadó, Budapest
- Zajko M (2017) Challenges of scaling-up process for start-ups. In: *Balkan region conference on engineering and business education* (vol. 3, No. 1). Sciendo, pp 62–70
- Zezulka F, Marcon P, Vesely I, Sajdl O (2016) Industry 4.0 – An introduction in the phenomenon. *IFAC-PapersOnLine* 49:8–12

Key Competencies of Startup Teams Sought After by Investors



Erika Jáki, Fruzsina Major, and Endre Mihály Molnár

1 Introduction

The aim of this study is to measure the venture capital investors' preferences in connection with the personal aspects of a new venture. What do investors want to find in an entrepreneur or a team? What they think is a predictor of a startup's success. Block et al. (2019) investigated the investment criteria of more than 700 private equity investors. Their results indicate that the revenue growth is the most important investment criterion, followed by the value added of product/service, the management team's track record, and profitability.

In this study, we attempted to find out what investors say predicts profitability from the characteristics of the management team. The international literature so far only used questionnaires, interviews, and the investigation of a screening process as data collection tools to try to uncover the preferences of investors. However, so far they do not observe actual investment decisions in real time. Due to the *Dragon's Den* investment TV show and its derivations in multiple countries, we could study this real investment decision-making process. The literature gap is that the established literature didn't observe actual investment decisions and pitches, contrary to us. We used this opportunity to build a database based on this show and examine the management team qualities.

The literature on venture capital investment generally alludes to the fact that it is difficult to define the concept of venture capital precisely because there is no uniform interpretation.

Based on Invest Europe (2016, 2017), venture capital is a subset of private equity that provides equity investments for startups, in the early growth and expansion

E. Jáki (✉) · F. Major · E. M. Molnár
Corvinus University of Budapest, Budapest, Hungary
e-mail: erika.jaki@uni-corvinus.hu; molnar.endre@uni-corvinus.hu

stage. More generally, referring to the intention of investors, *“Today’s western interpretation of venture capital covers long-term, high-risk capital investments by professional investors whose primary purpose is to obtain a capital gain on exit, supplemented by distributions received during the investment”* (Karsai 1997, 168.pp).

Venture capital is a financial intermediary since investments are made not from the investors’ own money, but resources pool for this purpose by other organizations or individuals. Investments will only be directed to companies that continue to operate on a private basis at the latest after the completion of the transaction (Karsai 2012). Especially in early-stage investments, investors play an active role in the life of portfolio companies, providing companies with their expertise and network of relationships alongside invested capital. However, operative management remains the responsibility of the company’s management. The goal is to maximize returns, as transactions carry a high risk, so investors expect above-average returns. However, just a few companies can meet the high return expectation. Venture capitalists select along with strict application principles the companies to invest in. Therefore, to reduce risk, venture capitalists invest in several companies creating a portfolio. The return is realized on exit, during which the investor sells his/her stake either to the original owners of the company or a third party. To achieve the extra return, the investor is interested in developing the company, increasing the company value (Osman 2006; Karsai 2012).

The first on the market for entrepreneurial finance was the formal venture capitalists (VCs) in the mid-1980s in the USA, when their professional practice had become institutionalized. After that, they gradually spread across the globe and entrepreneurial finance has evolved significantly in the last 30 years (Wallmeroth et al. 2018). Private individuals or “angels” operating outside formal financial institutions are willing to invest their resources in new business, originating an “informal” venture capital market. Cavallo et al. (2019) said angels play an active role in professionalizing those firms in which they invest. Angels typically are former entrepreneurs or industry executives whose managerial experience and personal network of contacts may assist and foster venture development and performance, similar to VC funds.

The development of the venture capital industry in the Central and Eastern European region and Hungary began in the early 1990s, with the transition to the market economy of the countries of the region. Most recently, the JEREMIE program has had the greatest impact on the Hungarian market. The JEREMIE program introduced a new form of state intervention in Hungary, based on the implementation of co-financing with private investors (Europai Bizottság 2008; Kállay and Jáki 2020). The importance of startups for the development of national and regional economies, coupled with the desire to address potential supply-side weaknesses in domestic VC markets, is the primary reason for the creation of governmental VC funds (Pavlova and Signore 2019).

The program has been launched in four phases in Hungary between 2009 and 2013. The investment period of the JEREMIE program was between 2010 and

2016; nevertheless, new programs were announced for the 2014–2020 period and additional programs are planned to be launched by the state, so the government remained an active player in the Hungarian venture capital market. A significant amount is available for startups; therefore, it is an important requirement to become familiar with the selection criteria more in detail.

1.1 *Investment Decision Process*

In the venture capital market, the key players are the target companies for whom equity investment is provided by venture capital fund management companies. Venture capital companies, with their extensive experience and databases, can evaluate the chances of survival of a business based on the presentation of projects/ideas by the entrepreneurs. The investors need to know the project, the business idea, and the management team thoroughly to decide whether it is worth investing in a business (Hall and Hoffer 1993; Molnár and Jáki 2020).

There is numerous literature on introducing the investment decision process. Most of them interpreted it in a linear structure consisting of several stages.

According to László (2019), the process consists of eight steps:

1. Attracting investor interest
2. Kick-off or the first personal meeting
3. Due diligence
4. Internal approval phase
5. Term sheet phase
6. Legal and financial due diligence
7. Syndicate contract
8. Investment tranche

From our point of view, the first two steps are the most important regarding our investigation.

1. *Attracting investor interest*: One tool for this is a teaser, which is one to two pages of written material about the target company. The other is pitch, where the company presents its idea in a short presentation. Based on these, if the investor finds the company a potential investment candidate, the team is invited to a personal meeting.
2. *Kick-off or the first personal meeting*: At the kick-off meeting, investors decide, in most cases, within the first 10 minutes whether they are interested in the project or reject the candidate. If they find it interesting, there is a good chance that participants will continue to make progress in the investment process.

These steps have been highlighted by other authors as well. In Boocock and Woods (1997), the first step was called deal origination followed by pre-screening of investment opportunities and the first meeting. According to Silva (2004), deal

origination is also the first step in the process and then screening begins which includes both informal and formal screening.

Numerous literature deals with the criteria used by venture capitalists when screening investment proposals.

In the investment evaluation process, the management team is one of the most important factors. For example, at the kick-off meeting, a vital success criterion is the entrepreneur(s), whether they are sympathetic to investors or whether the entrepreneur's team has all the relevant competencies to improve their business. Research by Tyebjee and Bruno (1984), Robinson (1987), and Dixon (1991) points out that it is a very important criterion to have a complete management team behind the project. More precisely, the management team should possess relevant leadership, marketing, and financial expertise based on relevant experience. However, preferences may vary by the company life cycle. For an early stage, investors do not expect perfect management according to Fried and Hisrich (1994).

Hall and Hoffer (1993) summarize and regularize the investor decision-making process in the USA based on five authors. They stated also that the character of the entrepreneur/team, mainly the managerial capabilities of them, is one of the most important parts of the venture capitalists' investment criteria. The characteristics consist of eight subcategories: the ability to evaluate risk, articulate revenue, background/experience, capable of sustained effort, managerial capabilities, management commitment, references, and stake in the firm. The most common of the eight is the manager capabilities of the team, but the management commitment, background/experience, and the ability to evaluate the risk are also highly relevant.

We are persuaded that the person-specific competencies in investor decisions play an important role. Based on Hall and Hoffer (1993), four main characteristics of the management team can be distinguished:

1. *Sympathy*: To attract the investors' interest with the first pitch or at the first meeting. The importance of the first impression is not negligible during the evaluation process.
2. *Commitment/motivation*: Because the team is responsible for the operation after the venture capital investments, it is crucial whether they are committed to the company.
3. *Authenticity*: The authenticity of the team members is also substantial for the operation of the business. It indicates proficiency in the subject, which means they are experts in the specialty.
4. *Financial knowledge*: The knowledge of the management team has come up in several places like marketing knowledge, or management capabilities. It is appealing to investors when the entrepreneurs can submit at the outset of the planning numbers.

1.2 Database

Daly and Davy (2016) made a structural, linguistic, and rhetorical analysis of the entrepreneurial pitch in the British version of the TV show, the *Dragons' Den*. In our investigation, we also have focused on the pitch. From 4th November to 22nd November in 2019, we empirically tested the teams' characteristics. We watched all of the episodes of the Hungarian *Among Sharks* and made a database from them which contains the comments of the "sharks" in a coded form and also contains the entrepreneurs/teams' parameters. In connection with the show, we watched various expert vlogs, interviews with the jury, and articles that were also built in to determine the values.

The first season of the show was running at the beginning of 2019 (18 February 2019 to 15 April 2019). The show is similar to *The Tigers of Money* from Japan, the *Dragon's Den* from Great Britain, and the *Shark Tank* from the USA. The aim of the show is that the starter companies find an investor(s) to their idea. The investors in the Hungarian version were Levente Balogh, who is the owner of the "Szentkirályi Kékkúti Ásványvíz," which is the market leader in mineral water and a significant actor in the soft drink industry in Hungary; Péter Balog, who is the co-founder of the NNG; Anna Apró from the OXO investor team; Gyula Fehér, who is the co-founder of the Ustream; and András Moldován, who is the owner of many companies in the food industry. All of them made investments in the market. In the series, the entrepreneurs made a pitch and try to sell their idea to investors.

Finally, if the jury members saw enough imagination in the business, they made an investment offer. The entrepreneur indicated from the outset the amount of investment he was asking for and the share of ownership he was willing to offer in return for the business. The jury might make an investment offer on unchanged terms, or different terms, or reject the investment.

However, it happened that investors not only invested in the company, but also other forms of support like credit or mentoring were offered.

We considered **successful** teams that succeeded in attracting investors to their business from among the jury members. Those who failed to do business with investors in any form are **unsuccessful**. Some companies **only received mentoring or credit** from investors.

1.3 Methodology

Based on Hall and Hoffer (1993), we defined the main characteristics of the team supplemented with subcategories and a coherent coding system to be able to measure¹ and compare these qualitative variables:

¹Evaluation of the given categories (sympathy, commitment, authenticity, financial knowledge) based on a short presentation is a rather difficult task due to its subjectivity. In our methodology,

1. *Sympathy* could be measured only in a subjective way based on the feedback from the “sharks.” Each group was ranked from 0 to 5.
2. *Commitment/motivation*, first each group was ranked from 0 to 3 in a subjective way based on the feedback from the sharks. However, we defined two objective measurements. The first one is whether this is the solo project of the entrepreneur giving zero points if the entrepreneur possesses one or more additional projects, and one of the given projects was the main job of the entrepreneur. Adding these three items, the commitment was evaluated also by a 0–5 scale.
3. *Authenticity*: Three sub-criteria were defined, and all ranked from 0 to 5. The three sub-criteria were the following: subjective evaluation of authenticity, personal involvement, and professional experience in the field. In this characteristic, the subjective evaluation was based on the feedbacks of the investors as well. Professional experience was rated five if one of the members of the team had qualifications in the specialty, e.g., in the case of a gluten-free bakery, if at least one of the members had qualifications and practice as a confectioner, then 5 points were given. Similar to this the personal involvement was ranked. Following the previous example, if one of the members had a gluten allergy, then 5 points were given. We gave 3 or 4 points if a family member had this illness. The average of the three criteria gives the final evaluation.
4. *Financial knowledge*: Four sub-criteria were defined, and all ranked from 0 to 5. During the pitch, the team has to prove that they can plan revenue and another criterion was the ability to give earnings estimations which require basic knowledge in accounting. An objective measurement was whether someone of the managements possesses relevant financial qualification. We realized that financial qualification can be substituted with appropriate business experience, and we defined it as the fourth sub-criteria. The average of the four criteria gives the final evaluation.

In the construction of our database, all the four main variables were evaluated from 0 to 5 accordingly comparable. Finally, counting the average of the main criteria, we got a value for the character of the team ranked from 0 to 5. To test our hypotheses, we had to systematize the data from our research base. Methodologically we compared the arithmetic average of the above-detailed variable. In the analysis, we will look at the mean values of these management quality scores to determine the hierarchy between them in the class of successful, unsuccessful teams and teams that only received a loan or mentoring. We will also use the Mann-Whitney U test to test for significant differences between the groups regarding the management team qualities (Table 1).

we still tried to decode them based on the ratings we saw and heard in the show.

Table 1 The detailed explanation of the database

TEAM					
Main categories based on Hall and Hoffer (1993)		Defined subcategories and coding system			
Each ranked from 0 to 5	Sympathy (max 5 points)	Subjective ranking based on the jury's reactions ranged from 0 to 5			
	Commitment (sum max 5 points)	Subjective ranking based on the jury's reactions ranged from 0 to 3	The team has one project or more from 0 to 1	The project is the main job for the entrepreneur(s) from 0 to 1	
Each ranked from 0 to 5	Authenticity (average max 5 points)	Subjective ranking based on the jury's reactions ranged from 0 to 5	The personal involvement of the team ranked from 0 to 5	Professional experience within the team ranked from 0 to 5	
	Financial knowledge (average max 5 points)	Ability to plan revenue ranked from 0 to 5	Ability to plan earnings ranked from 0 to 5	Financial qualification ranked from 0 to 5	Business experiences within the team ranked from 0 to 5

1.4 Research Question

As we mentioned above, the first step of our study was to classify the teams into three groups. Teams supported by equity investment were called a **successful** team. Teams obtained only credit or mentoring were called **only credit/mentoring** team. As the aim of the pitch was to get remarkable equity investment and the given credit was much smaller amount than demanded and mentoring means getting professionals' consultancy and access to the personal networks of the mentor, these teams should be distinguished from successful ones; however, either credit or mentoring is more than nothing. **Unsuccessful** teams were rejected in any form of assistance.

Our expectation is that judgment of startup management teams in terms of sympathy, commitment, authenticity, and financial knowledge explains the investors' decisions both in the main criteria and at the level of the four sub-criteria.

First, we outline our research questions.

RQ1: What are the highest-rated management team qualities of successful startup teams?

We need to distinguish between teams that only received credit/mentoring from the jury. We do not consider this to be a successful team, so it is interesting what they lacked to succeed. We believe that factors that are most capable of developing/

learning skills, such as financial literacy, can play a role here. The qualities like sympathy, commitment, or authenticity can trigger the jury's desire to help.

RQ2: What are the highest-rated management qualities of startup teams that received only credit or mentoring?

There was something in these teams that captured the jury's attention and they wanted to support them, even though the startup company was not considered to be a good investment. We expect high sympathy for only credit/mentoring teams; meanwhile, they may lack financial knowledge. Then it is also informative to look at the scores of the unsuccessful teams to see which quality they lacked the most. This can help entrepreneurs who seek investment.

RQ3: What were the results of the management qualities of the unsuccessful teams?

Finally, after looking at the scores, we also want to test whether there are significant differences among the subgroups in terms of management qualities.

RQ4: Are there any significant differences among successful, unsuccessful, and loan/mentoring startups in terms of the management qualities?

2 Results

There were 34 teams' pitches in the show during 9 episodes, and the participant teams had 1–3 members. We analyzed the competencies of the successful management teams from the Hungarian TV show based on the pitches and the jury's comments.

Overall, 17 teams were **successful** and the evaluation of the management team, in general, was 4.08. Three teams were supported in the form of **only credit or mentoring**. These teams' average evaluation was 3.6. There were 14 **unsuccessful** teams with a 3.33 average evaluation (Table 2).

To investigate RQ1, we analyze the results in Fig. 1, where we can see the scores of management team qualities in successful teams. Overall, we can state that the strongest quality of successful teams is their commitment, followed by authenticity, sympathy, and then financial knowledge at the end. The reason for this ranking can be that investors want to see the management team focused solely on the startup

Table 2 Classes of the teams and evaluation of the four main factors of the management skills

Class	Number	The average of team evaluation
Successful	14	4.08
Only credit/mentoring	3	3.6
Unsuccessful	17	3.33
SUM	34	

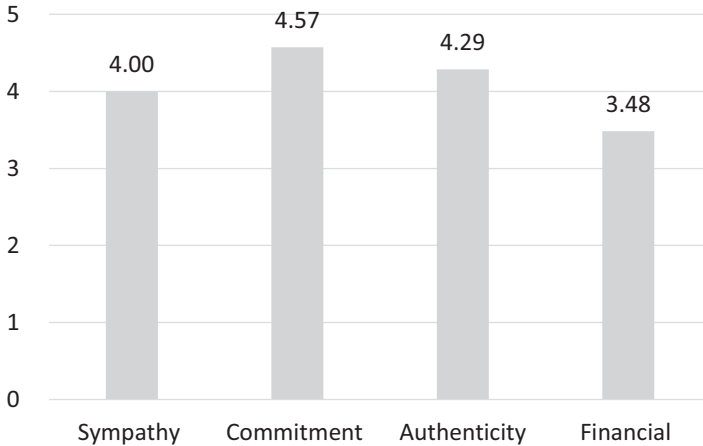


Fig. 1 Evaluation of the four main categories of the management skills along with successful teams

business to grow the company and generate profit for the investors. Indeed, this result is also supported by comments of the investors that highlighted their approval of certain startups such as “*so you put your whole life on this,*” and those teams indeed received investment. Authenticity, as we defined it, shows the prior experience and sector knowledge of the entrepreneur, and it is another major requirement of the investor, who may not know the business sector very well. The sector knowledge was often conveyed by the entrepreneurs by presenting and operating their product in front of the investors, which also provoked positive comments, such as “*he knows what he is doing.*”

We can see in Fig. 2 the results of management team qualities of teams that received only credit or mentoring, which will help answer RQ2. The commitment was again the strongest, with sympathy following, then the authenticity, and financial knowledge at the end. The ranking is different compared to teams that received equity investment, notably that authenticity was ranked in the fourth place, while in successful teams it was ranked in the second place. This suggests that being highly committed and sympathetic but not authentic enough may lead investors to rather provide less risky support in the form of credit and mentoring, and once they verified for themselves the true capabilities of the management, they can decide later to invest.

To answer RQ4, we examine Fig. 3 that shows the scores of management team qualities in unsuccessful teams. Their strongest characteristic is commitment (as with the previous groups), followed by authenticity, financial knowledge, and finally sympathy. The fact that sympathy is their weakest quality, may result that investors possibly are reluctant to invest or provide any other support to the teams despite the fact that it may have a possibly profitable business.

Let us move on to RQ4 to see if there are any significant differences in the management team qualities of successful, unsuccessful, and loan/mentoring class. To

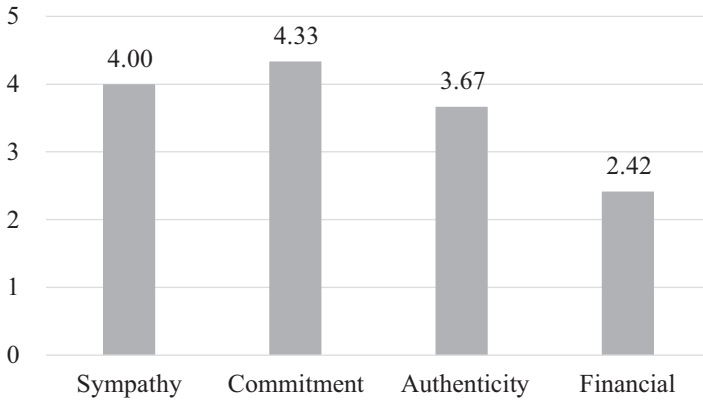


Fig. 2 Evaluation of the four main categories of the management skills along with teams that received only credit or monitoring

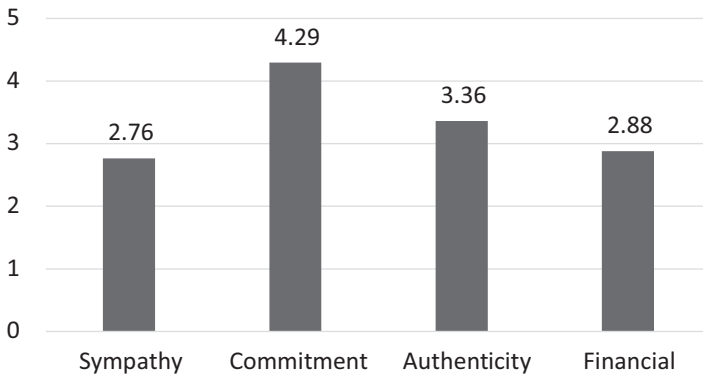


Fig. 3 Evaluation of the four main categories of management skills along with unsuccessful teams

this end, we employed the Mann-Whitney U test for all pairwise comparisons between these groups along with sympathy, commitment, authenticity, and financial knowledge scores and found a significant difference between the successful and unsuccessful groups in terms of sympathy rating (see Table 3).

This proves that without sympathy, startup management team members may appear committed, authentic, and even financially knowledgeable; they are likely to not receive investment from the investor. We expect to see more significant differences in the future on an expanded database once the second season of the TV show comes out and will be available to analyze.

This study aimed to define the main management skills sought after by investors. First, we defined the main characteristics of the management team based on the literature that was conceived to be vital for the investors. In the second step, we defined a methodology to measure these qualities. Finally, we tested our model in a database created by the authors observing real investment decisions.

Table 3 Comparison of subsample means (Mann-Whitney at $\alpha < 5\%$)

Sympathy	Subgroup	Subsample mean	Subgroup	Subsample mean	Mann-Whitney U test Sig
	Successful	4.00	Unsuccessful	2.76	0.025

2.1 Further Research Opportunities

We strongly believe that there is a strong need to survey the characteristics of the team searched by the investors based on **interviews** with investment board members. Therefore, we believe that our research can provide a very good basis for constructing a questionnaire for real venture capitalists.

On the other hand, the study can expand additional control **variables** such as gender, the age of the team members, operating years of the companies, demanded equity investment and offered shares, gained equity investment and gave shares of the company, etc. Another success criterion could be whether the family company has a better or worse chance to find an equity investor. The characteristics of the product/idea as a success factor can be an interesting research topic as well. Is it true that the investors prefer those products or ideas that are innovative, persuaded, and demanded by a real market problem with real market demand and marketable?

It is a further task to develop the methodology to make it applicable in other countries as well, so the research can be expanding in the **CEE region or V4** countries.

3 Discussion and Conclusion

In the first phase of the research, we defined the term venture capital investment based on the existing literature. We examine thoroughly the investment process focusing primarily on the very beginning like kick-off meetings and pitch. We concluded that management skill is an essential factor at this stage of the process. We defined the management skills with four subfactors indicated for further investigation like **sympathy, commitment, authenticity, and financial knowledge**. Methodologically we defined a model to grade these subcategories at a six-level scale (from 0 to 1) and tested it.

In our research, we examined the *Among Sharks* TV series which presents real investment decision with real investors and startups. Decision outcomes are classified as follows: successful, unsuccessful, and only credit/mentoring. We measured the impact of the defined four characteristics on the success of investments.

Successful teams had strong commitment, authenticity, sympathy, and financial knowledge being their weakest characteristic based on our measurement. Surprisingly financial knowledge finished as the weakest quality, which is in stark contrast to venture capital studies where the financials of the company are often the most important (Mason and Stark 2004). Teams that received credit or mentoring

had strong commitment and sympathy, followed by authenticity and weak financial knowledge. The investors who were willing to support these startups may have been unable to determine the profitability of their business but will probably reconsider investing in the future once they worked together. Finally, according to our statistical testing, the unsuccessful teams had significantly worse sympathy ratings than the successful teams, while their other scores are comparable.

Our research shows that it is essential to have sympathy between the investor and the management team of the startups. Research most often focuses on the professional history and the track record of startup teams when mentioning team-specific decision preferences of the investor. Our research points out that decisions can also be influenced by a subjective human factor such as sympathy. However, it is very difficult to measure exactly which competencies matter. We think that the needed management skills should be unfolded more precisely based on interviews with investment managers. Further research is needed to extend the database with more control variables and expand it regionally. As additional variables, the characteristics of investors can be included in the study as well.

References

- László Ádám (2019) Befektetési döntési folyamat Jáki, E., Aranyossy, M., Csepy, G., Molnár, E. M., László, Á., & Freész, G. (2019). A kockázati tőkefinanszírozás elméleti kérdései gyakorlati problémákkal illusztrálva I
- Becsky-Nagy P, Fazekas B (2015) Speciális kockázatok és kockázatkezelés a kockázati tőkefinanszírozásban (The special risks and risk management of venture capital). *Vezetéstudomány-Budapest Management Review* 46(3):57–68
- Block J, Fisch C, Vismara S, Andres R (2019) Private equity investment criteria: An experimental conjoint analysis of venture capital, business angels, and family offices. *J Corporate Finan* 58:329–352
- Boocock G, Woods M (1997) The evaluation criteria used by venture capitalists: Evidence from a UK venture fund. *Int Small Business J* 16(1):36–57
- Cápák Között 1. évad (2019): „Televíziós műsor”, RTL Klub, Magyarország, (2019. február 18. – 2019. április 15.)
- Cavallo A, Ghezzi A, Dell’Era C, Pellizzoni E (2019) Fostering digital entrepreneurship from startup to scaleup: The role of venture capital funds and angel groups. *Technol Forecast Social Change* 145:24–35
- Daly P, Davy D (2016) Structural, linguistic, and rhetorical features of the entrepreneurial pitch: Lessons from Dragons’ Den. *J Manag Dev* 35(1):120–132
- Damodaran, A. (2009). Valuing young, start-up, and growth companies: Estimation issues and valuation challenges. Available at SSRN 1418687.
- Dixon R (1991) Venture capitalists and the appraisal of investments. *Int J Manag Sci* 19(5):333–344
- Európai Bizottság (2008): N 355/2008. sz. állami támogatás – Magyarország. Magyar JEREMIE kockázati tőke-intézkedés. Európai Bizottság, Brüsszel, 1–13. p.
- Fried VC, Hisrich RD (1994) Toward a model of venture capital investment decision making. *Finan Manag* 23(3):28–37
- Hall J, Hofer CW (1993) Venture capitalists’ decision criteria in new venture evaluation. *J Business Venturing* 8(1):25–42
- INVEST EUROPE (2016–2017): Central and Eastern Europe private equity statistics, Brussels.

- Jáki, E. (2018) A befektetési társaságok döntéshozatali folyamatai, in Jáki E., Berlinger E., Lovas A., Csepy, G. (2018): Szemelvények a vállalatfinanszírozás témaköréből I. Budapest, Budapesti Corvinus Egyetem.; 41–71. old. ISBN 978-963-503-748-3; <http://unipub.lib.uni-corvinus.hu/3861/>
- Jáki E, Molnár EM, Kádár B (2019) Characteristics and challenges of the Hungarian startup ecosystem. *Vezetéstudomány-Budapest Manag Rev* 50(5):2–12
- Kállay, L., and Jáki, E., (2020). The impact of state intervention on the Hungarian venture capital market. *Econ Res-Ekonomska istraživanja*, 33(1), pp.0–0.
- Karsai J (1997) A kockázati tőke lehetőségei a kis- és középvállalatok finanszírozásában. *Közgazdasági Szemle* 44(2):165–174
- Karsai J (2009) Az aranykor vége. A kockázati tőke-ágazat fejlődése Közép-Kelet-Európában. *Közgazdasági Szemle* 56(1):46–68
- Karsai, J. (2012). A kapitalizmus új királyai: Kockázati tőke Magyarországon és a közép-kelet-európai régióban. *Közgazdasági Szemle Alapítvány-MTA Közgazdaság-és Regionális Tudományi Kutatóközpont Közgazdaság-tudományi Intézet*.
- Mason C, Stark M (2004) What do investors look for in a business plan? A comparison of the investment criteria of bankers, venture capitalists, and business angels. *Int Small Business J* 22(3):227–248. <https://doi.org/10.1177/0266242604042377>
- Molnár EM, Jáki E (2020) What qualities do government-owned venture capital investors seek in a new venture? *Vezetéstudomány/Budapest Manag Rev* 51(11):64–76
- Osman, P. (2006). A kockázati tőkéről. *Makra, Zs.(szerk.)*[2006]: A kockázati tőke világa. Aula Kiadó, 11-32.
- Pavlova, Elitsa, Simone Signore (2019) The European venture capital landscape: An EIF perspective
- Sharma AK (2015) Venture capitalists' investment decision criteria for new ventures: A review. *Proc-Soc Behavioral Sci* 189:465–470
- Silva J (2004) Venture capitalists' decision-making in small equity markets: A case study using participant observation. *Venture Capital* 6(2/3):125–145
- Tyebjee TT, Bruno AV (1984) A model of venture capitalist investment activity. *Manag Sci* 30(9):1051–1066
- Wallmeroth J, Wirtz P, Groh AP (2018) Venture capital, angel financing, and crowdfunding of entrepreneurial ventures: A literature review. *Foundations Trends® Entrepreneurship* 14(1):1–129

Objective Assumptions for the Monte Carlo Simulation when Historical Data with a Desired Interval Have Limited Size



Jan Kaczmarzyk

1 Introduction

The Monte Carlo method was introduced into finance for risk measurement quite a long time ago (Hertz 1964). The Monte Carlo simulation is applied in risk measurement as a technique for advanced extended scenario analysis. Simply, it is being applied as a technique which enables considering nearly all possible scenarios (Brealey et al. 2014, p. 254; Chapman 2006, p. 177; Lam 2003, p. 111; Golden and Golden 1987, p. 54; Kroese et al. 2014, p. 388). Each risk measurement focuses on a risk variable being affected by the behavior of risk factors. The changes of risk factors reflected in the Monte Carlo simulation can be simultaneous, interdependent and nonlinear at the same time (Kaczmarzyk 2016a, p. 27). A crucial step in every simulation is, above all, to make reliable assumptions. Making assumptions means attributing probability distributions to risk factors which describe their behavior in the best possible way. A general approach lists objective or subjective assumptions based on empirical evidence or on the elicitation of information from an expert opinion, respectively (Vose 2008, p. 263, 393; Hull 2012, pp. 425–426).

Objective assumptions are and will always be intuitively better perceived than experts' subjective recommendations. Unfortunately, there are some serious limitations to objective assumptions under real-world circumstances. The financial models applied by enterprises (e.g., prospective financial analysis models, investment profitability models, valuation models, etc.) mostly use an annual interval for cash-flow projections. Therefore, the probability distributions which describe risk factors in those models have to be annual as well. Obtaining empirical data with annual interval is almost impossible in many situations due to a very limited number of

J. Kaczmarzyk (✉)
University of Economics in Katowice, Katowice, Poland
e-mail: jan.kaczmarzyk@ue.katowice.pl

observations (e.g., the respective market is simply too young, the risk factor is relatively new, or the period chosen as suitable to reflect a future situation is too short).

The aim of the paper is to indicate that to build a time-series model of a risk factor with an interval more frequent than annual to achieve an annual horizon of its probability distribution can be a reasonable solution for making objective assumptions when empirical data are somehow limited. The paper focuses on three of available approaches for reproducing a probability distribution of a risk factor over a longer horizon: (1) the traditional geometric Brownian motion with normally distributed changes of a risk factor, (2) the simulation-based motion with changes of a risk factor randomly sampled from an empirical probability distribution (the statistical bootstrap), and (3) the simulation-based motion with changes of a risk factor randomly sampled from the best-fitting probability distribution (the Monte Carlo simulation). The paper addresses currency exchange rates and commodity prices under different market circumstances as the examples of market risk factors affecting the entrepreneurial activity of enterprises.

2 Deriving a Probability Distribution of a Risk Factor in a Longer Horizon when Empirical Data Are Limited

The objective assumptions rely on empirical data availability. There are numerous techniques of fitting a probability distribution to empirical data. These include, among others, goodness-of-fit statistics or goodness-of-fit plots. Statistics provide an objective, quantitative outcome, whereas plots provide an overall picture which enables a more qualitative and intuitive choice of the best-fitting probability distribution (Vose 2008, pp. 281–297). One can consider quasi-objective assumptions too. They are based on empirically derived parameters which are subjectively modified with regard to a specific analytical situation (Kaczmarzyk 2016b, p. 100). Attributing a probability distribution to a risk factor is the first step in the Monte Carlo simulation. The second step involves capturing interdependencies between a given risk factor and the other identified ones. A theoretical probability distribution may be fitted to either values or changes of a risk factor. Generally, the historical values of market risk factors are not random, whereas their changes are. Therefore, these changes are the subject of probability distribution fitting. Additionally, changes can be converted into scenarios of a risk factor value in a given time horizon on the basis of the same initial value. These scenarios are to be random too.

The access to empirical data is primarily limited in nonfinancial enterprises, which are not particularly used to collecting empirical data of risk factors, unlike financial enterprises, which collect enormous amounts of empirical data describing their specific activities. The longer the forecasting horizon is, the more significant problem with empirical data size becomes. Financial institutions quantify risk over a daily horizon (Best 1998, pp. 17–18) which should not imply any problems with data size. Nonfinancial entities use cash-flow focused financial models which

usually refer to a relatively longer horizon of a few or over a dozen of annual periods (e.g., in a prospective financial analysis or investment profitability assessment). Enterprise models can refer even to an infinite horizon as well (e.g., in an enterprise valuation). These models are usually based on a yearly interval which forces the distributions of risk factors to be annual as well. A direct empirical data use for the fitting of a probability distribution is then nearly impossible. In most cases, empirical data size will be too small to make reliable fitting for an annual horizon.¹ The problem will especially arise when a very specific period in terms of market circumstances is chosen. The graphical analysis of an empirical probability distribution may significantly help understand the simple rule that the larger the sample is, the more reliable the fitting is (Vose 2008, p. 267). The solution may be going down to a lower than an annual interval, e.g., a monthly, weekly, or even a daily interval, and derive a respective probability distribution with a 1-year horizon using a time-series model.

The basic time-series model for reproducing a probability distribution of a risk factor exposed to market risk in a desired time horizon is the geometric Brownian motion (GBM). The general idea behind GBM assumes that financial asset logarithmic changes are normally distributed, whereas its future value has a lognormal probability distribution (Glasserman 2004, pp. 94–95). The most popular example of the GBM implementation is the famous Black-Scholes model for option pricing (Black and Scholes 1973, p. 640). The GBM dedicated equations set enables finding the expected value and the standard deviation of a capital invested in an asset. The only required parameters in fact consist of the expected value and standard deviation of logarithmic changes of an asset. Those are quantified on the basis of empirical changes derived from historical quotations (Brigo et al. 2007, pp. 5–6, 9). Using an inverse function of the lognormal cumulative distribution function, one can calculate quantiles for a given significance level. Those calculations can be easily performed using spreadsheets (which are equipped with all the necessary functions, including the respective inverse functions) (Kaczmarzyk 2018a, p. 52, 54). Above all, the traditional approach to GBM is very efficient.

Unfortunately, the normal probability distribution does not cover well extreme changes. There are more realistic probability distributions, but they are more difficult to handle in a mathematical manner (Wilmott 2006, pp. 297–299). Those more realistic theoretical probability distributions which fit better empirical changes of assets exposed to market risk are, among others, logistic, LogLogistic, hyperbolic secant, and Laplace. This has been proved in research so far (e.g., Kaczmarzyk 2018a, pp. 57, 61; Bagnato et al. 2015, p. 1232). Using these non-normal, more realistic distributions is actually quite easy through the application of the Monte Carlo simulation (Boyle 1977, p. 334; Ochoa 2004, p. 1, 15; Kaczmarzyk 2018a, pp. 53–55).

¹For example, Euro has been quoted against Polish Zloty since 01/01/1999. Till now, we have only 20 yearly changes of Euro and up to 1087 weekly changes available (stooq.pl, accessed 04/11/2019).

The Monte Carlo simulation boils down to building a step-by-step model for reproducing thousands of scenarios of future value of an asset. The step-by-step mechanism can be developed in a spreadsheet using a built-in random number generator and the inverse function of the respective cumulative distribution function (Vose 2008, pp. 330–331).

Obviously, if the changes of an asset are normally distributed, the simulation approach will bring the same results as the traditional GBM. After all, the advantages of simulation still exist then and include the following: (1) the clear presentation of the GBM mechanism, easy to get familiar with for those without significant statistical experience and (2) the simplicity of calculations of measures like quantiles or value at risk in consequence (Kaczmarzyk 2018a, p. 54).

It has to be emphasized that an empirical probability distribution always contains the actual extreme changes of a risk factor. Intuitively, using real changes instead of those reproduced from a theoretical probability distribution should be better by definition. A technique of sampling random numbers from an empirical probability distribution is commonly referred to as the statistical bootstrap (Alexander 2008, pp. 217–218). Future scenarios are generated in a multistep procedure when data for short periods are available and a longer time horizon is required. This method naturally incorporates any non-normality (Wilmott 2006, pp. 338–339).

The GBM is the basic model for reproducing a risk factor probability distribution over a longer time horizon. The Monte Carlo simulation with a best-fitting probability distribution (MCBF) and a simulation using the statistical bootstrap (BS) try to deal with a questionable normal probability assumption, being easier to get familiar with in parallel. The lower interval model (GBM, BS, or MCBF) may be (1) directly a part of a main financial model or (2) used separately just to fit an annual probability distribution of a risk factor. The best-fitting probability distribution is then used separately in a final decision model. Although the first approach does not require fitting a theoretical probability distribution to the results of a time-series model (BS and MCBF), it may significantly reduce efficiency of a final decision model due to multiplication of random numbers.² In contrast, the other approach loses efficiency when a huge number of iterations are involved in deriving an annual distribution through simulation. The larger the number of random scenarios is, the longer it takes to fit a theoretical distribution for its later use in a final decision model.

²For example, let's assume a financial model with a 1-year forecast and five risk factors (5 random numbers). If one of them is a market risk factor, embedding a weekly time-series model will multiply random numbers up to 56. The more random numbers are generated in an iteration of the Monte Carlo simulation, the longer it takes to finish calculations.

3 Methodology for Deriving the Annual Distributions of Currency Exchange Rates and Commodities

The risk factors chosen for the research were five currency exchange rates (Euro, EURPLN; Pound Sterling, GBPPLN; Swiss Frank, CHFPLN; American Dollar, USDPLN; Japanese Yen, JPYPLN) and five commodities (Crude Oil Brent, SC.C; natural gas, NG.C; wheat, ZW.C; coffee, KC.C; cocoa , CC.C). The risk factors chosen for the comparison of presented methods are only the examples of market risk factors which might affect the entrepreneurial activity of an enterprise. The catalogue of market risk factors is obviously much broader.

The research was conducted using a weekly and daily interval. Two historical periods were selected as a source of empirical data for the research. The first one (Period A) covers 230 weekly logarithmic changes of risk factors from February 27, 2004, to July 25, 2008, and it reflects time when the currency exchange rates were depreciating in relation to Polish Zloty. Period A covers 1122 daily changes of risk factors with a daily interval from February 27, 2004, to July 25, 2008. In terms of commodities behavior and their prices, Period A was a time of growth. However, due to much higher volatility of commodities, it was not so obvious. The other period taken into account (Period B) covers 196 weekly logarithmic changes of risk factors from December 25, 2015, to September 27, 2019, and there is no visible long-term trend for currency exchange rates or commodities. Period B covers 971 daily changes of risk factors with a daily interval from December 24, 2015, to September 27, 2019.

The daily data were merged on business days when the Euro was quoted against the Polish Zloty (for all considered risk factors). The weekly data were consolidated with “every Friday” criterion. The data with the daily interval had a lot of gaps in the group of commodities. This problem was marginal in terms of the weekly interval (compare Tables 1, 2, 3, and 4). Partially, such a case could occur due to differences in business days on different markets. The forecasting horizon of 1 year was 52 weeks long for the weekly interval and 257 days long for the daily one (257 is an average number of the daily quotations of the Euro during every year between 1999 and 2018). The present value of risk factors was standardized to 100.00 for the easier comparison of the results.

The procedure for GBM consisted just of (1) calculating the basic parameters (expected value, standard deviation, 1% and 99% quantiles) of the annual probability distribution of a risk factor using the GBM dedicated equations. The BS procedure was relatively more complex than the GBM procedure and involved the following: (1) building a simulation-based time-series model of the future value of a risk factor in a 1-year horizon with the changes of a risk factor reflected by randomly chosen empirical changes with replacements, (2) performing the simulation, (3) calculating the same set of basic parameters of a risk factor on the basis of its annual probability distribution, and (4) fitting the theoretical probability distribution to the annual probability distribution (to the simulation result). The MCBF procedure was the longest one and included the following: (1) fitting a theoretical

Table 2 The annual probability distributions of risk factor on the basis of weekly data – Period B

Historical period		25/12/2015 - 27/09/2019 on the basis of 196 weekly changes of a risk factor									
Distribution type / parameter	Risk factor / Method	196 (0)	196 (0)	196 (0)	196 (0)	196 (0)	196 (1)	196 (3)	196 (0)	196 (0)	196 (16)
The distribution type for reflecting weekly changes of risk factor and its parameters	GBM	Normal Mean 0.00017 Volatility 0.00643	Normal Mean 0.00018 Volatility 0.01233	Normal Mean 0.00073 Volatility 0.01447	Normal Mean 0.00288 Volatility 0.04674	Normal Mean 0.00227 Volatility 0.07810	Normal Mean 0.00085 Volatility 0.03526	Normal Mean 0.00088 Volatility 0.02736	Normal Mean 0.00088 Volatility 0.02736	Normal Mean 0.00088 Volatility 0.02736	Normal Mean 0.00088 Volatility 0.02736
	BS	RiskLognorm(0.038012, 0.03561, 10.387)	RiskErf(57.478)	RiskLogst(0.0006210, 8.0, 0.0079186)	RiskLaplace(0.0014853, 0.047863)	RiskLaplace(0.00098711, 0.075896)	RiskErf(20.102)	RiskErf(25.912)	RiskLaplace(0.03658)		
The future value of risk factor after 1 year	GBM	101.01	101.32	104.43	121.66	131.86	106.74	101.57			
	BS	100.99	101.36	104.40	121.85	132.48	106.81	101.69			
The standard deviation of risk factor after 1 year	GBM	0.13	0.96	0.59	7.33	22.12	3.58	0.38			
	BS	4.69	9.03	10.92	42.20	80.56	27.98	20.23			
The 1% quantile of risk factor after 1 year	GBM	4.69	8.82	10.88	42.51	84.93	27.95	20.25			
	BS	4.69	8.82	10.88	42.51	84.93	27.95	20.25			
The 99% quantile of risk factor after 1 year	GBM	90.58	82.06	81.48	52.47	30.35	57.20	62.95			
	BS	90.90	82.26	81.56	52.74	32.07	57.46	62.95			
The 99% quantile of risk factor after 1 year	GBM	0.33	1.63	0.59	4.22	5.60	1.96	0.44			
	BS	112.40	124.12	132.39	251.79	417.11	186.71	157.62			
The annual distribution of risk factor (best fitting in case of simulation)	GBM	101.01, Standard Deviation 4.69	101.32, Standard Deviation 9.03	104.43, Standard Deviation 10.92	121.66, Standard Deviation 42.20	131.86, Standard Deviation 80.56	106.74, Standard Deviation 27.98	101.57, Standard Deviation 20.23	101.69, Standard Deviation 20.23	101.69, Standard Deviation 20.23	101.69, Standard Deviation 20.23
	BS	RiskLognorm(55.0055, 4, 0.094317, RiskShift(45.958))	RiskLognorm(100.74, 8, 0.08578, RiskShift(1.581))	RiskLognorm(105.8, 10, 0.08413, RiskShift(1.1894))	RiskLognorm(165.5, 165.5, RiskShift(-34.334))	RiskLognorm(110.42, 6, 5.448, RiskShift(-0.889054))	RiskLognorm(104.5, 26, 429, RiskShift(-1.14))	RiskLognorm(94, 748, 2, 3.53, RiskShift(-1.0767))	RiskLognorm(94, 748, 2, 3.53, RiskShift(-1.0767))	RiskLognorm(94, 748, 2, 3.53, RiskShift(-1.0767))	RiskLognorm(94, 748, 2, 3.53, RiskShift(-1.0767))

Source: own study

Table 3 The annual probability distributions of risk factor on the basis of daily data – Period A

Historical period		27/02/2004 - 25/07/2008 (on the basis of 1122 daily changes of a risk factor)									
All empirical changes (zero changes)		1122 (4)	1122 (1)	1122 (3)	1122 (1)	1122 (7)	1122 (107)	1122 (115)	1122 (122)	1122 (109)	
Distribution type / parameter	Risk factor / Method	RF01 EURPLN	RF02 GBPPLN	RF04 USDPLN	RF05 JPYPLN	RF06 SCC	RF07 NGC	RF08 ZWC	RF09 KCC	RF10 CCC	
The distribution type for reflecting weekly changes of risk factor and its parameters	GBM	Normal, Mean -0.00038, Volatility 0.00956	Normal, Mean -0.00048, Volatility 0.00548	Normal, Mean -0.00058, Volatility 0.00699	Normal, Mean -0.00753, Volatility 0.00573	Normal, Mean 0.00120, Volatility 0.02245	Normal, Mean 0.00052, Volatility 0.04022	Normal, Mean 0.00034, Volatility 0.02516	Normal, Mean 0.00053, Volatility 0.01722	Normal, Mean 0.00052, Volatility 0.01748	
	BS	RiskLogistic(-0.073375, 0.072857, 29.0) (0.00056691, 0.0031337)	RiskLogistic(-0.0856048, 0.085468, 28.0) (0.090616, 0.089746, 23.4)	RiskLogistic(-0.090616, 0.089746, 23.4) (0.089590, 0.08947, 20.81)	RiskLogistic(-0.089590, 0.08947, 20.81) (0.0008438, 0.0008438)	RiskLogistic(-0.002842, 0.002842, 29.0)	RiskLogistic(-0.438916, 0.438916, 0.12383, 8.71)	RiskLogistic(-0.691397, 0.691397, 0.0000000)	RiskLogistic(-0.025748, 0.025748, 0.016437)	RiskLogistic(-0.016437, 0.016437, 0.016827)	RiskLogistic(-0.016827, 0.016827, 0.016827)
The future value of risk factor after 1 year	GBM	91.02	87.75	86.61	86.93	145.39	140.77	118.46	118.96	118.89	
	BS	91.04	87.72	86.60	86.93	145.22	141.10	118.47	118.84	118.81	
The standard deviation of risk factor after 1 year	GBM	6.67	7.93	9.73	10.54	54.08	101.08	33.48	33.48	33.97	
	BS	6.65	7.93	9.75	10.54	54.05	102.70	33.44	33.44	33.80	
The 1% quantile of risk factor after 1 year	GBM	6.68	7.90	9.69	10.35	50.36	80.19	47.02	47.81	28.55	
	BS	6.67	7.90	9.69	10.35	50.36	80.19	47.02	47.81	28.55	
The 99% quantile of risk factor after 1 year	GBM	76.57	70.86	66.32	66.16	58.98	25.51	42.72	60.25	59.57	
	BS	76.60	70.89	66.38	66.23	59.13	25.90	42.55	60.05	59.64	
The 99% quantile of risk factor after 1 year	GBM	107.62	107.80	111.69	116.30	314.84	512.52	279.12	217.65	219.35	
	BS	107.66	107.92	112.02	114.44	314.84	517.55	278.17	217.42	219.08	
The annual distribution of risk factor (best fitting in case of simulation)	GBM	0.10	1.21	0.65	1.43	23.26	112.08	16.61	32.54	30.97	
	BS	0.10	1.21	0.65	1.43	23.26	112.08	16.61	32.54	30.97	

Source: own study

Table 4 The annual probability distributions of risk factor on the basis of daily data – Period B

Historical period		24/12/2015- 27/09/2019 (on the basis of 971 daily changes of a risk factor)											
All empirical changes (zero changes)		971(0)	971(0)	971(1)	971(1)	971(0)	971(1)	971(146)	971(101)	971(91)	971(72)	971(485)	
Distribution type / parameter	Risk factor / Method	RF01 EURPLN	RF02 GBPRLN	RF03 CHPLN	RF04 USDPLN	RF05 JPYPLN	RF06 SCC	RF07 NGC	RF08 ZWC	RF09 KCC	RF10 CCC		
GBM	Normal, Mean 0.00003, Volatility 0.03337	Normal, Mean 0.00004, Volatility 0.00604	Normal, Mean 0.00004, Volatility 0.00747	Normal, Mean 0.00015, Volatility 0.00747	Normal, Mean 0.00045, Volatility 0.02026	Normal, Mean 0.00046, Volatility 0.03585	Normal, Mean 0.00013, Volatility 0.01250	Normal, Mean -0.00002, Volatility 0.01250	Normal, Mean -0.00002, Volatility 0.01250	Normal, Mean -0.00002, Volatility 0.01250	Normal, Mean -0.00002, Volatility 0.01250		
		RiskLogStict-(0.00045/9893.0, 0.03377)	RiskLogStict-(0.00015/641.0, 0.03165)	RiskLogStict-(0.07831, 0.073713, 28.3)	RiskLogStict-(0.03648, 0.038775, 9.575)	RiskLogStict-(0.074495, 0.074286, 20.2)	RiskLogStict-(0.022106, 0.0219681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	
BS	RiskHYGSeantc-(2)	RiskLogStict-(0.00045/9893.0, 0.03377)	RiskLogStict-(0.00015/641.0, 0.03165)	RiskLogStict-(0.07831, 0.073713, 28.3)	RiskLogStict-(0.03648, 0.038775, 9.575)	RiskLogStict-(0.074495, 0.074286, 20.2)	RiskLogStict-(0.022106, 0.0219681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	RiskLogStict-(0.019681)	
MCDF												RiskCauchy(0.00000398, 22.0, 0.016942) could be using errors so 42 RiskLogStict-(0.013222) was used instead in simulation	
GBM	The future value of risk factor after 1 year	LogNormal, Mean 101.05, Standard Deviation 5.47	LogNormal, Mean 96.29, Standard Deviation 8.96	LogNormal, Mean 101.14, Standard Deviation 7.95	LogNormal, Mean 101.14, Standard Deviation 9.84	LogNormal, Mean 104.60, Standard Deviation 12.57	LogNormal, Mean 121.13, Standard Deviation 40.40	LogNormal, Mean 135.69, Standard Deviation 83.02	LogNormal, Mean 110.64, Standard Deviation 42.33	LogNormal, Mean 101.63, Standard Deviation 20.57	LogNormal, Mean 94.34, Standard Deviation 26.39		
		RiskLogNormal(101.05, 5.47)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
MCDF	The standard deviation of risk factor after 1 year	LogNormal, Mean 101.05, Standard Deviation 5.47	LogNormal, Mean 96.29, Standard Deviation 8.96	LogNormal, Mean 101.14, Standard Deviation 7.95	LogNormal, Mean 101.14, Standard Deviation 9.84	LogNormal, Mean 104.60, Standard Deviation 12.57	LogNormal, Mean 121.13, Standard Deviation 40.40	LogNormal, Mean 135.69, Standard Deviation 83.02	LogNormal, Mean 110.64, Standard Deviation 42.33	LogNormal, Mean 101.63, Standard Deviation 20.57	LogNormal, Mean 94.34, Standard Deviation 26.39		
		RiskLogNormal(101.05, 5.47)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
GBM	The 1% quantile of risk factor after 1 year	LogNormal, Mean 101.05, Standard Deviation 5.47	LogNormal, Mean 96.29, Standard Deviation 8.96	LogNormal, Mean 101.14, Standard Deviation 7.95	LogNormal, Mean 101.14, Standard Deviation 9.84	LogNormal, Mean 104.60, Standard Deviation 12.57	LogNormal, Mean 121.13, Standard Deviation 40.40	LogNormal, Mean 135.69, Standard Deviation 83.02	LogNormal, Mean 110.64, Standard Deviation 42.33	LogNormal, Mean 101.63, Standard Deviation 20.57	LogNormal, Mean 94.34, Standard Deviation 26.39		
		RiskLogNormal(101.05, 5.47)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
MCDF	The 99% quantile of risk factor after 1 year	LogNormal, Mean 101.05, Standard Deviation 5.47	LogNormal, Mean 96.29, Standard Deviation 8.96	LogNormal, Mean 101.14, Standard Deviation 7.95	LogNormal, Mean 101.14, Standard Deviation 9.84	LogNormal, Mean 104.60, Standard Deviation 12.57	LogNormal, Mean 121.13, Standard Deviation 40.40	LogNormal, Mean 135.69, Standard Deviation 83.02	LogNormal, Mean 110.64, Standard Deviation 42.33	LogNormal, Mean 101.63, Standard Deviation 20.57	LogNormal, Mean 94.34, Standard Deviation 26.39		
		RiskLogNormal(101.05, 5.47)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
GBM	The annual distribution of risk factor (best fitting in case of simulation)	LogNormal, Mean 101.05, Standard Deviation 5.47	LogNormal, Mean 96.29, Standard Deviation 8.96	LogNormal, Mean 101.14, Standard Deviation 7.95	LogNormal, Mean 101.14, Standard Deviation 9.84	LogNormal, Mean 104.60, Standard Deviation 12.57	LogNormal, Mean 121.13, Standard Deviation 40.40	LogNormal, Mean 135.69, Standard Deviation 83.02	LogNormal, Mean 110.64, Standard Deviation 42.33	LogNormal, Mean 101.63, Standard Deviation 20.57	LogNormal, Mean 94.34, Standard Deviation 26.39		
		RiskLogNormal(101.05, 5.47)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
MCDF		RiskGamma(60.067, 0.15)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		
		RiskGamma(60.067, 0.15)	RiskLogNormal(96.29, 8.96)	RiskLogNormal(101.14, 7.95)	RiskLogNormal(101.14, 9.84)	RiskLogNormal(104.60, 12.57)	RiskLogNormal(121.13, 40.40)	RiskLogNormal(135.69, 83.02)	RiskLogNormal(110.64, 42.33)	RiskLogNormal(101.63, 20.57)	RiskLogNormal(94.34, 26.39)		

Source: own study

probability distribution to empirical logarithmic changes of a risk factor, (2) building a simulation-based time-series model of the future value of a risk factor in a 1-year horizon with the changes of a risk factor reflected by changes generated randomly using the best-fitting theoretical probability distribution, (3) performing simulation, (4) calculating the basic set of parameters of a risk factor annual probability distribution, and (5) fitting the theoretical probability distribution to the simulation result.

Simulation in BS and MCBF consisted of 100,000 random scenarios of the future value of every risk factor for achieving the very high level of precision. The Akaike information criterion (AIC) was chosen as an objective, quantitative fitting criterion for both the empirical changes of risk factors and the scenarios of the future value of a risk factor. The software used for calculations and fitting was Microsoft Excel 2019 and Palisade @RISK 7.6.1.

4 The Annual Distributions of Currency Exchange Rates and Commodities

For Period A and a weekly interval (Table 1), all the models (GBM, BS, and MCBF) gave very convergent outcomes for the considered set of currency exchange rates. Taking into account standardized present value of the risk factors equal to 100.00, the highest range between expected values resulting from the different models was 0.49 in case of JPYPLN. The highest difference between standard deviations was also determined for JPYPLN and it amounted to 0.48. In case of extreme values, the differences were significantly higher, undoubtedly due to their lower stability. The highest ranges between 1% and 99% quantiles occurred for JPYPLN and were equal to 0.62 and 3.17, respectively. The probability distribution of future value that fitted best to the results of the BS model was lognormal for EURPLN, GBPPLN, and CHFPLN. For USDPLN and JPYPLN, it occurred that Pearson5 was the theoretical distribution type which worked better. The fitting of a probability distribution to the results of the MCBF model delivered the same theoretical distribution types in case of three currency exchange rates (GBPPLN, USDPLN, and JPYPLN). The differences occurred in case of two risk factors – EURPLN (Gamma) and CHFPLN (FatigueLife).

The situation was slightly different in case of the commodities in Period A (Table 1). The highest range between expected values appeared to be 21.76. The biggest difference between standard deviations turned out to be 17.13. Both values originated from the calculations designated for NG.C. NG.C featured the highest difference between 99% quantiles which accounted for incomparable 82.76. The highest range was indicated for CC.C in terms of the range between 1% quantiles derived from various models. The difference turned out to be 7.05. The commodities were much more volatile than currency exchange rates in Period A. This had been initially justified, e.g., by much higher volatility of empirical logarithmic

changes. The results of GBM and BS were rather convergent, whereas the MCBF model sometimes significantly stood out (especially when MCBF reflected changes using the Laplace distribution). The fitting of a probability distribution for the future values of risk factors resulted with lognormal in case of every commodity for both BS and MCBF.

Period B (Table 2) was visibly different in terms of the state of the markets. The trends were rather horizontal. Still, the volatility was much higher among commodities which seems to be typical. Having compared the results, one should say that outcomes for Period B and a weekly interval were still more convergent among currency exchange rates than commodities. Considering the assumed 100.00 of standardized present value of risk factors, the highest range between expected values derived from various time-series models was 1.77 in case of GBPPLN. The most marked difference between standard deviations among currencies also appeared for GBPPLN and accounted for 0.40 in Period B. GBPPLN featured the highest range between results gained from different models for 99% quantile – 3.59. The highest range between 1% quantiles was calculated for CHFPLN (1.63). The BS model brought the probability distributions of the future values of risk factors which turned out to be closest to lognormal for every single currency exchange rate. The same happened in case of applying the MCBF model.

Due to intensified volatility on commodity markets, the ranges between measures quantified using different models were again visibly higher in Period B. The most significant range between expected values was calculated for NG.C (22.12). NG.C featured also the highest difference between standard deviations (19.38), 1% quantiles (5.60), and 99% quantiles (96.84). In terms of the probability distributions fitting the future values of risk factors at best, lognormal was the closest to ZW.C, KC.C, and CC.C in the BS model and to NG.C, ZW.C, and KC.C in the MCBF model. Pearson5 fitted best to SC.C and NG.C and their results of the BS model, whereas it was the closest one to the annual results of the MCBF model in case of SC.C and CC.C.

The MCBF model stood out significantly, especially when the probability distribution reflecting changes of a risk factor was Laplace. The MCBF results were rather close to those coming from the BS and GBM models when other types of theoretical probability distributions were applied.

The daily interval (Table 3, Period A, and Table 4, Period B) is very inefficient and demands much longer time to complete simulation. Considering the 100.00 standardized present value of risk factors, the key measures examined in the research (expected values, standard deviations, and extreme quantiles) were generally very close to those derived using a weekly interval. The differences were more visible among the commodities than among the currency exchange rates (especially in terms of standard deviations and quantiles). The Laplace distribution was found to be the closest one to the majority of the considered commodities in terms of their daily logarithmic changes. In Period A, Laplace was not fitted as the closest one in case of NG.C. The best-fitting distribution occurred to be the Dagum distribution. Unfortunately, it turned out to be giving errors every few or several iterations. Therefore, it was replaced by Laplace which had proven to be the

second-best-fitting distribution in order. In Period B, similar results were achieved for CC.C. The problematic distribution was Cauchy which was finally replaced with Laplace (the second best). This way all the calculations for the commodities were performed using Laplace. This affected the outcomes of the MCBF model which stood out of the results coming from the BS and GBM models.

5 Conclusions

A person responsible for risk analysis can build a lower interval time-series model of a risk factor, fit a theoretical probability distribution to the result, and use it in a final model. The other approach is to simply embed a lower interval model in a final model and omit the final distribution fitting to the scenarios of risk factor future values. All of the models under consideration suited well for embedding in a risk analysis model.

Taking into account that the MCBF model sometimes visibly stood out (especially while reflecting changes of risk factor with the Laplace distribution) and the simplicity of BS and GBM, it appears that embedding BS or GBM and avoiding fitting is the right solution for making the Monte Carlo simulation assumptions when historical data are limited. When it comes to the interval, the weekly one seems to be more practical, especially in terms of efficiency (less changes, less random numbers). The daily interval results were close to the weekly interval results for the currency exchange rates. The differences were a little bit more apparent among commodities.

The further discussion on objective assumptions when empirical data are limited should encompass the use of more advanced time-series models which are able to reflect a past trend of a risk factor. The problem of reflecting the independencies between risk factors and their changes is also an important issue (e.g., the case of an enterprise which possesses a portfolio of receivables in different currencies has already been addressed in terms of MCBF implementation) (Kaczmarzyk 2018b, pp. 140–150). The research brought an additional conclusion in terms of completeness of data. The daily interval had many gaps in case of commodities, whereas for the weekly interval, this problem turned out to be marginal. This indicates that a weekly interval should be used when it comes to implementation of the presented approaches in actual enterprises in their actual decision processes.

References

- Alexander C (2008) *Market risk analysis. Volume I: quantitative methods in finance*. Wiley, West Sussex
- Bagnato L, Potì V, Zoia M (2015) The role of orthogonal polynomials in adjusting hyperpolic secant and logistic distributions to analyse financial asset returns. *Stat Pap* 56:1205–1234. <https://doi.org/10.1007/s00362-014-0633-3>
- Best P (1998) *Implementing value at risk*. Wiley, West Sussex

- Black F, Scholes M (1973) The pricing of options and corporate liabilities. *J Polit Econ* 81(3):637–654
- Boyle P (1977) Options: a Monte Carlo approach. *J Financ Econ* 4:323–338
- Brealey R, Myers S, Allen F (2014) Principles of corporate finance. McGraw-Hill, New York
- Brigo D, Dalessandro A, Neugebauer M, Triki F (2007) A stochastic processes toolkit for risk management. <https://ssrn.com/abstract=1109160> (date accessed: 29/10/2019)
- Chapman R (2006) Simple tools and techniques for Enterprise risk management. Wiley, West Sussex
- Glasserman P (2004) Monte Carlo methods in financial engineering. Springer, New York
- Golden C, Golden M (1987) Beyond “what if”: a risk-oriented capital budgeting model. *J Inf Syst* 1(2):53–64
- Hertz D (1964) Risk analysis in capital investment. *Harv Bus Rev* 42(1):95–106
- Hull J (2012) Risk management and financial institutions. Wiley, New Jersey
- Kaczmarzyk J (2016a) Prospective financial analysis with regard to enterprise risk exposure – The advantages of the Monte Carlo method. *Financ Sci* 2(27):23–37. <https://doi.org/10.15611/nof.2016.2.02>
- Kaczmarzyk J (2016b) Reflecting interdependencies between risk factors in corporate risk modeling using Monte Carlo simulation. *Econometrics* 2(52):98–107. <https://doi.org/10.15611/ekt.2016.2.07>
- Kaczmarzyk J (2018a) Forecasting currency risk in an enterprise using the Monte Carlo simulation. *Financ Sci* 4(23):50–62. <https://doi.org/10.15611/fins.2018.4.04>
- Kaczmarzyk J (2018b) Forecasting currency risk of enterprise’s asset portfolio using the Monte Carlo simulation. *Finanse* 1(11):140–150. <https://doi.org/10.24425/finanse.2018.125396>
- Kroese D, Brereton T, Taimre T, Botev Z (2014) Why the Monte Carlo method is so important today. *WIREs Comput Stat* 6(6):386–392. <https://doi.org/10.1002/wics.1314>
- Lam J (2003) Enterprise risk management. From incentives to controls. Wiley, New Jersey
- Ochoa C (2004) Valuation of financial assets using Monte Carlo: when the world is not so normal. *Revista de Economía del Rosario, Bogotá (Colombia)* 7(1):1–18
- Vose D (2008) Risk analysis. A quantitative guide. Wiley, West Sussex
- Wilmott P (2006) Paul Wilmott on quantitative finance, 2nd edn. Wiley, West Sussex

Financial Determinants of Development in the Process of Gmina Management in the Silesian Voivodeship in Poland



Justyna Łukomska-Szarek

1 Introduction

Development is mostly considered as a group of positive changes, occurring both in qualitative and quantitative terms, and in the long term, it results in an increase in effectiveness and efficiency in meeting the needs of local communities (Chądryński et al. 2007). The concept could be seen to imply a favourable change, a movement from worse to better (Coetzee and Graaff 1996). The scientific output in the field of developmental problems is very rich, both in terms of the multiplicity of concepts and the level of detail of the analyses (Gałązka 2017). In the literature on the subject, attention has been drawn to the essence, specificity and scope of development at the local and regional levels (Ćwikliński 2004). It is also pointed out that the scope of activities of local governments is constantly expanding, its coordinating functions are being strengthened and optimal solutions are being sought in order to increase the effectiveness of activities and the efficiency of their financing (Brzozowska et al. 2018). Effectiveness and stability are among the most desirable qualities of a community's income. Unfortunately, increasing the investment potential and meeting the needs of the community largely depend on budgetary resources (Zawora 2018; Bartle et al. 2003).

Development can be considered from the standpoint of defining and satisfying human needs, increasing the effectiveness of a given system and capability of allocating resources located in a given area. As emphasized by Deyana (2006), it is also a process whereby the members of a society increase their potentials and institutional capacities to mobilize and manage resources to produce sustainable and justly distributed improvements in their quality of life consistent with their own

J. Łukomska-Szarek (✉)

Faculty of Management, Czestochowa University of Technology, Czestochowa, Poland

e-mail: j.lukomska-szarek@pcz.pl

aspirations. The process of local development should be based on the application of a wide range of organizational activities taking into account theoretical and practical aspects of public management assuming the performance of a wide range of public services in order to improve the quality of life. Local government units represent the basic organization in local public life, obliged to perform public tasks and manage municipal property, thus meeting social needs. Fiedor (2013) defined development at a local level and indicated that it is a systematic and harmonized activity aimed to improve conditions and ensure social, economic and spatial governance. It can be defined as a positive social, economic and political change in a country or community (Kotze 1997). However, Kudłacz (2008) stressed that local development is most often interpreted within the framework of specific planes (economic, socio-cultural, political, ecological and spatial), while it should be noted that these planes are not uniform and interrelated to each other. Their links and relationships contribute to the creation of a new sustainable development potential generating its own internal evolutionary mechanism. Local development is, therefore, an example of an autonomous model based on internal potential. In the public sector, local government units are of great importance for infrastructure investments (Jarosiński et al. 2015).

To a large extent, the development of local government units and, first of all, their investment activity are determined primarily by appropriate financial resources, which help these entities efficiently manage local finances. It is primarily the investment activity of the local government that is carried out in order to improve the quality of life of the local community and satisfy its needs. Therefore, it should guarantee long-term development of local government units through economic activation of the region (Misterek 2008). One of the most important criteria determining the investments is to ensure the possibility of financing the stages of the investments within the required deadlines (Sierak and Górnica 2011). Due to the limited nature of financial resources, it is necessary to focus on overarching objectives which contribute to the achievement of measurable results of the activities. Skilful management of a gmina determines its effectiveness and efficiency. Strengthening the development processes in local government units, especially gminas, results from their innovativeness, transfer of social knowledge and development of individual solutions to problems, which, in the course of time, will be disseminated (Hausner 2013).

Based on the group of financial indicators, it is possible to assess the financial determinants for the development of LGUs. Research assessing financial conditions in LGUs started in the 1980s, in the business sector 20 years earlier (Kloha et al. 2005). In the business sector, Beaver (1966) and Altman (1968) established a seminal model to assess the financial conditions of a firm. As emphasized by Ritonga et al. (2012), unlike the business sector in which financial assessments of firms are clearly defined, research assessing the financial conditions of LGUs is relatively new. In the LG sector, scholars and practitioners have tried to develop measures for assessing local financial conditions using various dimensions and indicators (Groves et al. 1981; Brown 1993, 1996; Mercer and Gilbert 1996; Honadle and Lloyd Jones 1998; Kleine et al. 2003; Nollenberger et al. 2003; Hendrick 2004; Kloha et al.

2005; Wang et al. 2007; Zafra-Gómez 2009; Zafra-Gómez et al. 2009). As emphasized by Wang (Wang et al. 2007) and Dennis (2004), there is still little agreement about what appropriate dimensions and indicators (which can occur in different contexts) can be used to measure the LGUs' financial condition.

With this in mind, the paper deals with the possibility of self-government authorities to influence their development on a local scale. The aim of the paper was to evaluate the financial potential of the local government in gminas in the process of local development. The study focuses primarily on revenue and expenditure instruments related to the implementation of infrastructural investments since the amount of investment expenditures of local government unit in gminas reflects its development potential. The ratio analysis covered gminas in the Silesian Voivodeship, characterizing their ability to finance investments and the scope of investment activities conducted by these units compared to gminas in Poland in total. The assessment was carried out taking into account the division of gminas into urban (without towns with powiat status, because they perform tasks of both municipalities and powiats at the same time – because they perform powiat tasks in addition to communes), mixed urban-rural and rural.

2 Selected Problems of Financial Determinants of Development in Gminas

2.1 Methodology and Data

The study covered 148 gminas (excluding 19 towns with powiat status) located in the Silesian Voivodeship, including 30 urban gminas, 96 rural gminas and 22 mixed urban-rural gminas. In order to make a comparative assessment possible, the financial condition of gminas in the Silesian Voivodeship was presented against the background of gminas in Poland in total, with the research period covering the years 2012–2017. The empirical material was prepared based on the data from the Local Data Bank of the Statistics Poland, studies by the Ministry of Finance, data from regional accounting chambers and reports on the implementation of budgets of gminas in the Silesian Voivodeship.

The choice of gminas of the Silesian Voivodeship was determined by the willingness to examine whether local governments located in a highly urbanized area of Poland use their financial development potential to stimulate investment activity. The main objective of the study was to assess the financial development potential of gminas located in the Silesian Voivodeship, taking into account their profile, urban, rural and mixed urban-rural gminas, and the reference of the ratios surveyed to gminas in Poland in total. The following research theses were therefore adopted:

- The development potential of local government units in gminas is determined by the level of operating surplus and property revenues.

- A low percentage of property revenues leads to the regression of the total capability of the gminas of the Silesian Voivodeship to develop.
- Restrictive debt policy and accumulation of own funds play a significant role in slowing down the investment activity in gminas in the Silesian Voivodeship.

The verification of the above research theses will be facilitated by financial ratio analysis, carried out ex post based on historical data in 2012–2017. The study adopted the groups of ratios covering the following research areas (Łukomska-Szarek 2011):

- Degree of financial liquidity: in the cash-based arrangement, measured as a ratio of total budget revenues and incomes to the total of budget expenditures and disbursements. The liquidity analysis is also supplemented by the assessment of the relations of revenues and incomes with expenditures and disbursements.
- Degree of financial independence: expressed as a ratio of own revenues to total budget revenues.
- Debt ratio: individual debt ratio constituting the arithmetic mean of its current revenues increased by revenues on sales of property and decreased by current expenses to total budget revenues calculated for the last 3 years; general debt limit measured as a ratio of total liabilities to total revenues (until the end of 2013 $\leq 60\%$) and debt service constituting a ratio of repayments of principal instalments and interests to budget revenues (until the end of 2013 – limit of 15%); an important element is also the measurement of due liabilities in total liabilities.
- Assessment of investment activity: ratio of property revenues in total revenues, ratio of investment expenditures to total expenditures, degree of self-financing of investment activity measured as a ratio of operating surplus and property revenues to property expenditures.
- Assessment of developmental potential: operational capability of development measured as a ratio of the difference between current revenues and current expenditures to current expenditures and total capability of local government units to develop, ratio of the difference between total revenues and current expenditures to total revenues.

Based on the above-mentioned group of indicators, it is possible to assess the financial determinants for the development of gminas in the Silesian Voivodeship. Obviously, the ratio analysis can be supplemented by vertical analysis of the development of budget revenues and expenditures, which allows for the assessment of their percentage structure according to selected classification criteria. This is a pilot test; further research will be conducted on a larger scale in different regions of Poland and in other types of local government units.

2.2 Results and Discussion

Gminas in Poland in total and those located in the Silesian Voivodeship were characterized by an escalation of budget revenues in the years 2012–2017, ranging from PLN 78.4 to 112.2 billion for the former and from PLN 5.7 to 8.15 billion for the latter. Therefore, it can be concluded that in the period of the 6 analysed years, the average budget revenues of gminas of the Silesian Voivodeship accounted for 7.4% of the total revenues of gminas in Poland. This allowed for the implementation of budget expenditures of gminas in the Silesian Voivodeship in the amount of PLN 5.8 billion in 2012 and their dynamic progression in subsequent years to PLN 8.15 billion in 2017. Revenues and budget expenditures generated in this way translate into the financial result of the budget of the local government units. A budget surplus was recorded only in the years 2015–2016, while in the remaining years, a budget deficit was found, which resulted mainly from the investment activity, since in the entire period under study, gminas generated an operating surplus. Consequently, it reached the level of PLN 0.7 billion in 2017 in the Silesian Voivodeship (a 51.4% increase compared to PLN 0.36 billion in 2012) and in gminas in total in Poland with PLN 9.1 billion (a 57.8% increase compared to PLN 5.25 billion in 2012). The operating surplus generated only in the years 2015–2016 fully covered the deficit at the property level, which for the gminas in the Silesian Voivodeship in the entire period studied ranged from PLN 0.36 to 0.7 billion. Detailed data on the budget revenues and expenditures and the financial result of the gmina budget are presented in Table 1.

The financial results recorded by local government units were affected by the structure of budget revenues. Therefore, their vertical analysis was carried out by the evaluation of the ratio of current and property revenues in total revenues, with detailed data illustrated in Table 2.

Table 1 Budget revenues and expenditures and financial result of gminas in the Silesian Voivodeship compared to gminas in Poland in total in 2012–2017 (in billion PLN)

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	D	78,4	80,0	84,5	87,7	101,8	111,2
	W	78,5	79,4	85,0	85,9	98,2	112,0
	WF	-0,1	0,6	-0,5	1,8	3,6	-0,8
	WF _O	5,25	6,27	7,11	7,58	9,34	9,09
	WF _M	-5,35	-5,67	-7,61	-5,78	-5,74	-9,89
Gminas total in the Silesian Voivodeship	D	5,7	5,92	6,3	6,54	7,6	8,15
	W	5,8	5,98	6,4	6,5	7,2	8,17
	WF	-0,1	-0,06	-0,1	0,04	0,4	-0,02
	WF _O	0,36	0,43	0,57	0,55	0,76	0,70
	WF _M	-0,46	-0,49	-0,67	-0,51	-0,36	-0,72

Source: own study based on data from the Ministry of Finance

D revenues total, *W* expenditures, *WF* financial result, *WF_O* operating financial result, *WF_M* financial result at property level

Table 2 Structure of current and property revenues of gminas in 2012–2017 (in %)

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	DB	90	91.9	91.9	91.7	95.8	95.2
	DM	10	8.1	8.1	8.3	4.2	4.8
Urban gminas	DB	89.6	91.4	91.7	92.3	94.5	94.4
	DM	10.4	8.6	8.3	7.7	5.5	5.6
Urban and rural gminas	DB	90	92.1	91.9	91.8	96	95.3
	DM	10	7.9	8.1	8.2	4	4.7
Rural gminas	DB	90.3	92.2	92	90.8	96.8	95.8
	DM	9.7	7.8	8	9.2	3.2	4.2
Gminas total in Silesian Voivodeship	DB	89.4	91	91.6	90.7	94.5	95.1
	DM	10.6	9	8.4	9.3	5.5	4.9
Urban gminas	DB	91	91.7	91.7	93	93.3	94.6
	DM	9	8.3	8.3	7	6.7	5.4
Urban and rural gminas	DB	89	92	91.5	89.7	95.2	95.4
	DM	11	8	8.5	10.3	4.8	4.6
Rural gminas	DB	88.1	89.3	91.5	89.2	94.8	95.3
	DM	11.9	10.7	8.5	10.8	5.2	4.7

Source: own study based on data from the Ministry of Finance

DB current revenues, *DM* property revenues

Table 3 shows the revenues broken down into own and transfer revenues, using the type criterion. Percentage of property revenues, which are significant from the point of view of the development activity conducted by local governments in Poland, was alarmingly low in 2016–2017 ranging from 4.2% to 4.8%. It should be noted that the lowest percentage of property revenues of 3.2% was recorded in 2016 by rural gminas, while for urban gminas, the last 2 years were marked by the level of this ratio of ca. 5.6%. Individual types of gminas in the Silesian Voivodeship had higher values of the ratio, although the amplitude of its fluctuations compared to the total number of gminas in Poland mostly did not exceed 1%. Such a low percentage of property revenues resulted mainly from lower absorption of EU funds, because only in 2016 subsidies for investment activity decreased by almost half. On the other hand, the percentage of current revenues was dominant in the structure of budget revenues. For gminas in Poland in total, it ranged between 90% and 95.8% on average, and for gminas in the Silesian Voivodeship, this was 89.4–95.1%.

The development activity of gminas depends on the degree of their financial independence, which can be quantified by calculating the share of own revenues in total revenues. Financial independence of local government units is recognized as a right to have sufficient resources to perform tasks, among which own revenues should be dominant. Based on the data presented in Table 3, it can be indicated that in the years 2012–2017, own revenues of gminas in Poland in total accounted for between 42.3% and 48.5% of total revenues, while in 2016–2017, their revenues were the lowest. A much higher degree of financial independence was observed in gminas of the Silesian Voivodeship in 2012–2015 (52.9–55.9%), 2016 (50%) and in 2017 (49.3%). Greater independence in terms of generating own revenues was

Table 3 Structure of own and transfer revenues of gminas in 2012–2017 in %

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	DW	45.3	47	48.1	48.5	43.3	42.3
	DT	54.7	53	51.9	51.5	56.7	57.7
Urban gminas	DW	57	58.6	59.2	59.3	53.6	52.5
	DT	43	41.4	40.8	40.7	46.4	47.5
Urban and rural gminas	DW	43.7	45.6	46.5	46.9	41.6	40.7
	DT	56.3	54.4	53.5	53.1	58.4	59.3
Rural gminas	DW	35.2	36.8	38.5	39.3	34.5	33.6
	DT	64.8	63.2	61.5	60.7	65.5	66.4
Gminas total in Silesian Voivodeship	DW	52.9	54.6	55.7	55.9	50	49.3
	DT	47.1	45.4	44.3	44.1	50	50.7
Urban gminas	DW	64	66.6	66.5	66.4	59.6	59.3
	DT	36	33.4	33.5	33.6	40.4	40.7
Urban and rural gminas	DW	47.8	50	51.6	52.5	46.5	45.3
	DT	52.3	50.1	48.5	47.6	53.6	54.8
Rural gminas	DW	46.9	47.3	49	48.7	43.8	43.0,3
	DT	53.2	52.8	51.1	51.4	56.3	56.8

Source: own study based on data from the Ministry of Finance

DW own revenues, *DT* transfer revenues

recorded by urban gminas in the Silesian Voivodeship (59.3–66.6%) compared to rural gminas (43.3–49%). It should be noted that the rapid progression of transfer revenues in 2016–2017 was caused, on the one hand, by an increase in special-purpose subsidies for the payment of benefits with the 500+ Programme and, on the other hand, by a simultaneous decrease in special-purpose subsidies for investment activities, especially EU subsidies. This resulted in a declining degree of financial independence of all types of gminas, with the greatest extent observed in rural gminas.

Analysis of the structure of budgetary expenditures presented in Table 4 reveals that the largest ratio of property expenditures to total expenditures was recorded by rural gminas both in the Silesian Voivodeship (11–20.5%) and in Poland in total (9.9–18.1%). Irrespective of the type of gmina (urban, rural), it may be concluded that gminas in the Silesian Voivodeship had a higher ratio of property expenditures in total expenditures than the average in Poland. It should also be noted that this ratio can be described as an indicator of the level of investment activity, which unfortunately has slowed down considerably after 2015. In the case of gminas, the total value of this ratio ranged between 15.2% and 17% in 2012–2015, and it was 10.2% in 2016 and 13.6% in 2017. The gminas of the Silesian Voivodeship invested at the level of 17.2–18.8% of total expenditures until 2015, 10.8% in 2016 and 13.9% in 2017. The last 2 years show that the average values of the ratios for the gminas in Poland in total and in the Silesian Voivodeship are very similar, also in individual types of gminas.

These data allow for the conclusion that gminas in the Silesian Voivodeship, using their financial potential, conducted investment activity similar to the average values for gminas in Poland in general, although, despite similar trends in the changes in the ratio, gminas in the Silesian Voivodeship recorded higher values but only to about 1%.

Table 4 Structure of current and property expenditures of gminas in 2012–2017 (in %)

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	WM	16.8	15.3	17	15.2	10.2	13.6
	WB	83.2	84.7	83	84.8	89.8	86.4
Urban gminas	WM	16.4	14.3	15.9	14.2	10.3	13.2
	WB	83.6	85.7	84.1	85.8	89.7	86.8
Urban and rural gminas	WM	16.8	15.3	17	15	10.3	13.6
	WB	83.2	84.7	83	85	89.7	86.4
Rural gminas	WM	17.2	16.3	18.1	16.2	9.9	13.9
	WB	82.8	83.7	81.9	83.8	90.1	86.1
Gminas total in Silesian Voivodeship	WM	18.4	17.1	18.8	17.2	10.8	13.7
	WB	81.6	82.9	81.2	82.8	89.2	86.3
Urban gminas	WM	16.9	16	17.4	15.4	10.8	13.4
	WB	83.1	84	82.6	84.6	89.2	86.6
Urban and rural gminas	WM	18.2	15.5	18.5	17.7	10.5	13.4
	WB	81.9	84.6	81.6	82.4	89.6	86.7
Rural gminas	WM	20.1	19.7	20.5	18.5	11	14.4
	WB	80	80.4	79.6	81.6	89.1	85.7

Source: own study based on data from the Ministry of Finance
WB current expenditures, *WM* property expenditures

Table 5 Ratios of operational and total capacity of development of gminas in 2012–2017 (in %)

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	WOR	7.44	8.53	9.15	9.42	9.58	8.59
	WORC	16.69	15.94	16.51	16.94	13.38	12.98
Gminas total in the Silesian Voivodeship	WOR	7.12	7.98	9.95	9.27	10.58	9.03
	WORC	16.97	16.26	17.51	17.71	15.49	13.49

Source: own study based on data from the Ministry of Finance
WOR operational capacity of development, *WORC* total capacity of development

The investment activity was determined in the years 2012–2017 by the operational and total development capacity. The evaluation of the development potential indicates the actual possibilities of financing the expenditures related to the development of local government units due to the surplus of free financial funds. In the case of operational development capacity (measured as a ratio of the difference between current revenues and current expenditures to current expenditures), property income is not taken into account. Thus, the examined measure can be used for projection of operating expenses. Furthermore, in the case of the total capacity of local government units to develop (ratio of the difference between total revenues and current expenditures to revenues in total), property revenues are taken into account, but it can be pointed out that they have a minor character (Dylewski et al. 2010). Table 5 presents the calculated measures in this respect for gminas in Poland and in the Silesian Voivodeship. Their analysis shows that although gminas located in the Silesian Voivodeship showed a slightly higher operational capacity to develop

(7.12–10.58%) compared to gminas in Poland in total (7.44–9.58%) and total capacity to develop (13.49–17.71% compared to 12.98–16.94% for gminas in Poland in total), the trends of changes were similar in individual years. The highest development capacity was found in 2014–2015 and the lowest in 2016–2017, which was also reflected in the investment activities.

The rapid decrease in both the operating capacity and total development capacity of the units surveyed in 2016 was mainly due to lower property revenues, especially from subsidies for investment activities. The years 2016 and 2017 were also characteristic for high opportunities for self-financing of development activities, as for the gminas in Poland in total, the ratio was 180.9% and 264.7%, respectively. In 2016, the gminas of the Silesian Voivodeship generated the ratio at the level of 179% (Table 6). The lowest level of self-financing was observed in mixed urban-rural gminas in the Silesian Voivodeship, which were the only ones in 2014 to reach a value below 100%. Unfortunately, the reduction in the operational and total development capacity and the accumulation of free funds from self-financing and the restrictive debt policy adversely affected the investment activities of the units studied. It was only in 2017 that a change of trend was observed and local government units returned to the path of moderate investment activity.

According to legal regulations, since 2014–2018, debt has been monitored primarily based on individual debt ratio assessment. Until the end of 2013, a general debt limit was used (max. 60%) and a debt service limit (max. 15%). Detailed data concerning the evaluation of the debt level for the gminas studied are presented in Tables 7 and 8. Their analysis leads to the conclusion that in the years 2012–2017, the ratio of total liabilities in total revenues in gminas in Poland was characterized by a decreasing trend from 33.4% to 22.4%, and for gminas in the Silesian Voivodeship, this was from 28.3% to 20.0%. The presented data confirm the thesis of the decreasing debt level and increasing the possibility of self-financing of gminas in Poland.

Over the years studied, urban and urban-rural gminas increased liabilities to a greater extent compared to rural gminas. Much lower and very similar values of the ratio were observed for individual types of gminas located in the Silesian

Table 6 The degree of self-financing of gminas investments in 2012–2017 (in %)

Specification	2012	2013	2014	2015	2016	2017
Gminas total in Poland	130.3	190.2	114.3	148.1	180.9	264.7
Urban gminas	106.8	255.4	124.8	156.8	177.1	124.6
Urban and rural gminas	131.2	152.3	105.4	137.1	160.1	118.8
Rural gminas	153	162.9	112.6	150.4	205.5	550.8
Gminas total in Silesian Voivodeship	108.0	124.3	112.8	135.9	179.0	117.0
Urban gminas	100.4	130.4	138.7	148.6	176.9	114.8
Urban and rural gminas	103.8	116.4	96	134.9	168.3	112.1
Rural gminas	119.8	126.1	103.7	124.3	191.8	124

Source: own study based on data from the Ministry of Finance

Table 7 Debt ratios of gminas in 2012–2017 (in %)

Specification		2012	2013	2014	2015	2016	2017
Gminas total in Poland	WZ ₁	33.4	32.0	31.3	28.8	23.4	22.4
	WZ ₃	8.9	9.0	5.5	5.8	4.4	3.8
Urban gminas	WZ ₁	35.5	33.6	32.1	29.6	23.9	22.7
	WZ ₃	8	8,5	5	5	4,3	3,6
Urban and rural gminas	WZ ₁	35,8	34,6	34,1	31,7	26	25
	WZ ₃	9.4	9.7	5.7	6	4.6	4.2
Rural gminas	WZ ₁	28.8	27.8	27.7	25.2	20.4	19.6
	WZ ₃	9.2	8.9	5.8	6.4	4.3	3.7
Gminas total in in Silesian Voivodeship	WZ ₁	28.3	28.2	28.7	27.6	22.0	20.0
	WZ ₃	7.5	8.2	5.2	6.7	4.9	3.7
Urban gminas	WZ ₁	27	27.1	26.1	26	20.9	19.1
	WZ ₃	5.9	7.3	4.4	4.4	4.5	3.1
Urban and rural gminas	WZ ₁	29.2	28.9	29.9	28.9	22.9	20.2
	WZ ₃	7.8	7.6	5.6	9.2	5.6	4.3
Rural gminas	WZ ₁	28.6	28.7	30.1	28	22.2	20.8
	WZ ₃	8.8	9.8	5.6	6.5	4,6	3.7

Source: own study based on data from the Ministry of Finance
WZ₁ share of total liabilities in total revenues, WZ₃ total amount of debt

Table 8 Individual debt ratio in 2014–2018 (in %)

Specification	2014	2015	2016	2017	2018
Gminas total in Poland	9.1	9.8	10.3	10.4	10.4
Urban gminas	9.0	9.7	10.4	10.4	10.5
Urban and rural gminas	8.9	9.4	10.0	10.3	10.3
Rural gminas	9.5	10.2	10.5	10.5	10.4
Gminas total in Silesian Voivodeship	9.3	10.0	10.4	10.5	10.6
Urban gminas	9.4	10.0	10.7	10.8	10.5
Urban and rural gminas	8.7	9.4	10.2	10.3	10.6
Rural gminas	9.8	10.4	10.4	10.5	10.6

Source: own study based on data from the Ministry of Finance

Voivodeship, because the ratio decreased from 27% to 19.1% for urban gminas, from 29.2% to 20.2% for urban-rural gminas and from 28.6% to 20.8% for rural gminas. A similar declining trend and at the same time a small amplitude of fluctuations can be observed in the case of the debt service ratio, which decreased from 8.9% to 3.8% for gminas in Poland in total and from 7.5% to 3.7% for gminas in the Silesian Voivodeship. It is worth noting that local governments also did not show a high ratio of due liabilities to total liabilities, because the ratio characterized by a constant regression did not exceed 0.8% for gminas in Poland in total and 1.2% for gminas in the Silesian Voivodeship. The assessment of the debt level is complemented by an analysis of the individual debt ratio, which has been obligatorily monitored by local government units in Poland since 2014. The comparison of the

calculated measure for individual types of gminas is presented in Table 8. Their analysis allows for concluding that the possibilities of repayment of instalments and interest on the generated income were very similar in the types of gminas studied and were characterized by a gradual escalation. For gminas in total in Poland, the ratio changed from 9.1% in 2012 to the level of 10.4% in 2017, whereas for gminas in the Silesian Voivodeship, this changed from 9.3% to 10.6%, respectively.

Therefore, possibilities of repayment of financial liabilities are increasing, but the ratio of liabilities incurred in total revenues is decreasing, which confirms that the introduction of the new ratio in 2014 has led to the restrictive policy of gminas in terms of debt, but also to the stabilization of financial liquidity. The ratios used to evaluate the financial liquidity are presented in Table 9. When evaluating financial liquidity on a cash basis, it may be indicated that the units studied reached a value above unity, and thus the budget revenues and income fully covered the budget expenditures and disbursements, although the calculated measures were very close to the value of 1.

It is accepted that liquidity ratios should be at least equal to unity (1.0). If this is the case, budget expenditures and disbursements are fully reflected in revenues and incomes, and there is no tension in the repayment of due liabilities in local

Table 9 Financial liquidity ratios of gminas in 2012–2017

	Gminas total in Poland	Gminas of Silesian Voivodeship			
		Total	Urban	Urban and rural	Rural
WPK – degree of financial liquidity in the cash-based arrangement					
2012	1,05	1,06	1,08	1,04	1,06
2013	1,05	1,05	1,06	1,03	1,06
2014	1,05	1,07	1,09	1,04	1,06
2015	1,06	1,07	1,09	1,05	1,07
2016	1,07	1,09	1,11	1,07	1,09
2017	1,06	1,08	1,08	1,06	1,09
WPWO – ratio of coverage of expenditures in total with budget incomes and revenues					
2012	1,13	1,12	1,12	1,11	1,13
2013	1,14	1,13	1,14	1,10	1,16
2014	1,11	1,11	1,13	1,09	1,11
2015	1,12	1,12	1,12	1,11	1,13
2016	1,12	1,13	1,14	1,12	1,13
2017	1,11	1,11	1,11	1,11	1,12
WPDO – ratio of coverage of expenditures and disbursements with incomes					
2012	1,08	1,07	1,06	1,06	1,08
2013	1,08	1,08	1,09	1,06	1,10
2014	1,06	1,05	1,02	1,06	1,07
2015	1,04	1,04	1,04	1,04	1,04
2016	1,01	0,99	0,99	1,00	0,99
2017	1,05	1,03	1,04	1,03	1,03

Source: own study based on data from the Ministry of Finance

government units. If the ratios are below unity, the liquidity of the local government budget is undermined, and, consequently, the risk of losing the possibility of financing current operations occurs. The gminas are not threatened with excess financial liquidity, with the ratios of covering expenditures and disbursements in total with revenues and incomes in total also are at the level of slightly over 1, which results from the fact that the gminas properly performed their own tasks and implemented effective income policies (Łukomska-Szarek 2011).

3 Conclusions

In conclusion of the investigations of the financial determinants of the development of local government units in Poland, it can be pointed out that the ratio analysis of the budget management allowed for the presentation of the structure and directions of changes in the revenues and expenditures of the gminas studied in the years 2012–2017. The research conducted based on a selected group of ratios allows for the conclusion that until 2016, there was a significant slowdown in investment activity of gminas in Poland and in the Silesian Voivodeship and a restrictive policy with regard to their financial liquidity and debt and the accumulation of free cash within the framework of self-financing. The investment capacity of gminas in the economic dimension is expressed in the amount of financial resources which they can allocate to finance investment tasks. The amount of these funds is related to the level of budget revenues of the local government and the level of expenditures on current tasks. One of the basic problems of local government units is limited financial resources in relation to the scope of investment needs. The fast growth dynamics of social expectations compared to the deteriorating financial capabilities of public budgets leads to the escalation of crisis situations. The growing debt in the local government sector and statutory restrictions resulting from public finance regulations encourage local government units to seek alternative ways of financing investments (Hajdys 2014). In the years 2012–2017, local government units in Poland generated relatively little property revenues, and the increase in special-purpose subsidies within the framework of current activities translated into a weakening of their financial independence. The gminas also did not have any major problems with the repayment of financial liabilities, especially those due. The operational and total development potential of the units studied, high in the years 2014–2015, has decreased since 2016, translating into the lowest level of investments in the period analysed. Despite the high self-financing capacity of the gminas, the units conducted a moderate investment policy in this period. The slowdown in investment activity of gminas in Poland and the Silesian Voivodeship resulted from the inability to increase budget revenues allocated to financing investments, repayment of debt resulting from the implementation of investment projects in the previous years and change in the principles of managing the level of debt, in particular the change in the structure of the individual debt ratio since 2014, which forced gminas to limit and monitor debt, consequently leading to a decrease in the ability of these units to incur

new liabilities. The restrictive debt policy and accumulation of own financial resources played a significant role in slowing down the investment activity of gminas in the Silesian Voivodeship, but also contributed to the stabilization of their financial liquidity, which in the analysed years oscillated above a unity, ensuring full covering of budget expenditures and disbursements by budget revenues and incomes. It should be noted that the development potential of local government units in gminas is determined by the level of operating surplus and property revenues. In the period studied, the years of high operating surplus and the progression of property revenues resulted in an increase in capital expenditures. In contrast, a low percentage of property revenues leads to the regression of the total capability of the gminas of the Silesian Voivodeship to develop. Intensification of investment activities and acceleration of development at the local level has been recorded only since 2017. This was due to the good economic situation, progressive budget revenues and especially development subsidies. Further research will be conducted on a larger scale in different regions of Poland and in other types of local government units. Further stages of the study may include the use of the regression model, to allow for assessing the relationship between the assessed indicators.

References

- Altman EI (1968) Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *J Financ* 23(4):589–609. <https://doi.org/10.2307/2978933>
- Bartle JR, Ebdon C, Krane D (2003) Beyond the property tax: local government revenue diversification, *Journal of Public Budgeting, Account Financ Manag* 15(4):622–648. <https://doi.org/10.1108/JPBAFM-15-04-2003-B006>
- Beaver WH (1966) Financial ratios as predictors of failure. *J Account Res* 4:71–111. <https://doi.org/10.2307/2490171>
- Brown KW (1993) The 10-point test of financial condition: toward an easy-to-use assessment tool for smaller cities. *Gov Financ Rev* 9:21–26
- Brown KW (1996) Trends in key ratios using the GFOA financial indicators databases 1989–1993. *Government Finance Review* 12:30–34
- Brzozowska K, Gorzałczyńska-Koczkodaj M, Kogut-Jaworska M (2018) Szaja M. Finansowe determinanty rozwoju lokalnego i regionalnego. *edu-Libri, Kraków-Legionowo*
- Chądzyński J, Nowakowska A, Przygodzki Z (2007) Region i jego rozwój w warunkach globalizacji. *CeDeWu, Warsaw*
- Coetzee JK, Graaff J (eds) (1996) *Reconstruction, development and people*. International Thompson Publishing, Johannesburg
- Ćwikliński H (ed) (2004) *Polityka gospodarcza*. Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk
- Dylewski M, Filipiak B, Gorzałczyńska-Koczkodaj M (2010) *Metody analityczne w działalności jednostek podsektora samorządowego*. Difin, Warsaw
- Dennis LM (2004) *Determinants of financial condition: a study of US cities*. University of Central Florida Orlando, Florida
- Deyana NI (2006) *Evaluating local economic development in the City of Cape Town*. University of Stellenbosch, Stellenbosch
- Fiedor B (2013) Normatywny charakter koncepcji trwałego rozwoju a potrzeba poszukiwania jej podstaw mikroekonomicznych. *Handel wewnętrzny* 1:7–20

- Gałązka A (2017) Teoretyczne podstawy rozwoju regionalnego – wybrane, teorie, czynniki i bariery rozwoju regionalnego. *Studia BAS* 1(49):9–61
- Groves SM, Godsey WM, Shulman MA (1981) Financial indicators for local government. *Public Budg Financ* 1(2):5–19
- Hajdys D (2014) Partnerstwo publiczno-prywatne a polityka inwestycyjna samorządów. *Finanse Komunalne* 3:49–56
- Hausner J (2013) Narastające dysfunkcje, zasadnicze dylematy, konieczne działania. Raport o stanie samorządności terytorialnej w Polsce. Małopolska Szkoła Administracji Publicznej. UE w Krakowie, Kraków, p 14
- Hendrick R (2004) Assessing and measuring the fiscal health of local government: focus on Chicago suburban municipalities. *Urban Aff Rev* 40:78–114
- Honadle BW, Lloyd Jones M (1998) Analyzing rural local governments, financial condition: an exploratory application of three tools. *Public Budg Financ* 18(2):69–86
- Jarosiński K, Maśloch G, Opalka B, Grzymała Z (2015) Financing and management of public sector investments on local and regional levels. PWN, Warsaw
- Kotze DA (1997) Development administration and management. A holistic approach. Van Schaik, Pretoria
- Kleine R, Kloha P, Weissert CS (2003) Monitoring local government fiscal health: Michigan's new 10-point scale of fiscal distress. *Gov Financ Rev* 19(3):18–24
- Kloha P, Weissert CS, Kleine R (2005) Developing and testing a composite model to predict local fiscal distress. *Public Adm Rev* 65(3):313–323
- Kudłacz T (2008) Rozwój lokalny. In: Hausner J (ed) *Ekonomia społeczna a rozwój*, Małopolska Szkoła Administracji Publicznej. UE w Krakowie, Kraków, pp 103–123
- Łukomska-Szarek J (2011) Financial analysis as a method of assessment of financial standing in local self-governments. Publish house Education and Science s.r.o., OOO Rusnauckniga, Praha-Belgorod
- Mercer T, Gilbert M (1996) A financial condition index for Nova Scotia municipalities. *Gov Financ Rev* 12(5):36–38. 40
- Misterek W (2008) Zewnętrzne źródła finansowania działalności inwestycyjnej jednostek samorządu terytorialnego. Difin, Warsaw
- Nollenberger K, Groves SM, Valente MG (2003) Evaluating financial condition: a handbook for local government. International City/County Managers Association, Washington, DC
- Ritonga IT, Clark C, Wickremasinghe G (2012) Assessing financial condition of local government in Indonesia: an exploration. *Pub Munic Financ* 1(2):37–50
- Sierak J, Górniak R (2011) Ocena efektywności i finansowanie projektów inwestycyjnych jednostek samorządu terytorialnego współfinansowanych funduszami Unii Europejskiej. Oficyna Wydawnicza SGH, Warsaw
- Wang X, Dennis L, Tu YSJ (2007) Measuring financial condition: a study of US states. *Public Budg Financ* 27(2):1–21. <https://doi.org/10.1111/j.1540-5850.2007.00872.x>
- Zafra-Gómez JL, López-Hernández AM, Hernández-Bastida A (2009) Developing a model to measure financial condition in local government. *Am Rev Public Adm* 39(4):425–449. <https://doi.org/10.1177/0275074008320710>
- Zafra-Gómez JL (2009) Evaluating financial performance in local government: maximizing the benchmarking value. *Int Rev Adm Sci* 75(1):151–167. <https://doi.org/10.1177/0020852308099510>
- Zawora J (2018) Synthetic assessment of financial situation of local governments in Podkarpackie Voivodeship compared with other polish provinces. *Lex Localis J Local Self Gov* 16(2):311–335. [https://doi.org/10.4335/16.2.311-335\(2018\)](https://doi.org/10.4335/16.2.311-335(2018))

Is the Situation of Polish Public Hospitals Healthy? Indebtedness Analysis



Katarzyna M. Miszczyńska and Piotr M. Miszczyński

1 Introduction

Problems concerning the performance of public healthcare units are widely analysed both by national and foreign centres: Alemi and Gustafson (2006), Martin et al. (2012), Vanberkel et al. (2012) and Smith and Topol (2013). Well-organized performance of healthcare units is crucial not only from the perspective of patients' satisfaction but also from the perspective of managers. In the literature, it is commonly assumed that the performance of healthcare sector in Poland is far from satisfactory. This statement is confirmed in the studies conducted by Nojszewska (2011a, b), Suchecka (2011), Frączkiewicz-Wronka (2010), Hass-Symotiuik (2011), Susmarski (2016) and Miszczyńska (2018, 2019).

The main problems of Polish public hospitals are concentrated upon unsatisfactory financial situation connected with growing indebtedness that adversely affects not only the development of healthcare but also quality of medical services provided.

An interesting study, from the point of view of the analysis of the financial condition of hospitals in Poland, was presented by Dubas-Jakóbczyk (2017). In that study, the assessment of the financial condition of university hospitals in Poland was made. As a result, it was concluded that the financial situation of university hospitals varied. Over 70% of the hospitals in question were characterized by high level

K. M. Miszczyńska (✉)

Faculty of Economics and Sociology, Department of Public Finance, University of Łódź, Łódź, Poland

e-mail: katarzyna.miszczynska@uni.lodz.pl

P. M. Miszczyński

Faculty of Economics and Sociology, Department of Operations Research, University of Łódź, Łódź, Poland

e-mail: piotr.miszczynski@uni.lodz.pl

of indebtedness. On the other hand, Krzeczewski (2014) studied the impact of the founding body on the financial efficiency of hospitals in the Lodz region. The author indicated differences in the financial efficiency of hospitals subordinate to various founding bodies. The analysis carried out in the article has led to the conclusion that the founding body has a significant impact on the financial efficiency of its hospitals.

In the study of Łagowski (2016), indicators from the group of liquidity assessment, indebtedness and profitability were used to analyse the financial situation of medical entities from the Silesian Voivodeship. In the final stage of the study, the model to assess the risk of bankruptcy (which was created in Poznań academic centre) was used.

What is more, Bem et al. (2015) examined the relationship between profitability of hospitals and their debt ratios. The study led to the statement that the hospitals characterized by low profitability were more heavily indebted than those having high profitability ratios.

Rabiej (2018) examined in her article some issues related to the financial situation of independent public healthcare providers and the consequences for their functioning. The analysis was conducted on the selected public hospitals. It was based on the methodology created by the Ministry of Health and published in the regulation of the Minister of Health on April 12, 2017, in Journal of Laws No. of 2017.

Miszczńska (2019) analysed in her work some determinants of the indebtedness of selected public hospitals in Łódź, and in 2020 she extended her research to include public hospitals from Poland. Both studies made it possible to identify the factors causing the increasing level of indebtedness of public hospitals, using financial analysis and advanced econometric modelling methods (Miszczyńska and Antczak, 2020).

All in all, by means of in-depth analysis of professional literature and the economic situation of healthcare sector in Poland in the years 2007–2017 helped to identify the main subject of the study, which was the assessment of indebtedness of public hospitals in Poland. Referring to the subject of the study, the following main goals were identified:

- Construction of the “unhealthy debt” indicator
- Assessment of the unhealthy debt in terms of individual hospitals/voivodeships and founding bodies over time

According to the goals set in the study, the following research questions have been raised:

1. What is the value of unhealthy debt in 2007–2017?
2. What percentage of hospitals have unhealthy debt?
3. What are the trends in the formation of unhealthy debt in terms of quantity and value?

2 Methodology and Data

2.1 Methodology

The study was based on public hospitals operating in Poland in the years 2007–2017. The scope of the research was based on the availability of data. During the analysis, a particular emphasis was put on the features that differentiate the units in question. The founding body of the unit was the feature that distinguished the hospitals and constituted the basis for the analyses. Therefore, the following groups of units were distinguished: universities (abbr. “U”), poviats-commune (abbr. “P-C”), marshal’s office (abbr. “M”) and ministry hospitals (abbr. “MIN”). In order to achieve the goals, an indicator analysis was conducted. What is more, the analysis of trends of financial ratios, carried out as a part of spatial analysis of time series, was made from different perspectives:

- Individually
- Divided into homogeneous groups of hospitals from the perspective of the founding body

Additionally, the study was enriched by the analysis of hospitals divided into groups according to their location in one of Polish Voivodeships.

2.2 Data

The hospital financial characteristics were obtained from the audited annual financial reports that originated from the Amadeus database. On that basis, all hospital financial indicators were calculated. The authors did not have any insight into individual balance sheet categories. However, as the data were obtained for all hospitals from one source, they were comparable. The conducted study was based on indebtedness ratios. To all of the analysed indicators, the reference values were assigned, which enabled a later assessment of the performance of the analysed hospitals. The reference values were taken from the guidelines of the Ministry of Health and originated from the regulation of the Minister of Health on April 12, 2017, on economic and financial indicators necessary to prepare an analysis and forecast of the economic and financial situation of independent public healthcare institutions (Journal of Laws No. of 2017, item 832). Basing the financial analysis of hospitals on the guidelines of the Ministry of Health is a frequently used practice that is supported by the literature on the subject (Czerw and Religioni 2012, Miszczyńska 2019, Rabiej 2018). Table 1 contains a list of indicators with reference values.

For the whole period, descriptive statistics of all hospitals in question were calculated. The descriptive statistics, in terms of debt ratio, for these hospital characteristics are included in Table 2.

Table 1 List of indicators with reference values

Field	Ind.	Formula	Reference value
Indebtedness	Solvency [SLV]	(current liabilities + long-term debt)/shareholder's funds	0,00 – 0,5
	Debt ratio [DT]	[(current liabilities + non-current liabilities)/total assets]*100%	≈40%

Table 2 Descriptive statistics for debt ratio between years 2007 and 2017

Variable	Descriptive statistics (DT)					
	N	Mean	Median	Min.	Max.	Stand. dev.
2017	321	0,771,000	0,710,694	0,071129	2,962,947	0,436,345
2016	321	0,766,923	0,708,254	0,068819	2,934,048	0,437,794
2015	321	0,775,077	0,714,781	0,073440	2,991,846	0,436,422
2014	321	0,758,769	0,691,453	0,064197	2,876,250	0,445,195
2013	321	0,759,461	0,692,324	0,079597	3,422,307	0,470,657
2012	321	0,759,668	0,691,831	0,044729	3,718,165	0,507,216
2011	321	0,560,269	0,464,018	0,077541	3,528,852	0,444,164
2010	321	0,497,454	0,384,029	0,000738	2,845,870	0,412,342
2009	321	0,482,129	0,367,198	0,033934	2,535,411	0,389,222
2008	321	0,493,274	0,367,079	0,002338	2,781,740	0,408,472
2007	321	0,541,198	0,368,719	0,043944	3,307,556	0,512,915

Source: own calculations

3 Results

The analysis was conducted on the basis of 321 public hospitals, from over 600 operating units located in Poland and operating in the years 2007–2017. According to the data collected from the Amadeus database, almost 49% out of 600 public hospitals constituted poviats-commune hospitals (abbr. “P-C”). Detailed statistics on the population structure is presented in Fig. A.1. As it was described earlier, the hospitals were divided according to their founding body as follows: universities (abbr. “U”), poviats-commune (abbr. “P-C”), marshal’s office (abbr. “M”) and ministry hospitals (abbr. “MIN”). Due to the fact that the choice of the sample was dictated by the availability of data, it was necessary to verify some assumptions regarding the distributions of both samples. That is why the χ^2 test was conducted according to which the results of this study could be generalized to the entire population. Details concerning the sample structure are presented in Annex 1 in Table A.1 and Fig. A.1, respectively.

3.1 Financial Situation – Individual Entities

The financial situation of the analysed public hospitals did not change significantly in years 2007–2017. The hospitals were characterized by alarming indices in all of the analysed ratios. In many cases the hospitals were losing the ability of paying their liabilities. At the same time, a similarly large group of units was characterized by the inability of effective application of external financing. There were also some units with negative values of the analysed indicator resulting from a negative level of shareholder’s funds. That concerned mainly poviats-commune hospitals. On the other hand, extremely high levels were related to the negative level of shareholder’s funds in the previous year and very low level in the currently analysed year. Figure 1 presents values of solvency ratio in the year 2017. The vast majority of the analysed units had a solvency ratio ranging from -2 to 2.

The overall debt ratio is another analysed indicator. According to the guidelines of the Ministry of Health, it should not exceed 0.4. However, this is not the case here, either. Almost all the analysed hospitals exceeded this reference value. In 2017, only 289 out of 321 hospitals exceeded the reference value. For comparison, in 2007 that level was exceeded by 192 units. Figure 2 presents values of debt ratio in the year 2017.

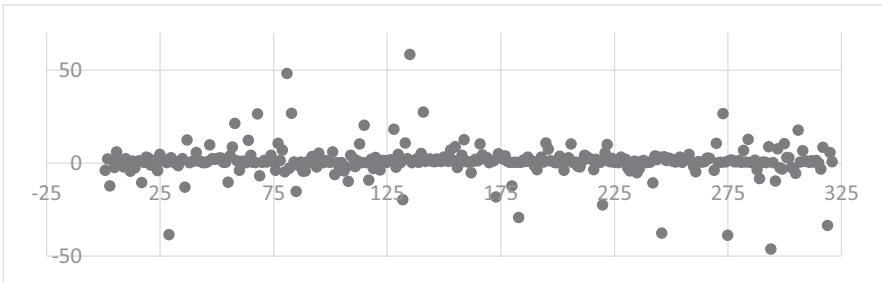


Fig. 1 Public hospitals – solvency ratio, SLV (year 2017)

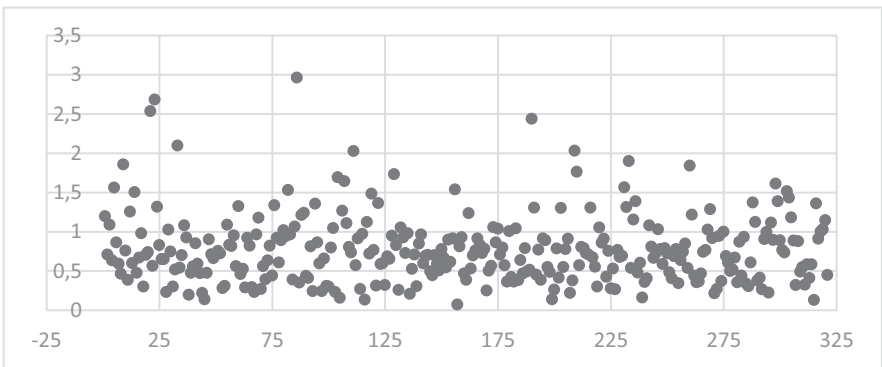


Fig. 2 Public hospitals – debt ratio (year 2017)

The total debt of the analysed hospitals is rising year by year despite all the reforms that have been implemented in the Polish healthcare sector. The detailed results are presented in Fig. 3.

3.2 The “Unhealthy Debt” Ratio

According to the analysis of the debt ratio, the “unhealthy” debt ratio was constructed in terms of quantity and value. In terms of value, it determines the value of debt generated by hospitals with a debt ratio higher than 30% (for suggested value, see Table 1 and the equation below).

$$\text{Unhealthy debt}_v = (\text{debt of entities with debt ratio over 40\%})$$

In quantitative terms, it presents the number of hospitals with debt ratio higher than 30% (see the equation below).

$$\text{Unhealthy debt}_{ql} = (\text{number of entities with debt ratio over 40\%})$$

The results of the analysis in terms of the total debt and unhealthy debt in terms of their values are presented in Fig. 4. As shown in Fig. 3, both the total debt and unhealthy values increased almost fourfold in the years 2007–2017. In 2017 they amounted to over 20 million PLN. Thus, as illustrated in Fig. 5, they account for as much as 96% of total debt. Over the analysed years, this share increased by almost 18 percentage points.

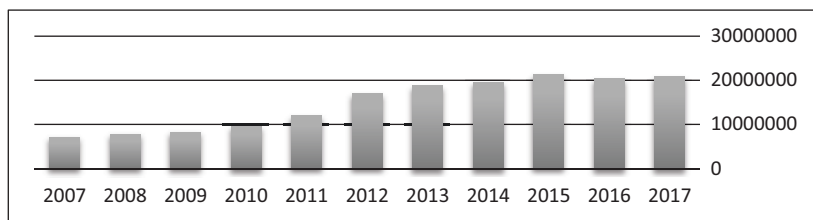


Fig. 3 Public hospitals – total debt (2007–2017)

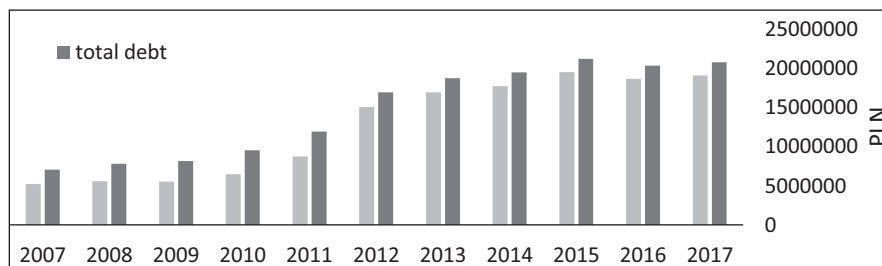


Fig. 4 Public hospitals – total debt and “unhealthy debt” (2007–2017)

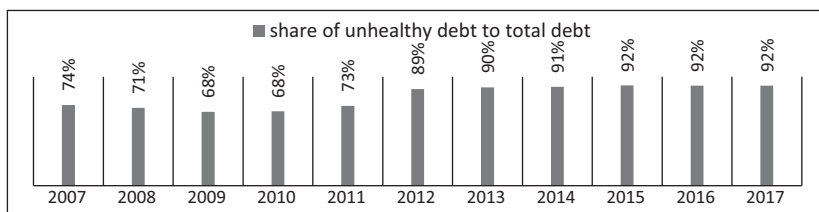


Fig. 5 Share of “unhealthy debt” in total debt (2007–2017)

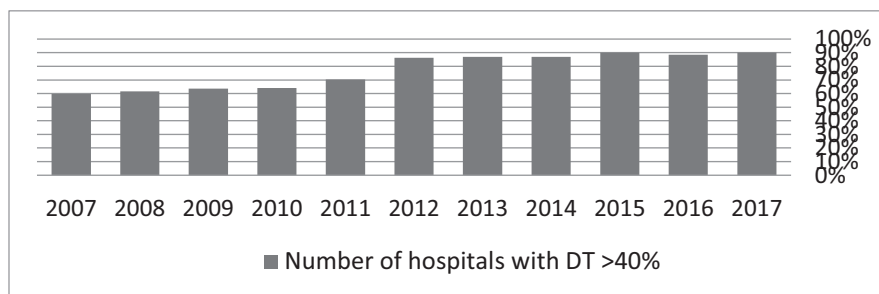


Fig. 6 Number of hospitals with “unhealthy debt” (2007–2017)

The number of hospitals with unhealthy debt also looks alarming. In 2017, these entities accounted for 90% of all the entities. This represented an increase of 29 percentage points compared to 2007. The results in terms of quantitative unhealthy debt ratio are presented in Fig. 6. On the other hand, a fairly significant change in the number of hospitals with alarming debt values between 2011 and 2012 resulted from the introduction of the act on medical activities (Journal of Laws of 2011, No. 185, item 1092), which brought about financial and organizational consequences for public hospitals.

The percentage of hospitals with unhealthy debt is at a similar level in individual voivodeships. In each province, around 85% of entities have unhealthy debt. For comparison, in 2007 it was about 55%. Details are presented in Fig. 7.

The most significant increase in the number of hospitals characterized by unhealthy debt was observed in the case of hospitals whose founding bodies were marshal offices, poviats and communes. However, the percentage of hospitals in debt, depending on their founding body, was 90% in 2017, while in 2007 it was only 60%. Thus, between the years 2007 and 2017, there was an observed increase in the number of hospitals with unhealthy debt. The highest increase was noticed in the group of marshal hospitals (almost 15 p.p.) and the lowest in university and ministry entities. Details are shown in Fig. 8.

The results of the analysis are consistent with the literature on the subject. The use of the ratio analysis performed on the basis of financial statements was carried out in the context of Polish healthcare system, e.g. by Krzeczewski (2014), Bem et al. (2015), Rabiej (2018), Miszczyńska (2019) or Miszczyńska and Antczak

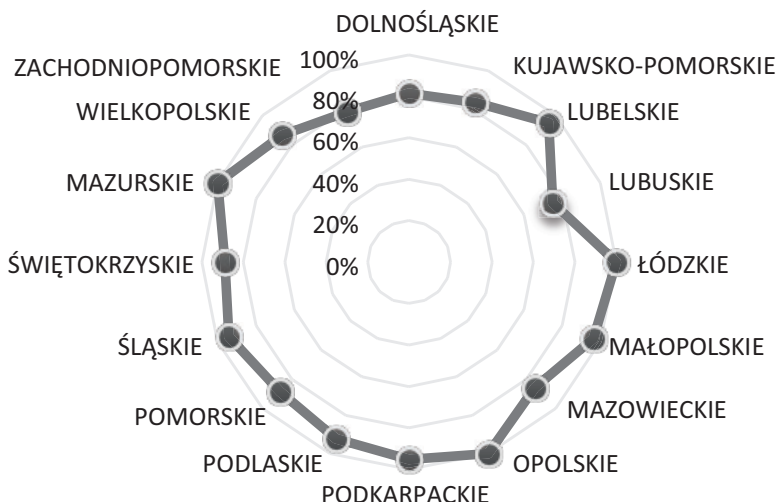


Fig. 7 Share of hospitals with “unhealthy debt” in 2017

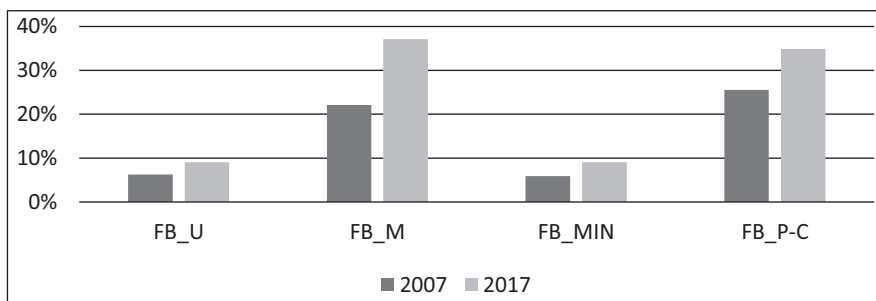


Fig. 8 The number of hospitals with “unhealthy debt” according to the founding body (2007–2017)

(2020). According to the presented analysis, the debt differs in time and depends on the founding units of hospitals. Similar conclusions had also been confirmed in the research by Miszczyńska and Antczak (2020), Krzeczewski (2014) or Dubas-Jakóbczyk (2017).

Moreover, the indicated upward trend in both the number of indebted hospitals and the value of debt results not only from the growing health needs, aging society and development of modern and cost-consuming medical technologies but, above all, from insufficient expenditure on healthcare in Poland as well. A detailed analysis of the health expenditure in Poland is presented in the work by Miszczyńska and Miszczyński (2020). On the other hand, a fairly significant change in the number of hospitals with alarming debt values between 2011 and 2012 resulted from the introduction of the act on medical entities, which brought about financial and organizational consequences for some hospitals.

4 Conclusions

The results of the conducted proceedings indicate the alarming situation of public hospitals in Poland. As for the research questions, almost 90% of the hospitals exceeded the level of 30% in terms of debt ratio, which undermines the credibility of the hospital. The value of “unhealthy debt” exceeded the level of 20,794,302 PLN in the year 2017. What is more, the “unhealthy debt” constituted around 96% of the total debt in 2017. In terms of both perspectives of unhealthy debt, the trends of shaping their values get increasing. What is more, no voivodeships have met the standards applicable to debt ratio since 2011.

The unhealthy debt ratio, being the result of an audit, seems to be an extremely useful measure of early warning of an entity’s poor financial condition. Relating it to the medical industry can be a kind of benchmark supporting managers in the decision-making process.

To sum up, it should be underlined that creation of the unhealthy debt indicator, which was presented in this paper, will be a starting point for further, more advanced studies.

Acknowledgements This article is an output from the research project “Multicriteria assessment of efficiency of public hospitals in Poland and identification of determinants of their indebtedness” financed by the National Science Centre, decision number DEC-2016/23/N/HS4/03410.

Annex 1

Fig. A.1 Public hospitals – structure of the sample

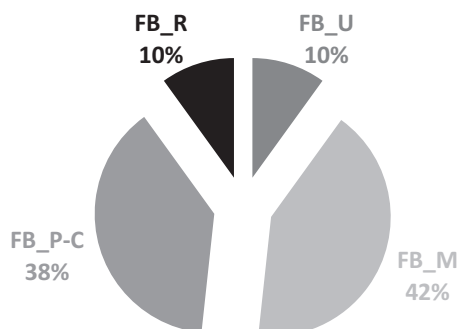


Table A.1 Verification of χ^2 test

Events	U	W	R	PG	sum
Observed events [Oj]	10	39	9	42	100
Expected events [Ej]	7	36	8	49	100
Eq. 1	0,9	0,3	0,1	0,9	2,29

$\chi^2_{0.05} = 7.815$

References

- Act of April 15, 2011 on medical activities (consolidated text: Journal of Laws of 2011, No. 185, item 1092, as amended)
- Alemi F, Gustafson DH (2006) Decision analysis for healthcare managers. Health Administration Press, Chicago
- Bem A et al (2015) Profitability versus debt in Hospital Industry. In: European financial systems 2015: proceedings of the 12th international scientific conference
- Czerw A, Religioni U (2012) Ekonomia podmiotów leczniczych w świetle obowiązujących uregulowań prawnych. *Problemy Higieny i Epidemiologii* 93(3):471–477
- Dubas-Jakóbczyk K (2017) Ocena sytuacji finansowej szpitali uniwersyteckich na podstawie sprawozdań finansowych za rok 2014. *Zeszyty Naukowe Politechniki Śląskiej* 100:99–108
- Frączkiewicz-Wronka A (2010) Pomiar efektywności organizacji publicznych na przykładzie sektora ochrony zdrowia. Akademia Ekonomiczna im. Karola Adameckiego, Katowice
- Hass-Symotiuk M (2011) System pomiaru i oceny dokonań szpitala. Wolters Kluwer, Warszawa
- Krzeczewski B (2014) Wpływ organu założycielskiego na efektywność finansową szpitali w województwie łódzkim. *Zeszyty Naukowe Uniwersytetu Szczecińskiego – Finanse, Rynki Finansowe, Ubezpieczenia* 65:569–581
- Łagowski P (2016) Analiza finansowa kluczowych podmiotów leczniczych w województwie dolnośląskim. *Finanse i Rachunkowość – Sytuacja przedsiębiorcy w warunkach pokryzysowych* 2:135–150
- Martin S et al (2012) Comparing costs and outcomes across programmes of health care. *Health Econ* 21(3):316–337
- Miszczńska K (2018) Determinants of public healthcare units indebtedness—the case of public hospitals in Lodz. In: *European Financial Systems 2018*
- Miszczńska K (2019) Efektywność funkcjonowania szpitali publicznych w Łodzi. Uniwersytet Łódzki, Łódź
- Miszczńska KM, Miszczyński P (2020) Inpatient costs in the perspective of polish health policy: Scenario analysis. *South East Eur J Econ Bus* 15(2):43–56
- Miszczńska KM, Antczak E (eds) (2020) Uwarunkowania zadłużenia szpitali w Polsce. Uniwersytet Łódzki, Łódź
- Nojszewska E (2011a) System ochrony zdrowia. Problemy i możliwości ich rozwiązań. Wolters Kluwer, Warszawa
- Nojszewska E (2011b) System ochrony zdrowia w Polsce. Wolters Kluwer, Warszawa
- Rabiej E (2018) Evaluation of the financial dimension of the effectiveness of the independent public health care provider. *Res Pap Wrocław Univ Econ* 514:355–365
- Regulation of the Minister of Health of April 12, 2017 on economic and financial indicators necessary to prepare an analysis and forecast of the economic and financial situation independent public health care institutions, *Journal of Laws No. of 2017, item 832*
- Smith JM, Topol E (2013) A call to action. Lowering the cost of health care. *Am J Prev Med* 44:S54–S57
- Sucecka J (ed) (2011) Finansowanie ochrony zdrowia. Wybrane zagadnienia. Wolters Kluwer, Warszawa
- Susmarski S (2016) Wybrane problemy oceny efektywności funduszy publicznych na podstawie Oddziałów Wojewodzkich Narodowego Funduszu Zdrowia. *Annales Universitatis Mariae Curie-Skłodowska Lublin – Polonia* 50(4):467–476
- Vanberkel PT et al (2012) Efficiency evaluation for pooling resources in health care. *OR Spectr* 34:371–390

Trends and Recommendations of the Municipal Spending Policy in the Context of Social Assistance Benefits – Initial Analysis



Katarzyna M. Miszczyńska and Żaklina Jabłońska

1 Introduction

Social policy is the activity of the state, local governments, and nongovernmental organizations aimed at shaping the general working and living conditions of the population and pro-development social structures and social relations based on equality and social justice, conducive to satisfying social needs at an available level. (Kurzynowski 2006; Stecko 2017).

According to Zamorska (2010), social policy and institutions of the welfare state, especially the educational system and social assistance, are the main way of expressing social rights. By ensuring a minimum standard of living, the state compensates for inequalities caused by market distribution mechanisms and also minimizes violence in interpersonal relationships. Social rights, being redistributive rights, impose certain obligations on both parties (Balcerzak-Paradowska 2004; (Zamorska 2010). In modern Poland, the subject of special attention of social policy is obstacles that block the possibility of satisfying basic human needs. It is believed that the most important social issues in our country are, among others, poverty, unemployment, social pathologies, housing issues, health care, and educational gap (Kwapiszewska and Kwapiszewski 2012).

K. M. Miszczyńska (✉)

Faculty of Economics and Sociology, Department of Public Finance, University of Łódź,
Łódź, Poland

e-mail: katarzyna.miszczynska@uni.lodz.pl

Ż. Jabłońska

Faculty of Management, Department of Strategy and Enterprise Value Management,
University of Łódź, Łódź, Poland

e-mail: zaklina.jablonska@uni.lodz.pl

State social policy refers to a number of tasks carried out by specialized organizational units' service-oriented society. The main subject of social policy is local government. Due to the decentralization of power, social policy powers were delegated to the level of municipal self-governments (Stecko 2017). Thus, local government has a fairly wide range of competences. His tasks include all public matters of local importance, in particular to meet the collective needs of the population (Kwapiszewska and Kwapiszewski 2012). The instrument of the state's social policy is social assistance. On the basis of the Act of 12 March 2004 on social assistance, it aims to enable individuals and families to overcome the difficult life situation that they are unable to overcome using their own rights, resources, and opportunities.

The term social policy is usually understood as purposeful actions of the state, aimed at directly satisfying social needs. Social assistance is recognized as a method of achieving social policy goals (Sierpowska 2011). The Act on social assistance introduces a division into cash and non-cash benefits. According to Article 36 of the Act of 12 March 2004 on social assistance, monetary benefits include permanent benefit, periodic allowance, targeted allowance and special targeted allowance, allowance and loan for economic self-empowerment, or assistance for self-empowerment and continuing education.

The issues related to the functioning of social policy are extremely important and are reflected in the literature on the subject (van Vliet and Wang 2019). The analyses presented in this area were based on analyses of solutions used in specific countries (Scheve and Slaughter 2004; Rehm 2016; Walter 2017) or on comparative analyses (Reynolds and Avendano 2019; van Vliet and Wang 2019). These analyses are also carried out from the perspective of various areas covered by social policy. Currently, the problem of deinstitutionalization is one of the most frequently discussed problems of social policy (Tomalak et al. 2011; Golczyńska-Grondas 2015; Petrowski et al. 2017).

The key challenge for social policy is to take into account the approach to broadly understood social assistance contemporary challenges posed by the current system of scientific knowledge, research results, as well as policies implemented at the national and EU level. Among them you can distinguish changed family model (infancy of families, single parenthood), late age of starting a family, increase in the number of single-person households, negative birth rate, decreasing fertility, or an increase in average life expectancy. Research conducted by the Regional Center for Social Policy shows that the phenomena strongly influencing the shape of social policy in Poland are currently aging of the society, long-term or severe illness and disability, helplessness in matters of care and upbringing or homelessness, and deepening disintegration of social groups. Thus, the purpose of the article will be to identify problems or areas of social life, which constituted the dominant category of expenditure of local government units in 2012–2018.

2 The Functioning of Social Policy in Poland in 2012–2018

2.1 Demographic Aspect

The demographic processes currently observed, such as changed family model (families of small families, single parenthood), late age of starting a family, increase in the number of one-person households, negative birth rate, decreasing fertility, or an increase in average, have a significant impact on the shape of social policy. According to the Population Forecast for 2014–2050 prepared by the Central Statistical Office in 2014, the downward trend in the population in Poland will deepen (see Fig. 1.). By 2050, the largest number of people in the 85 age group will increase, while the number of people in the 30–34 age group will decrease the most, by just over half. In 2018, the largest group were people aged 35–39 – they constituted 8% of the total population of the voivodship, while in 2050 the Central Statistical Office predicts that the most numerous group will be people aged 65–69 (almost 9% of the total population).

Another feature conditioning the shaping of social policy in Poland is the strong aging of the population observed. This situation determines, as it were, the creation of new solutions related to the state's social policy directed at innovative methods of supporting the accumulated functioning of the elderly. The average life expectancy in most of voivodeship residents is shorter than the national average. In Poland, in 2017 the average life expectancy for women was 81.8 years and for men 74 years (GUS data). Lodz voivodeship recorded the worst result in this category among all voivodeships. The same value of average life expectancy (in the case of the indicator for women) was achieved only by the Silesian Voivodeship (CRPiS 2019). At the same time, the life expectancy of women is longer in the countryside, while men in cities (see Fig. 2).

The age structure of the population undergoes unfavorable changes – the percentage of population in pre-working age decreases and increases in post-working age (see Fig. 3).

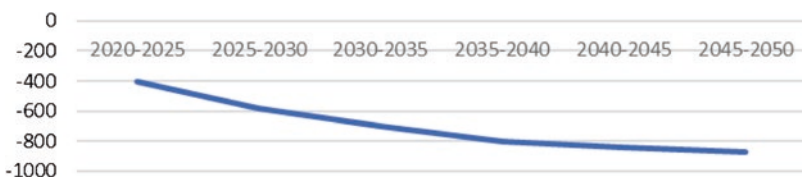


Fig. 1 Projected population changes in Poland in 2018–2050 compared to 2018. (Source: own study based on Population forecast for 2014–2050, CSO 2014; Population. Condition and structure, as well as natural movement in territorial division in 2018. As of 31 December, Central Statistical Office of Poland, Warsaw 2019)

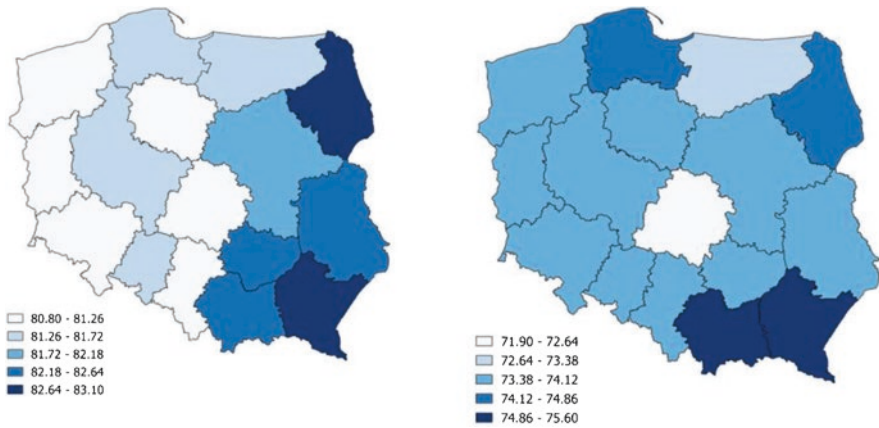


Fig. 2 Average life expectancy (in years) of women (left map) and men (right map) in 2017 by voivodeships in Poland. (Source: own study based on the data of the Local Data Bank of the Central Statistical Office; Population. Condition and structure, as well as natural movement in territorial division in 2018. As of December 31, Central Statistical Office, Warsaw 2019)

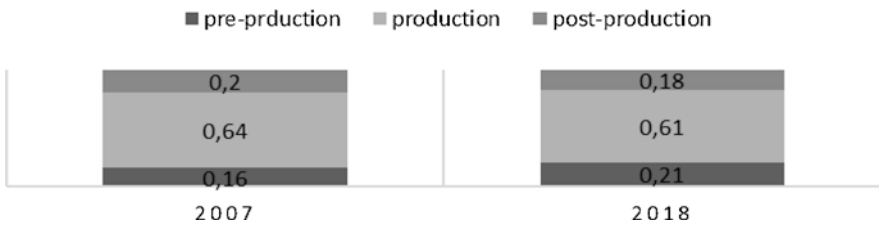


Fig. 3 The structure (in %) of the population by working age in Poland in 2007 and 2018. (Source: own study based on the data of the Local Data Bank of the Central Statistical Office; Population. Condition and structure, as well as natural movement in territorial division in 2018. As of December 31, Central Statistical Office, Warsaw 2019)

2.2 Characteristics of Social Benefits

The staff of social assistance organizational units are persons employed in social assistance centers (commune level), poviats family assistance centers (poviat level), and municipal family assistance centers (performing social assistance tasks at both commune and poviat level) on the basis of an agreement on work, regardless of the area of tasks performed (e.g., social assistance, family benefits, foster care). The staff also includes persons employed under the ESF resources. Data illustrating employment relate to years 2012–2018 (Fig. 4).

What is more, the share of people using social assistance in the total population of the region in Poland fluctuated between 3.5% and 8% in the years 2012–2018 (Fig. 5).

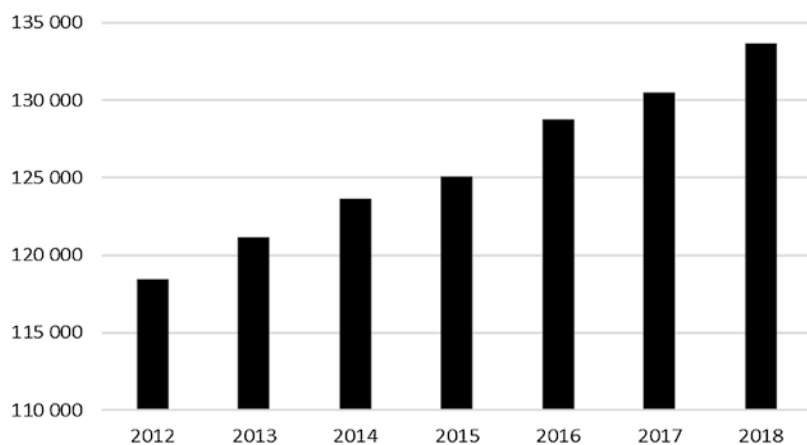


Fig. 4 Employment in organizational units of assistance and social integration. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

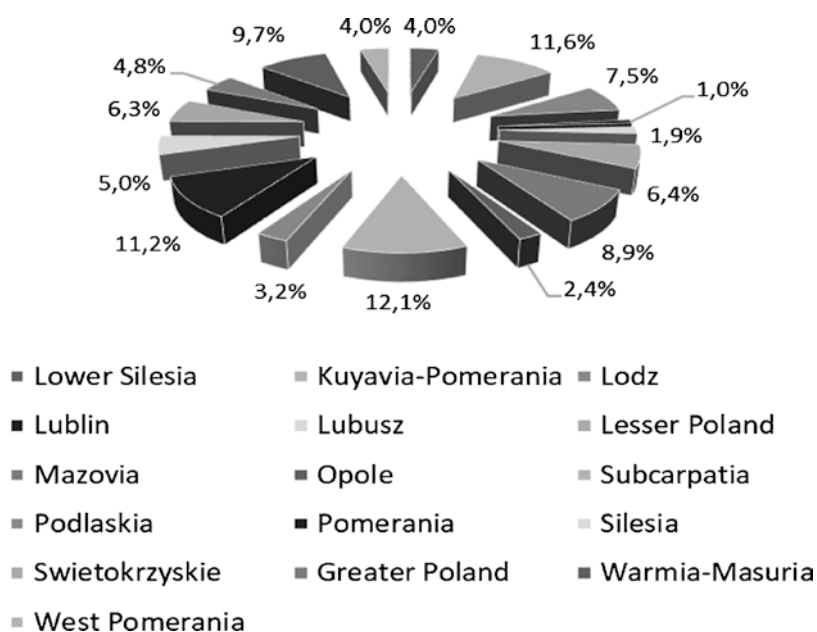


Fig. 5 The share of beneficiaries of social assistance in the total population of the voivodeship between years 2012 and 2018. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

Benefits provided by the state through municipalities are divided into own tasks and tasks assigned to municipalities. Forms of assistance financed as part of the tasks entrusted to municipalities are, among others, special care services at the place of residence for persons with mental disorders, objective benefits to cover expenditure related to a natural or environmental damage, and remuneration due to the guardian for providing care granted by the court. However, as part of these forms of assistance, the most important are special care services at the place of residence for persons with mental disorders and remuneration due to the guardian for providing care granted by the court. Their share in the total value of benefits is estimated at 81.33% and 14.76% in 2018, respectively. The highest costs of specialist care services for people with mental disorders were recorded in the years 2012–2018 in the Subcarpathian Voivodeship and the lowest in the Lodz Voivodeship.

Benefits granted as part of the municipal's own tasks include financial and non-financial benefits. Financial benefits are permanent benefits, periodic benefits, and targeted benefits, while nonfinancial are shelter, meal, clothing, care services, etc.

Non-cash benefits are social assistance services offered by municipal social assistance units. An important item in the framework of non-cash benefits is supporting residents of the Lodz Voivodeship by providing them with a free meal. This benefit is mainly granted under the multiannual program "State aid in the field of feeding." Data obtained from social assistance centers show that in the Lodz Voivodeship in 2018, support in the form of a meal covered 28.2 thousand persons (31.7% of persons covered by social assistance benefits), which is about 300 smaller than in 2017. The amount of benefits provided was nearly PLN 16.7 million (RCPiS 2019). For comparison, this value exceeded PLN 330 million nationwide.

As part of periodic benefits, benefits are granted because of unemployment, long-term illness, disability, etc. From among these categories, the highest value of benefits in the years 2012–2018 was allocated to permanent benefits (28%), periodic benefits (24%), and for meals (12%). The figure above (Fig. 6) presents one of these categories in the years under discussion.

The cash benefit which was granted in the highest value in 2018 was a permanent benefit. In addition, the value of these benefits is subject to an annual growth trend (Table 1).

Social assistance centers and poviats family assistance centers offer residents very broad support. In addition to support provided on the basis of an administrative decision, they provide support without the need to issue such a decision or carry out

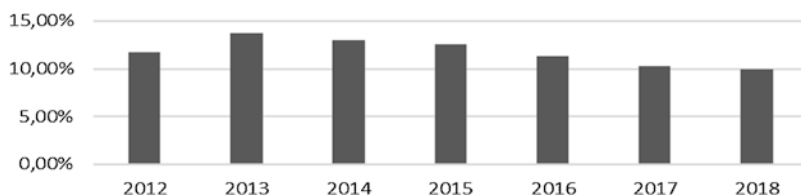


Fig. 6 Share of selected forms of assistance (meals) financed as part of municipalities' own tasks. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

Table 1 The value of social benefits by type (100 th. PLN)

	2012	2013	2014	2015	2016	2017	2018
Permanent benefits	711,45	862,84	898,16	939,58	1069,45	1057,04	1018,32
Periodic benefits	727,35	1007,06	961,27	908,90	838,61	701,55	588,40

Source: own calculations based on data provided by the Ministry of Labor and Social Policy

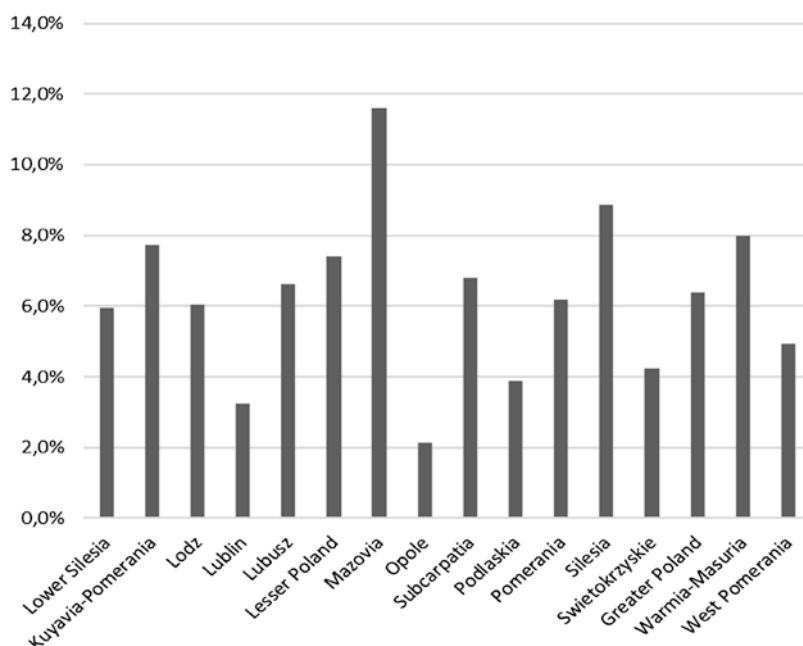


Fig. 7 The share of the number of people from individual voivodeships in Poland who were granted benefits between years 2012 and 2018. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

environmental intelligence. To present the scale of the demand of Polish residents for benefits financed under social assistance, it is worth referring to the number of people who were granted such a benefit. In 2018, 1.3 million people were covered by social assistance benefits (financed from both sources). This corresponded to about 915,050 families, of which 396,011 were families located in the countryside. Going into the details, it is worth looking at the share of the number of people from individual voivodeships in Poland who have been granted benefits (see Fig. 7). The voivodeship that received the most assistance was the Masovian Voivodeship, while the least aid was received by the Opole Voivodeship.

Social benefits are mainly granted because of the difficult financial situation, which refers, among others, to poverty, orphanage, homelessness, unemployment, disability, long-term or serious disease, fraudlessness in care-education matters and household care, or the need for protection of maternity. Going into the details, the Lodz Voivodeship was analyzed. The most common reasons for providing

assistance and support in the Lodz Voivodeship in 2018 (similar to previous years) were (RCPiS 2019) long-term or severe illness (social assistance was provided to 50.3% of families), poverty (43.9%), unemployment (42.3%), disability (39.5%), and helplessness in matters of care and education and running a household (19.5%). Other less frequent reasons for providing support include the need to protect motherhood (about 10%), alcoholism (8.6%), homelessness (less than 3%), and difficulties in adapting to life after release from prison (1.7%). However, between years 2012 and 2018, the most families assisted were those in connection with unemployment and poverty (Fig. 8). However, the number of families with aid granted decreases constantly since 2012.

The scale of using social assistance differs in individual voivodeships. The most favorable situation in this respect took place in 2018 in the Silesian Voivodeship, where people covered by support from social assistance in the area of poverty constituted only 1.8% of the population, as well as in Opole (2.1%) and Lower Silesia (2.1%). Definitely the least favorable situation was observed in the Warmia-Masuria (4.8%) and Kuyavia-Pomerania (4.7%) provinces. In the vast majority of the voivodeship, the percentage of inhabitants using social assistance decreased compared to the previous year or remained at a similar level (see Fig. 9).

To sum up, support provided under social assistance is more effective if it is comprehensive. One of the important elements of the complexity of support is cooperation with entities from the public social assistance environment, including non-governmental organizations. As it results from analyses carried out by governmental institutions (RCPiS 2019), almost half of communes within voivodeships do not use these possibilities. In the Lodz Voivodeship, in 2018, only fishing for communes undertook cooperation with nongovernmental organizations. The most common form of such cooperation was commissioning tasks, which may include, among

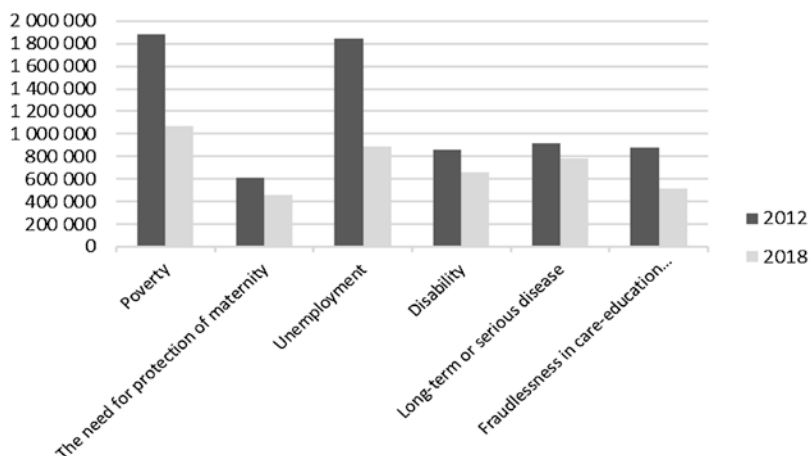


Fig. 8 Number of families with aid granted in Poland between years 2012 and 2018. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

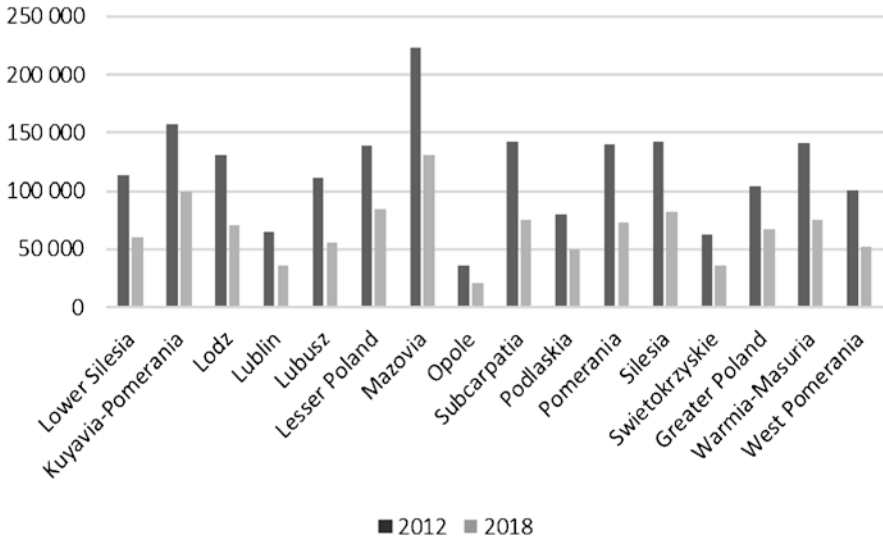


Fig. 9 The number of people receiving social assistance in the field of poverty. (Source: own elaboration based on data provided by the Ministry of Labor and Social Policy)

others, providing care services (also specialist) and running various types of social assistance units.

3 Conclusions and Recommendations

It seems obvious that the key challenge for social policy is the adaptation of activities resulting from the impact on the social policy of the current state of knowledge, research results, or the state policy itself. The essence of change in the contemporary approach consists primarily of the need to focus all activities carried out by individual units under social assistance tasks and effective solving of social problems and integration of the local environment as well as striving to professionalize staff and standardize services while deinstitutionalizing and individualizing the support provided (Golczyńska-Grondas 2015, RCPiS 2019).

The most important changes in this area include, inter alia, the implementation of a strengthening approach and launching empowerment, which assumes moving away from charity to supporting activities and moving from surrounding the unit with help towards its activation (Czarnecki 2013). In addition, it seems extremely desirable to move away from intervention solutions in favor of social, system, and network solutions (Grewiński and Krzyszkowski 2011). Activating the natural social environment and strengthening the community's potential also seem to be extremely important.

The demographic processes currently observed, such as a changed family model (family infancy, single parenthood), the late age of starting a family, an increase in the number of one-person households, a negative birth rate, decreasing fertility, or an increase in the average, have a significant impact on the shape of social policy and life expectancy. In addition, in accordance with Voivodeship Social Policy Strategies, particular emphasis should be placed on supporting people at risk of exclusion, such as aging population, long-term or severe illness and disability, helplessness in matters of care and upbringing or homelessness, and deepening disintegration of social groups (RCPiS 2019).

Considering the analysis, it is worth presenting a few recommendations (RCPiS 2019). First of all, it seems extremely important to guarantee the appropriate number of social service staff together with ensuring extensive support for the process of their professionalization. Secondly, it seems valuable to develop a form of support in the form of individual programs and plans of work with social assistance clients (including, among others, social projects), enabling adaptation of assistance to individual needs and individual situation of clients, and the use of a wide range of tools, including those from outside area of social assistance, including vocational activation (RCPiS 2019). Thirdly, it is also extremely important to match the offer of social care homes due to changes in the demographic structure of residents and the increase in their health needs and to provide adequate support to lonely elderly and disabled people by developing care services in the place of residence along with the extension of the offer of environmental forms of care. Fourth is the desire to deinstitutionalize foster care for family foster care and develop protected housing. It would also be particularly important to strengthen cooperation with nongovernmental organizations.

Recommended tasks are a necessary step on the way to transform the “rescue” assistance system into a supportive social assistance system. Systemic change in this area must be based not only on a new approach in thinking about social assistance as an important element of social policy but must be strengthened by new opportunities for social support and impact as well (RCPiS 2019).

The main limitation of the study was the high level of data aggregation. Conducting this analysis on the basis of data with a lower level of aggregation, e.g., at the poviats or commune level, would allow for a more detailed depiction of the processes taking place within the expenditure trends of the social policy.

In future studies, the authors will try to explore in details the structure of social assistance benefits on the example of family foster care in Poland.

References

- Balcerzak-Paradowska B (2004) *Rodzina i polityka rodzinna na przełomie wieków: przemiany, zagrożenia potrzeba działań*. Instytut Pracy i Spraw Socjalnych, Warszawa
- Czarnecki PS (2013) *Praca Socjalna*. Difin, Warszawa
- Golczyńska-Grondas, A. (2015) ‘Underprivileged children in the social space of impunity: The example of the children’s residential care system in the Polish People’s Republic’, *Sociological Review*, LXIV(1), pp. 103–120.

- Grewiński, M., Krzyszkowski, J. (2011) Współczesne tendencje w pomocy społecznej i pracy socjalnej. Warszawa.
- Kurzynowski, A. (2006) 'Polityka społeczna – podstawowe pojęcia i zakres', in *Polityka Społeczna*. Warszawa.
- Kwapiszewska, M., Kwapiszewski, J. (2012) *Polityka społeczna, praca socjalna i wolontariat*. Piła.
- Petrowski N, Cappa C, Gross P (2017) Estimating the number of children in formal alternative care: Challenges and results. *Child Abuse Neglect* 70:388–398
- Rehm P (2016) Risk inequality and welfare states: Social policy preferences, development and dynamics. Cambridge University Press, Cambridge
- Reynolds MM, Avendano M (2019) Social policy expenditures and life expectancy in high-income countries. *Am J Preventive Med* 54(1):72–79
- Scheve K, Slaughter MJ (2004) Economic insecurity and the globalization of production. *Am J Political Sci* 48(4):662–674
- Sierpowska, I. (2011) *Prawo pomocy społecznej*. Warszawa.
- Stecko S (2017) Polityka społeczna państwa względem rodziny. *Społeczeństwo i Rodzina* 50(1):139–151
- Tomalak D, Halloran J, Barnett S (2011) Tworzenie modelu pomocy środowiskowej. Dlaczego zmiana jest potrzebna i jak ją przeprowadzać. Brighton
- van Vliet O, Wang J (2019) The political economy of social assistance and minimum income benefits: A comparative analysis across 26 OECD countries. *Comp Eur Polit* 17:49–71
- Walter S (2017) Globalization and the demand-side of politics: How globalization shapes labor market risk perceptions and policy preferences. *Polit Sci Res Methods* 5(1):55–80
- Zamorska K (2010) *Prawa społeczne jako program przebudowy polityki społecznej*. Uniwersytet Wrocławski, Wrocław

Procuring Socially Responsible Services Within Sustainability-Driven Thessaloniki



Fragkoulis Papagiannis, Patrizia Gazzola, Seng Kok, and Mauro Romanelli

1 Introduction

The procurement of public goods and services accumulates approximately 14% of the European Union (EU) gross domestic product (GDP). Public procurement (PP) refers to the process where central and local governments purchase and provide services, public works and goods (Uyarra and Flanagan 2010). The European small and medium enterprises (SMEs) are increasingly contributing to these PP practices offering value-added services to local societies. SMEs are the drivers of the local communities as they are providing jobs and stimulate sustainable growth. In the past 5 years, they have created around 85% of new jobs and provided a path to prosperity for millions of families. Therefore, it is important to strengthen their active participation in public tenders, especially local ones. Historically, PP of business services is the primary performer with regard to three key SMEs' performance indicators in the supply chain process. Public services' procurement is forming the key public driver of economic growth (European Commission 2016). As a result, it is important to eliminate on-going PP problems that discourage SMEs' participation to public tenders. This paper explores, taking as an example Thessaloniki, a sustainability-driven PP framework that could surface the exact nature of the on-going problems that stifle entrepreneurial growth.

F. Papagiannis · S. Kok
Liverpool John Moores University, Liverpool Business School, Liverpool, UK

P. Gazzola
University of Insubria, Varese, Italy

M. Romanelli (✉)
University of Naples Parthenope, Naples, Italy
e-mail: mauro.romanelli@uniparthenope.it

In 2012 in Thessaloniki, a city in northern Greece, the city's mayor started planning a municipal procurement framework leading to public-private partnerships (PPP). The procurement methodology was based on a qualitative socially responsible public procurement (SRPP) framework, concerning three thematic, consulting-related categories: the city's history, social activities and culture and environment and urban landscape. The tender participation and public-private networking were significant. In 2012, Thessaloniki was preparing for its centenary celebration. Thus, it publicly procured consulting and promotion-related services in an effort to rebrand the city's social profile. These services still maintain social responsibility as a focal point, complementing the city's SSCM and sustainable procurement (SP) strategy (Amann et al. 2014; Donia and Sirsly 2016). SP strategy is considered the procurement that in our case is consistent with SSCM, ensuring transparency and accountability in a society, living within environmental limits and promoting socially responsible governance (Walker and Bammer 2009; Papagiannis et al. 2018).

The aim of the study is to reveal an innovative design of a socially responsible framework and its key performance indicators that should be monitoring its successful implementation. It aims to engender a lively discussion about the necessary activities (tactical or strategic) in order to engage the city's stakeholders, especially the SMEs, in public services' provision. Designing a socially responsible (SR) procurement framework is both a challenging and complex objective (Andersen and Skjoett-Larsen 2009; Perner et al. 2018; Adam 2008; De la Cuesta and Martinez 2004). It engages diverse, often conflicting, stakeholders into a sustainable strategic framework that helps SMEs (Crane et al. 2013). The city residents as the primary stakeholders and ultimate recipients of local public services are usually disappointed, whilst public services lack an SR orientation. Thus, Greece currently shows a decline in social impact and SCM quality-performance indicators (European Commission 2016). Socially responsible procurement designs in Greece are in their infancy. Therefore, it is the first time that the city of Thessaloniki explores such a procurement framework. Such a framework could serve as an example of a local economy stimulator. It could motivate Thessaloniki's stakeholder cities in the Balkans and contribute to SR international networking. Indicative stakeholder cities include Sofia, Bucharest, Belgrade and other cities in the Balkan Peninsula. The case's novel design is still attracting value-added, SR practices and promotion-related services for rebranding the city's profile (Apostopoulou and Papadimitrou 2014). Therefore, the study's findings contribute to the corporate social responsibility (CSR) literature by advancing SRPP research relating to contemporary procurement practices and legalities in EU. As a result, this study exhibits an alternative design for developing SR publicly procured services. The findings of this study reveal a strong association between traditional and digital communication approaches towards the tender's formulation design, as well as its successful implementation. An active interaction among diverse groups of stakeholders requires transparent and socially responsible (SR) support and methods of communication to be interlinked.

2 Public Procurement Theories and Practices: The Case of Thessaloniki

Thessaloniki Metropolitan Development Agency (TMDA S.A.) – a state-owned enterprise – was in charge as partner for procuring the consulting services. It branded the city's sustainability profile cooperating with the municipality of Thessaloniki in a public-private type of scheme. A socioeconomic procurement infrastructure focusing on transparent diffusion of public economic resources requires a well-balanced, sustainability framework. Regrettably, a handful of theories could fit and complement the complex Greek PP system. Therefore, these theories considered could potentially contribute to the solution of this on-going problem. This endeavour was and still is important as unsustainable economic development based on subjective, politically tinged, fiscal constraints excludes regional, socially responsible procurement and planning.

2.1 *An Overview of the Related Contemporary PP Theories*

In 2012, the Greek legal system privileged administrative and economic selection criteria. It relied on the principle of the lowest bid. Therefore, the lowest offer allows to win a tender (Cohen et al. 2017; Yu and Wang 2012; Albert 2010) without considering other qualitative criteria. These qualitative criteria were considered as secondary in the supply chain management (SCM) decision-making hierarchy (Metzger et al. 2017). Accordingly, we aimed to design based on compatible contemporary theories, a framework where the economic criteria harmonically coexist with environmental and social criteria.

It is imperative to design and implement a socially responsible framework, balancing administrative and social parameters for sustainability (Nikolaou and Loizou 2015; Papagannis et al. 2018). Currently PP theories merit practices and processes that encourage creativity and promote innovation. It is important to consider these two soft design aspects to overcome implementation challenges, in particular the challenges of institutionalising public procurement as part of a national or even international innovation policy (Uyarra et al. 2020). These new trends on public procurement and supply practices are increasingly relating to a service-oriented design. Therefore, the procurement elements (e.g. critical success factors and key performance indicators) of such designs should include technical and nontechnical specifications. These design elements (technical and nontechnical) should relate to product and service combinations, efficiently improving resource usage through circular economy (Witjes and Lozano 2016; Sönnichsen and Clement 2020).

Consequently, contemporary PP theories need to incorporate sustainability practices for infrastructural project designs. In Thessaloniki's case, this need was facilitated with the implementation vehicle of TMDA S.A., following a public-private partnership (PPP) type of scheme. EU and government policy documentation

stresses the important role of these types of partnerships for SRPP (Preuss 2009). In this case, as in others internationally, it is challenging to formulate measurable social sustainability criteria (Hueskes et al. 2017). In addition, Green Public Procurement (GPP), which is also considered in Thessaloniki's quality of life parameter, could serve as a potential policy instrument. It could contribute to products and services' environmental footprint reduction and improve environmental value for society (Braulio-Gonzalo and Bovea 2020).

As a result, PP services should be formulated through a balanced framework of critical success factors (CSFs) and key performance indicators (KPIs). This novel framework design balances CSFs with social, economic and environmental qualitatively focused KPIs. Therefore, this "triple bottom line" (e.g. social, economic, environmental) approach empowers a sustainability-focused procurement design (Wilshusen and MacDonald 2017).

2.2 *Engaging Stakeholders for a Socially Responsible Procurement Framework*

According to these contemporary theories and practices, the unbalanced and monolithic public practices that focus solely on price indicator are placed under examination. Following the discourse, the CSFs and their KPIs are presented:

CSF1: Thessaloniki's Promotion of Pull Attributes SRPP framework's first CSF (CSF1) was the services' offer relation to the city's pull attributes and social profile. Pull attributes for a city are defined as the attributes, which are attracting tourists to the destination (e.g. culture, history, climate, service and product prices, etc.) (Borodako 2014). Thus, the relevance to the thematic pillars was a prerequisite for a successful service offer. There were three thematic categories for the procurement of the services (e.g. historical consulting and promotion services, social activities and culture services, environment and urban landscape services) that were selected to support CSF1. All the proposals had to be submitted under a specific pillar. The organisational campaign's pillars procured were thematically analysed. They were based on the centenary programme's conception of the city's profile, pull attributes and social parameters (Truong and King 2009). It was decided by the mayor's cabinet that it was important to design a procurement framework encompassing the city's pull attributes as they are the main factors for attracting visitors. Thus, these pillars acted as social economic and environmental KPIs to these important promotional pull attributes (Sajad et al. 2015). The selected KPIs measured the relevance of each proposal to the following thematic pillars for sustainable development: (i) city's history, (ii) arts and culture of the city and (iii) environment and urban landscape.

The prominent stakeholders and collaborators of this procurement framework at a national and international level were invited to participate. For a long period,

approximately 5 years, the city of Thessaloniki was open to organisational proposals, relating to the city's rebranding for its centenarian celebration. An indicative list of such organisations includes national museums, social corporations, non-governmental organisations and others. The inclusion of the local communities and government stakeholders was also considered valuable for the successful framework design (Mella and Gazzola 2018). Therefore, national and international stakeholders assisted TMDA S.A. procurement organising committee, maximising the SR benefits of all engaging parties. Thus, stakeholders' engagement was necessary for signalling the second KPI of this CSF1, KPI2. A common way for public disclosure is digital data dissemination, as SOEs are legally obliged to communicate their actions and results to external stakeholders (Saxton and Guo 2011). At the same time, these novel procurement-design initiatives minimise the negative effects of the on-going Greek financial crisis (Papagiannis 2016). The public tender for these socially and environmentally balanced sustainability services commenced in 2012. The PPP cooperation model selected provided the necessary flexibility for embedding several qualitative CSFs and KPIs to the process. Research reveals that such dynamic collaborations among diverse institutions in relation to their CSR activities are important, especially for the arts-oriented thematic pillar of this CSF. Thus, the TMDA S.A. organising committee filtered its public procurement decisions through this SRPP framework with four CSFs that embraced specific KPIs.

CSF2: Promotion of Thessaloniki's Social Activities In an EU era of post-financial crisis, the introduction of socially oriented factors to a procurement-framework design is critical (Nikolaou and Loizou 2015). Such dynamic socioeconomic designs further complement and address the needs of the engaging stakeholders, as analysed in CSF1. The designing philosophy of this CSF2 is relating to the need of several managers and business collaborators to obtain essential information from personal ties and SN, and in their absence, organisations are constrained to rely on close collaborators. Therefore, there were three KPIs in this CSF: KPI1, entrepreneurial initiative; KPI2, youth friendliness; and KPI3, unemployment rate. All of these KPIs measure the SR orientation of this CSF2. The unemployment rate (KPI3) is socially important as the on-going financial crisis in Thessaloniki is accountable for the city's youth unemployment rate of 52% and an overall unemployment figure in its residents of 25% (Eurostat Report 2016). The entrepreneurial initiative (KPI1) is another socially responsible performance indicator as it catalytically therapises the unemployment figures by creating new SMEs (Angelidou and Psaltoglou 2017). The city's youth was also invited to participate voluntarily in the procured events by assisting in several ways (e.g. internships, volunteer work, etc.). Youth participation in the procured services and their related activities (e.g. professional and scientific conferences, thematic conferences and symposiums, presentations, etc.) provided the opportunity for the youths to create valuable contacts and accumulate experience with the participating institutions. Consequently, a youth-friendly proposal strengthened KPI2.

CSF3: Promotion of the City’s Social Networking (SN) and Quality of Life Adherence to the Greek public services’ social value is an EU legal rule (e.g. legal rule: Article 3 P.D. 186/1992) in relation to public procurement. Specifically, the compliance with the relevant EU legislation practices ensures that all national or international businesses and SMEs can bid for the procured tender (e.g. the three principles of transparency, equality and publicity). There are two KPIs supporting this CSF: KPI1, close cooperation with all the suppliers, including SMEs, and KPI2, consideration of the participants’ quality certifications and environmental documentations. KPI1 supports all the suppliers, including the SMEs, which expressed their interest in submitting an offer under one of the three tender pillars procured. The assistance towards SMEs for a qualitative proposal and the facilitation for tailor-made services is necessary for successful delivery. As public tenders in Greece tend to be daedal, time consuming and opaque, very few SMEs, which have limited resources, participate to such initiatives (Tsouhluou and Mylonakis 2011). Therefore, the role of digital marketing of the project was a priority (Arvanitis et al. 2013). As a result, municipality and TMDA S.A. with this designed SR framework, override the questionable past practices. The press release publications of a tender are important for publicity, but the adoption of digital marketing through a series of social media activities (Van Zoonen et al. 2017) was considered necessary for confirming publicity of the tender to the SMEs. KPI2 considers the participants’ environmental documentations and quality certifications that have to be referenced. The two main reference schemes for this KPI are the international standard ISO 14001 and the European standard EMAS (Eco-Management and Audit Scheme).

The SRPP framework is presented in Fig. 1.

2.3 Implementing the Procurement Framework as a Project

The interest was high, signifying a successful tender procedure and accumulated 285 proposals, which were economically compatible. Based on the presented qualitative framework, 60 proposals were selected, as bidding winners for implementation. These selected institutions received services contracts averaging 35,000 euros

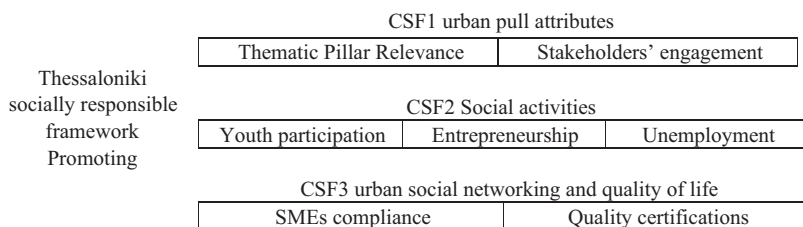


Fig. 1 The design of the SRPP framework

in three different thematic pillars. More than 50% of those were SMEs, which complied with the required quality indicators and environmental certifications.

Thematically oriented services' procured projects included the following: (i) scientific conferences, (ii) historic exhibitions and (iii) other culturally related projects exhibited changes in the city's environment, in neighbourhoods, in habits and city traditions. Most of these procured services were supported, and still are, through municipal volunteers, primarily young people. Simultaneously, these services provided valuable social support with working positions for the city residents especially young people (Papagannis et al. 2018). Once the procurement design and implementation were completed according to the methodology steps analysed, a research project for evaluating the impact of procured services was initiated. It aimed to provide significant information for the application and development of the exhibited SR framework.

3 Research Methodology

A mixed-method approach was utilised for the collection of rich data, which assists in the understanding of the key benefits of an SR procurement as well as in the examination of the stakeholder levels of satisfaction. Participating corporations are considered those which were successfully selected to implement the procured SR services, based on the designed procurement framework. TMDA S.A. administration staff supported the whole research methodology, both qualitative and quantitative.

The data collection lasted almost 3 years, due to public bureaucracy. A response rate of 98% was achieved, as 59 organisations out of 60 were able to complete the evaluation process through the structured questionnaire and interviews. Qualitative data was collected through a mix of one-to-one interviews lasting up to 30 minutes. Interviews were conducted with all the participating corporations. The three thematic categories were identified from the qualitative dataset by utilising content analysis (Bryman and Bell 2015). For quantitative data, interview participants were also recipients of hard copy questionnaires, which were utilised as the most effective tool for collecting data and administering a wide sample group of corporations (Bryman and Bell 2015; Saunders et al. 2015). Questionnaires were focused upon the levels of satisfaction regarding the procurement-process services provided by the TMDA S.A., the availability of support and administrative services relating to the projects' promotion during implementation and most importantly the usage of digital media streams throughout the procurement's methodology steps. The questions were designed to ensure simple, straightforward responses. This approach was undertaken in a bid to ensure increased response rates as well as reduce chances of incorrect completion. Respondents were also informed about the confidentiality of their responses. A 5-point Likert scale was utilised. The findings of this primary research reveal an SR procurement of municipal services that provides valuable empirical data for an alternative and innovative framework of public procurement.

4 Findings and Results

The findings suggest strong levels of satisfaction across both printed and digital materials used in the SRPP framework according to the CSF3 employed. Similarly, the combined usage of traditional and digital promotion tools was also found to be useful, according to CSF1 and CSF2 employed. The overall levels of satisfaction across the different elements related to KPIs of the CSFs are high, with digital marketing tools employed throughout the procurement services returning the highest score of 3.6. Such an unexpectedly high result indicates the value of the CSF3 in relation to SN transparency in public procurement (McKeivitt et al. 2014). In CSF3, modern forms of public procurement interspersed with the need for traditional ones create a balance in terms of moving forward with innovative procurement approaches whilst still providing appropriate traditional access for organisations and individuals. Figure 2 exhibits these findings, in which digital promotional activities, related to the quality of services and to SMEs' services compliance (CSF3), seem to be perceived as the most useful, scoring 3.6. The red line in Fig. 2 signifies the neutral satisfaction score of 3.

Therefore, taking into consideration the effects of the above three CSFs, it is clearly visible that the impact of the digital procurement policies, especially in communication and marketing practices of the tender, is rather significant. In addition, KPIs' integrating transparency and publicity through a series promotional activity were important, as all these KPIs scored well above the average of 3 out of 5.

The individual notions of procuring public services through printed media and digital media alongside promotional activities in traditional and digital approaches are all strongly correlated. The results indicate a positive correlation between all variables, which suggests the synergy and importance of these elements working in tandem. As such, it is difficult to apply digital or traditional approaches without utilising both in tandem. Indeed, the success of Thessaloniki's SR framework could be a product of the utilisation of both rather than a dominant focus upon one medium.

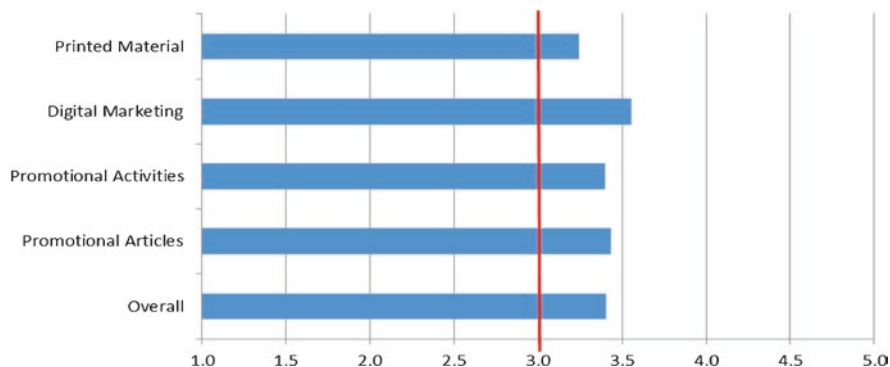


Fig. 2 CSFs' level of satisfaction among their related KPIs

Table 1 The Spearman correlation among different CSFs

Correlations	CSF1: promotion of thematic documents	CSF2: promotion of SR activities	CSF3: SN and quality of life – digital marketing	CSF3: SN and quality of life – printed material
CSF1: promotion of thematic pillar documents	1			
CSF2: promotion of SR activities	0.840 ^a	1		
CSF3: SN and quality of life – digital marketing	0.866 ^a	0.791 ^a	1	
CSF3: SN and quality of life – printed material	0.681 ^a	0.623 ^a	0.733 ^a	1

^aCorrelation is significant at the 0.01 level (2 tailed)

Table 1 exhibits the three CSFs employed and their Spearman correlation among them: Firstly, it presents the correlation of CSF1 (the promotional documents present the pull attributes of Thessaloniki). Secondly, it shows the correlation of CSF2 (the socially responsible activities of Thessaloniki). Third is the CSF3 correlation in terms of the promotion of the city’s social networking (SN) and quality of life, as marketed through digital tools and printed material. Table 1 shows results among the different categories of procuring activities that exhibit the strongest positive outcome for CSF3-innovative services of the digital promotion, a fact that confirms the satisfaction level exhibited in Fig. 2 (Romero and Molina 2011).

Therefore, findings provide (i) horizontal multilateral flexibility and transparency in regional CSR and governance, (ii) balanced regional stakeholders’ well-being and (iii) transferability potential to similar EU cities that lack multilevel, collaborative governance culture.

5 Conclusions

This case study reveals the designing efforts and the lessons learned, from the creation and application of an innovative SRPP framework. Currently, legal and managerial, municipal-procurement processes fail to provide impactful municipal services to the local communities (McKevitt et al. 2014). Paradoxically, the procurement of socially responsible, value-added, municipal services in Greece is vital to its economic survival, as youth unemployment reaches almost 45% (European Commission 2016). Therefore, there are several major contributions of the SRPP framework towards the solution of this on-going problematic situation.

The first contribution of this framework is its potential to serve as a valuable tool to the local business community and its engaging stakeholders. It combines all the

necessary SR communication elements, both on site and online. SMEs could reach these consulting services, receive an integrated service to their PP tender proposal and engage accordingly. In addition, the proposed CSFs could be encouraged both from municipal and private local stakeholders to the centralised PP decision makers. Previously, the local SMEs could not have access to any form of local consulting, even in relation to low-budgeted local PP tenders. As a result, local entrepreneurs were not aware on how to reveal these qualitative parameters. The “lowest economic bid” rule was the national norm.

The second contribution is that the newly formed company of TMDA S.A. and its SRPP framework could serve as a business communication vehicle between the Greek peripheral city of Thessaloniki and Athens. Such a socially responsible bilateral, periphery-centre communication could serve as an example for revealing the topical needs of the city and improve the quality of life of Thessaloniki citizens. Even more, a potentially dynamic national SRPP methodology could be developed, which will recognise the needs of the regional stakeholders and create a social network that stimulates value-added growth for local SMEs.

Third contribution is the framework’s design that balances CSFs and qualitative KPIs, which should be considered in the price of the offering services in a public tender. Thus, it contributes to the triple bottom line for the synergetic development of social and environmental factors with the economic ones. Procuring SR price-sensitive services provides an efficient and eventually effective procurement design in an EU member state. In addition, it provides the necessary flexibility in PP for small and peripheral actors through transparent, fair and socially responsible services (Nikolaou and Loizou 2015).

Fifth framework contribution relates to managerial practices behind the procurement-design structure. They are transparent and measurable and thus they could form a pole of attraction for SMEs (Borga et al. 2009). Current legal practices, especially for smaller tender offers, in our case averaging 35,000 euros, are not subject to EU regulations. As a result, small and regional tender offers in Greece are lacking transparency. Thus, current municipal practices, not only in Greece but also in EU, fail to comply with the transparent approach of this SR design.

Overall, the rich data collected from the city’s stakeholders verify the framework’s design as effective. Based on the specified thematic pillars (e.g. CSF1/KPI1) and together with the use of digital technological tools (e.g. CSF3/KPI1 and KPI2), this procurement design performs effectively according to the participating actors. Thus, the extensive use of digital communication and social networking seems to minimise the high cost of competitive bidding for all engaging stakeholders and especially for the valuable local SMEs (e.g. CSF1/KPI2). It also seems to improve the transparency levels of municipally procured practices. These explicit design features remain an absolute necessity for attracting SMEs to a public bidding process, especially in times of financial crisis. In addition, this framework’s design provides the ability to contribute to sustaining value pluralism and social responsibility in the public sector with (i) strong association between traditional and digital procurement approaches and (ii) clearly interlinked socially responsible support and methods of communication. Thus, as evaluation findings reveal, it allows the necessary

flexibility that circumvents rigid and expensive, time-consuming bidding currently in effect in several municipalities in Greece.

This case also provides a significant contribution to further understand the relationship between SMEs and CSR practices (Harrington et al. 2016). It concludes that the current use of the lowest-price bid should not be the main criterion for SRPP, as it perpetuates a problematic situation. The lowest-price criterion, if solely used, is a major barrier for economic growth. On the contrary, SR and transparency (e.g. CSF3) could improve the access and eventually the result of the public procurement of services through thematic disclosure (e.g. CSF1), SR publication of critical factors (e.g. CSF2) and dissemination of SR services that provide an effective SN (e.g. CSF3) with the engaging stakeholders. Although this SR framework is limited to the discovered qualitative factors (CSFs), which were examined and analysed in relation to their impact (see Table 1), it concludes that procuring SR services is not a one-stream supply chain process. It is rather a dynamic and interactive cross-functional process, engaging with a diverse number of vital administrative, managerial and legal considerations. Framework's implications are impactful to the European SR business practices and legalities due to its assimilation and synergetic application of mutually balanced factors.

Finally, given the project's success, we strongly believe that its application at national scale or in other regions of EU could solve the current problematic situation. The complexity associated with the framework's design and evaluation of its procurement processing results to further studies on SRPP practices for an on-going city effort to grow in sustainable manner. These studies do not necessarily have to promote the discussions relating to a city's profile, but rather to enhance the quality of its resident's everyday living.

References

- Adam F (2008) Mapping social capital across Europe: findings, trends and methodological shortcomings of cross-national surveys. *Soc Sci Inf* 74:159–186
- Albert A (2010) Greece breaches EU tender rules. *Supply Management*.
- Amann MK, Roehrich J, Eßig M, Harland C (2014) Driving sustainable supply chain management in the public sector: the importance of public procurement in the European Union. *Supply Chain Manag Int J* 19:351–366
- Andersen M, Skjoett-Larsen T (2009) Corporate social responsibility in global supply chains. *Supply Chain Manag* 14:75–86
- Angelidou M, Psaltoglou A (2017) An empirical investigation of social innovation initiatives for sustainable urban development. *Sustain Cities Soc* 33:113–125
- Apostopoulou A, Papadimitrou D (2014) The role of destination personality in predicting tourist behaviour: implications for branding mid-sized urban destinations. *Curr Issue Tour* 18:1–20
- Arvanitis M, Loukis E, Diamantopoulou V (2013) New technologies and traditional innovation determinants in the Greek economy. *J Balkan Near East Stud* 15:434–458
- Borga F, Citterio A, Noci G, Pizzumo E (2009) Sustainability report in small enterprises: case studies in Italian furniture companies. *Bus Strateg Environ* 18:162–176
- Borodako K (2014) Key foresight attributes of tourism companies in the City Krakow and the region. *Int J Tour Res* 16:282–290

- Braulio-Gonzalo M, Bovea MD (2020) Criteria analysis of green public procurement in the Spanish furniture sector. *J Clean Prod* 258(120704):1–14
- Bryman A, Bell E (2015) *Business research methods*. Oxford University Press, Oxford
- Cohen S, Karatzimas S, Naoum V (2017) The sticky cost phenomenon: a case study at the local government level: empirical evidence from Greece. *J Appl Acc Res* 18:445–463
- Crane A, Matten D, Spence J (2013) *Corporate social responsibility: readings and cases in a global context*. Routledge, London
- De la Cuesta GM, Martinez C (2004) Fostering social responsibility through public initiative: from the EU to Spanish case. *J Bus Ethics* 55:275–293
- Donia MB, Sirsly CAT (2016) Determinants and consequences of employee attributions of corporate social responsibility as substantive or symbolic. *Eur Manag J* 34:232–242
- European Commission (2016) *Single markets and standards: public procurement strategy*. http://ec.europa.eu/docsmodernising_rules
- Eurostat Report (2016) *Unemployment statistics at regional level*. <https://ec.europa.eu/Eurostat/index.php>
- Harrington TS, Singh Srail J, Kumar M, Wohlrab J (2016) Identifying design criteria for urban system ‘last-mile’ solutions—a multi-stakeholder perspective. *Prod Plan Control* 27:456–476
- Hueskes M, Verhoest K, Block T (2017) Governing public–private partnerships for sustainability: an analysis of procurement and governance practices of PPP infrastructure projects. *Int J Proj Manag* 35(6):1184–1195
- McKevitt DM, Flynn A, Davis P (2014) Public buying decisions: a framework for buyers and small firms. *Int J Pub Sect Manag* 27:94–106
- Mella P, Gazzola P (2018) Corporate social responsibility through stakeholder engagement and entrepreneurial communication processes. *Int J Bus Perform Manag* 19:36–54
- Metzger J, Soneryd L, Linke S (2017) The legitimization of concern: a flexible framework for investigating the enactment of stakeholders in environmental planning and governance processes. *Environ Plan A Econ Space* 49:2517–2535
- Nikolaou I, Loizou C (2015) The green public procurement in the midst of the economic crisis: is it a suitable policy tool? *J Integr Environ Sci* 12:49–66
- Papagiannis F, Kok SP, Michaelides Z (2018) The case of Thessaloniki’s branding: constructing social networking and CSR in the digital era. In: *Corporate responsibility and digital communities*. Palgrave Macmillan, Cham, pp 165–184
- Papagiannis F (2016) An ontologically innovative design of CSR strategies: enabling value added Institutional Collaborations. *Corporate Social Responsibility in the Post-Financial Crisis: CSR Conceptualizations and International Practices in Times of Uncertainty*. Palgrave Studies in Governance, Leadership and Responsibility, Palgrave MacMillan, Basingstoke.
- Papagiannis F, Kok SK, Michaelides Z (2018) Overhauls in water supply systems in Ukraine: a hydro-economic model of socially responsible planning and cost management. *J Clean Prod* 183:358–369
- Pemer F, Sieweke J, Werr A (2018) The relationship between national culture and the use of professional services: evidence from two cross-country studies. *J Purch Supply Manag* 24:314–325
- Preuss L (2009) Addressing sustainable development through public procurement: the case of local government. *Supply Chain Manag Int J* 14:213–223
- Romero D, Molina A (2011) Collaborative networked organisations and customer communities: value co-creation and co-innovation in the networking era. *Prod Plan Control* 22:447–472
- Sajad A, Eweje G, Tappin D (2015) Sustainable supply chain management: motivators and barriers. *Bus Strateg Environ* 24:643–655
- Saunders M, Lewis P, Thornhill A (2015) *Research methods for business students*, 7th edn. Pitman Publishing, London
- Saxton GD, Guo C (2011) Accountability online: understanding the web-based accountability practices of non-profit organizations. *Nonprofit Volunt Sect Q* 40:270–295
- Sönnichsen SD, Clement J (2020) Review of green and sustainable public procurement: towards circular public procurement. *J Clean Prod* 245(118901):1–18

- Truong TH, King B (2009) An evaluation of satisfaction levels among Chinese tourists in Vietnam. *Int J Tour Res* 11:521–535
- Tsouhluou A, Mylonakis J (2011) Public expenditure, public sector size and growth: the European Union marked structural differences report. *Rev Euro Stud* 3:33–51
- Uyerra E, Flanagan K (2010) Understanding the innovation impact of public procurement. *Eur Plan Stud* 18:123–143
- Uyerra E, Zabala-Iturriagoitia JM, Flanagan K, Magro E (2020) Public procurement, innovation and industrial policy: rationales, roles, capabilities and implementation. *Res Policy* 49(1):103844. 1–11
- Van Zoonen W, Verhoeven JWM, Vliegenthart R (2017) Understanding the consequences of public social media use for work. *Eur Manag J* 35:595–605
- Walker H, Bammer S (2009) Sustainable procurement in the United Kingdom public sector. *Supply Chain Manag Int J* 14:128–137
- Wilshusen PR, MacDonald KI (2017) Fields of green: corporate sustainability and the production of economic environmental governance. *Environ Plan Econ Space* 49:1824–1825
- Witjes S, Lozano R (2016) Towards a more circular economy: proposing a framework linking sustainable public procurement and sustainable business models. *Resour Conserv Recycl* 112:3744
- Yu W, Wang K (2012) Best value or lowest bid? A quantitative perspective. *J Constr Eng Manag* 138:128–134

Insurance Business Cycles in Liability Insurance – The Case of the Polish Market



Ewa Poprawska

1 Introduction

Business cycles in insurance, also called underwriting cycles, are typical for non-life insurance. The underwriting cycle can be shortly described as the tendency of property and casualty insurance premiums, profits and availability of coverage to rise and fall with some regularity over time. Therefore, the cycle consists of phases of low and high prices of insurance products and changes in the values of ratios of financial activities of insurers. In the challenging market phase, the supply of insurance coverage is shrinking, prices and profitability are rising, and insurance terms are less favourable for policyholders. On the other hand, the soft market phase is characterized by a fall in prices, an increase in the availability of insurance protection and better (for customers) terms of concluded contracts.

There are many theories explaining the appearance underwriting cycle and also points to the many reasons that cause their formation; the most important can be divided into (more in Doherty and Graven 1995; Manikowski 2013):

1. Internal causes, like:
 - Imbalance of supply demand (delays in adapting the insurance price to changing demand, errors in calculating premiums)
 - Capital constraints
2. External causes, like

E. Poprawska (✉)
Department of Insurance, Wrocław University of Economics and Business, Wrocław, Poland
e-mail: ewa.poprawska@ue.wroc.pl

- Changes in interest rates – in most of actuarial models, the expected value of the discounted future payments is used to calculate insurance premiums, so sudden changes in interest rates affect the level of premiums.
- Changes in law – it is a factor widely understood, for example, the changes in the liability insurance for damages by the rules relating to the administration (e.g. the scope of processing), to changes in the solvency and capital requirements.
- Catastrophic events – the most important causes of underwriting cycle, a sudden need to pay a large compensation or accumulation of payments in the short term could undermine the financial stability of insurers and increase the probability of insolvency, resulting in a capital increase or the need to raise the prices of insurance products.
- General economic trends, changes in GDP.

According to theory, business cycles in insurance are long, according to studies from other countries, e.g. Meier and Outreville (2006) and Venezian (1985); these are cycles 6–10 years long (longer cycles suggested by Lamm-Tennant and Weiss (1997), Chen et al. (1999), Meier (2006)).

In relation to the Polish market, up to now the cycle survey has been limited by the time horizon of available data, as unified data have been published by the Supervisory Authority since 1999; previous data are not entirely consistent – changes in the accounting of insurance companies. The analysis of insurance cycles in Poland has been conducted among others by Manikowski and Weiss (2008), Manikowski (2013) and Mocek (2009). This article is also a continuation of the author's research on motor insurance, conducted in the years 2011–2013 – Poprawska and Jędrzychowska (2011) and Jędrzychowska et al. (2013). These studies are from a few years ago. Currently, the scope of available data is much longer, which allows drawing new conclusions on this subject and comparing the results of earlier studies with newer ones, covering a longer time horizon, and thus determining whether the Polish market in terms of underwriting cycles has changed. In addition, it is possible to check whether the cycle lengths have reached values similar to those observed in developed markets.

2 Specificity of Liability Insurance

Liability insurance has been selected for the study due to the fact that they are particularly sensitive to changes in legal regulations, which were numerous on the Polish market, especially in the years 2007–2012, including numerous amendments to the Civil Code. The scope of the insurer's liability for damages in the case of liability insurance is closely related to the structure of the scope of liability under civil law. If the scope of liability increases, the insurer incurs higher costs related to the payment of claims. In Poland, third-party liability insurance covers (Civil Code 1964):

- Damage to property, such as loss or destruction to property (both losses incurred and benefits lost are covered)
- Bodily injuries, which include claims of directly (both pecuniary, Art. 444, and non-pecuniary damage, Art. 445) and indirectly (Art. 446 and 448) injured.

In Poland, significant changes have taken place in this respect, which have significantly expanded the insurers’ liability for personal injury (more in Dąbrowski et al. 2017). In 2007 (adopted 13 June 2007), amendment to the Civil Code extended the limitation period – even up to 20 years if the damage resulted from a crime or offense. In 2008, compensation for pain and suffering after the death of a close person was introduced to the Civil Code (Art. 446, par 4). In addition, there were several changes that affected the results of motor third-party liability (MTPL) insurance. An important one was the interpretation of the Supreme Court in 2010, in which they stated that families of accident victims may apply for compensation for events that took place before the amendment to the Civil Code, i.e. before 2008. In the period from 1 October 2007 to 31 December 2008, a fee that insurers transferred to the National Health Fund, to cover the costs of treating victims of traffic accidents (lump sum payment = 12% of the premiums), was in force. In March 2015, guidelines issued by the Financial Supervision Authority to insurers came into force. They contributed to the increase in operating costs related to the liquidation and the payment of claims from motor insurance, which in consequence affected higher premiums, primarily for MTPL insurance.

In addition, in the period from 1990 (since the beginning of the demonopolized insurance market in Poland), there were many changes regarding compulsory insurance (including MTPL). For example, the maximum limit of the insurer’s liability for claims in liability insurance has been raised several times. With regard to MTPL insurance, these sums were changing many times, since 2004 in connection with the adaptation of Polish law to EU requirements – see Fig. 1.

Another change is the possibility of valorization of the guaranteed sum to the currently applicable values (case law of the Supreme Court); from 1 January 2016, it is necessary to inform the pension beneficiary that 80% of the guaranteed amount

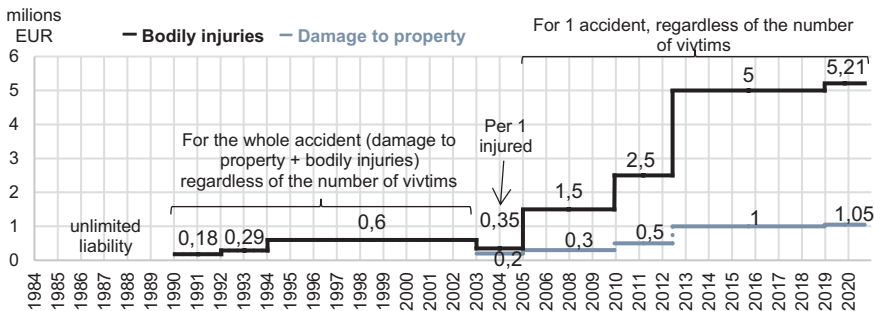


Fig. 1 Changes in minimum amount of coverage in MTPL insurance I Poland (Source: author’s work on the basis of Cwalińska-Weychert et al, (2014), Act of 23 October 2018, amending the Act on compulsory insurance, the IFG and the PMIB)

has been used, which is a convenience for the injured, and an additional (and not included at the stage of calculation premium and the creation of technical provisions for these types of insurance) at the cost of insurers. The profitability of MTPL insurance was influenced and still is by a number of judgements of the Supreme Court in the case of victims in a vegetative state – the scope of benefits for relatives is the same as for relatives of a deceased person as a result of an accident (which significantly extended the scope of benefits paid by insurers) (Jędrzychowska et al. 2013).

All of the mentioned changes, except for other reasons, may have been triggers of the underwriting cycle. Therefore, it is worth to analyse the existence of underwriting cycles in liability insurance (an interesting analysis of underwriting cycles in third-party liability insurance can be found, e.g. in Meier and Outreville (2010)). According to the Act on insurance and reinsurance activities (2017), liability insurance is in groups 10, 11, 12 and 13 of non-life insurance sector. Group 10 – motor third-party liability insurance (MTPL) – contains the most popular (compulsory) insurance products on Polish non-life market. In 2018 the share in gross written premiums of the whole non-life sector was around 37.5%, and the share in compensations paid is 44.4% (Polish Financial Supervisory Authority data). In contrary, groups 11 and 12 consist of niche products. Group 11 – aircraft liability – all liability arising out of the possession and use of aircraft, has a small share in the non-life insurance market in Poland (0.06% of written premiums, 0.02% of compensations paid). Similarly group 12 – liability for ships in sea and inland navigation arising out of the possession and use of sea and inland vessels – has market share in 2018 on the level of 0.05% and 0.06% in gross written premiums and compensations paid, respectively. Small, niche insurance groups can be very susceptible to events that may trigger the appearance of underwriting cycles. Studies on the occurrence of cycles in such niche insurance were conducted, for example, by Manikowski and Weiss (2013) concerning satellite insurance and by Lei and Browne (2015) concerning medical malpractice insurance. Group 13 contains compulsory liability insurance for farmers, general liability, product liability, D&O (directors and officers liability), professional liability (many of them compulsory in Poland), medical malpractice, excess liability, commercial multiple peril (liability), etc. It is therefore a very diverse group.

3 Methodology and Data

3.1 Data

The yearly, quarterly and monthly data are generally used in business cycle studies. In contrary, in underwriting cycle analysis, the vast majority of studies are based on yearly data (except, e.g. Grace and Hotchkiss [1995], Manikowski [2013]), usually due to unavailability and/or worse quality of quarterly data (monthly data are not published). The quarterly data are often published in a truncated version; not all

relevant data are available in this variant. In addition, quarterly data, unlike annual ones, are not always verified. Finally, not on all insurance markets, quarterly data are published by individual insurance groups. For the Polish market, both yearly (since 1999) and quarterly (since 2001) data are available. The yearly data for previous years are available for the entire non-life sector, but they are aggregated; there is no data for individual groups. For all these reasons, the study was based on annual data from the years 1999–2018.

A very important stage is the selection of appropriate quantities to be analysed. In research on underwriting cycles, profitability ratios are usually analysed. In the Polish market research, other performance indicators were also taken into account. Selected ratios and their expected behaviour during the different phases of the cycles, an indication of whether the indicator is reference, leading, lagging or coincident to the cycle, are presented in Table 1.

The choice of indicators was also determined by the quality of the available data – not all of them can be calculated from data from aggregate financial statements of insurers. For product groups, only data included in the technical account are published, data from the balance sheet and general profit and loss account are not published for the groups of products offered by insurers. Finally, in the study, selected efficiency ratios have been used, based on premiums, claims, other costs and technical results of insurers operating on Polish market. The definitions of efficiency ratios (see Table 2) and the value necessary to calculate them are published by Polish Financial Supervision Authority in Annual Bulletin. Insurance market (1999–2018).

The last of the described indicators – combined ratio – is the sum of three others. It is an indicator specific to the insurance market, informing whether the insurer earns on a given product group (values less than 1), taking into account the most important cost groups, i.e. damages and benefits (component of the loss ratio), as well as administrative costs and acquisition costs. The work analyzes both the values of this index for individual insurance groups and the values of its components.

Table 1 Expected behaviour of insurance metrics during the cycle and hypothetical relations between them

Ratio	“Hard” market phase	“Soft” market phase	Time relation
Profitability ratios	Increase	Decrease	Reference index
Dynamics of premiums	Increase	Decrease	Lagging
Dynamics of claims	Decrease	Increase	Leading
Claims ratios	Decrease	Increase	Coincident
Combined ratios	Decrease	Increase	Coincident
Rates	Increase	Decrease	Leading
Capacity	Decrease	Increase	Lagging

Source: Manikowski (2013), p. 120

Table 2 Definitions of efficiency ratios

No	ratio	Formula
1	Dynamics of gross written premiums (GWP)	Gross written premiums as at the end of the reporting period / gross written premiums as at the beginning of the reporting period
2	Dynamics of written premiums (WP) – net of reinsurance	(written premiums - net of reins. at the end of the reporting period) / (written premiums - net of reins. at the beginning of the reporting period)
3	Dynamics of gross claims paid	Gross claims paid as at the end of the reporting period / gross claims paid as at the beginning of the reporting period
4	Dynamics of claims paid – net of reinsurance	Claims paid - net of reinsurance at the end of the reporting period / claims paid - net of reins. at the beginning of the reporting period
5	Claims ratio	(gross claims paid + gross change in provision for claims outstanding) / gross earned premiums
6	Claims ratio net of reins.	Claims incurred / earned premiums - net of reinsurance
7	Acquisition costs ratio	Acquisition costs / gross written premiums
8	Administrative costs ratio	Administrative expenses / gross written premiums
9	Net operating expenses ratio	Net operating expenses / gross written premiums
10	Ratio of technical charges – net of reinsurance	(net operating expenses + other technical charges - net of reinsurance) / written premiums - net of reinsurance
11	Profitability ratio of technical activity	Technical result / earned premiums
12	Profitability ratio of technical activity – net of reinsurance	Technical result / earned premiums - net of reinsurance
13	Combined ratio	Claims ratio + acquisition costs ratio + administrative costs ratio

Source: Annual bulletin. Insurance market (1999–2018)

3.2 *Methods of Extracting Underwriting Cycles*

In the analysis of underwriting cycles, one can come across several groups of methods. The first of these is graphical analysis – used mainly as a preliminary method by, for example, Helten (1977), de Witt (1979) and Lemkowska (2007). The next is spectral analysis proposed by C. Mormino (Mormino 1979) also used in the works of Venezian EC (2006) for US market, Doherty and Kang (1988), Grace and Hotchkiss (1995), Leng and Meier (2006). The most popular method is the second-order autoregressive model AR (2), proposed by Venezian (1985) and developed by Cummins and Outrville (1987). This method was used by, among others M. Boyer, E. Jacquie and Van Norden (2012) and Harrington, Niehaus and Yu (2013); in research on the Polish insurance market, this method was used, among others, by Manikowski (2013) and Jędrzychowska and Poprawska (2011). Although this method has been criticized in recent years (e.g. Boyer and Owadally 2015), it is still considered the basic one, as a starting point for research of these area. In addition, this method was used in the author's previous research, so using it again allows for

comparison of the results. Other methods, such as non-parametric ones, like Hodrick-Prescott filter and Baxter-King filter, do not have much application in the study of underwriting cycles – more in Manikowski (2013). In recent years, other approaches to underwriting cycles have also appeared, such as Feng and Powers (2019), Haley (2017), Owadally et al. (2019) and Wang and Murdock (2019).

In the study an AR (2) model described below is used:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 Y_{t-2} + \omega_t \quad (1)$$

where Y_t is the value of the dependent variable at time t and ω_t is the random component.

In this method, it is assumed that the cycle occurs when the following conditions are met:

$$a_1 > 0 \quad \text{and} \quad a_2 < 0 \quad \text{and} \quad (a_1)^2 + 4a_2 < 0$$

Cycle length T is calculated (if determined the occurrence of cycle) as follows:

$$T = 2\pi / \cos^{-1} \left(\frac{a_1}{2\sqrt{-a_2}} \right) \quad (2)$$

Model coefficients are estimated by least squares method – see Dziechciarz (2002).

4 Results and Discussion

The test results are presented in Table 3. If a cycle is found to be present, its length, expressed in years, is presented for each of the analysed ratio. The results currently obtained have also been compared with the results of the author's previous research for the years 1999–2011 (in italics) – results obtained using the same methods.

In non-life sector and MTPL insurance (group 10), cycles with a length of 5–6 years have been observed, in most of the ratios analysed, primarily in profitability ratios, dynamics of premiums and compensation as well as technical cost ratios. On the other hand, the cycle for claims ratios (gross and net of reinsurance) and for the combined ratio was not found for the entire non-life sector. In group 10, for both combined ratio and gross claims ratio, cycles occur 4–5 years long. The data on selected indicators are presented in Figs. 2 (dynamics of premiums and compensations) and 3 (profitability ratios) for the whole non-life sector and for group 10 (MTPL insurance) in Figs. 4 (dynamics of premiums and compensations) and 5 (profitability ratios, combined ratio).

Basing the research on a longer time series allowed to confirm the cyclicity of more ratios than was the case in previous studies (e.g. claims ratio in group 10, net

Table 3 The length of the underwriting cycle based on the data in 1999–2018 vs 1999–2011 (for non-life and MTPL)

No	ratio	Non-life		Group 10		Group 11	Group 12	Group 13
		1999–2018	1999–2011	1999–2018	1999–2011			
1	Dynamics of GWP	5.94	6.18	5.98	6.27	–	–	4.28
2	Dynamics of WP – net of reins.	5.78	<i>n.a.</i>	6.01	<i>n.a.</i>	–	–	–
3	Dynamics of gross claims paid	5.47	5.54	5.32	4.98	–	–	–
4	Dynamics of claims paid – net of reins.	5.40	<i>n.a.</i>	5.86	<i>n.a.</i>	–	–	6.26
5	Gross claims ratio	–	–	4.04	–	–	4.96	–
6	Claims ratio – net of reins.	–	–	–	–	–	5.91	–
7	Acquisition costs ratio	–	–	–	–	–	–	–
8	Administrative costs ratio	–	–	–	–	–	–	–
9	Net-operating expenses ratio	3.97	–	5.41	–	–	–	–
10	Ratio of technical charges – net of reins.	4.51	–	4.72	–	–	–	–
11	Profitability ratio of technical activity	4.65	4.57	5.10	4.53	–	–	–
12	Profit. ratio of technical activity – net of reins.	4.47	–	5.12	3.65	–	6.23	–
13	Combined ratio	–	<i>n.a.</i>	4.54	<i>n.a.</i>	4.89	5.33	–

n.a. – not analysed previously

Source: author’s own calculations, Jędrzychowska et al. (2013)

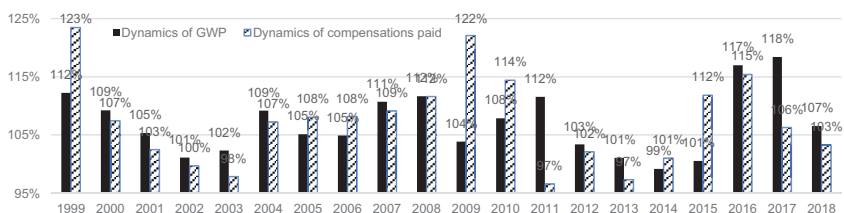


Fig. 2 Dynamics of gross written premiums and compensations paid for non-life sector in Poland 1999–2018 (Source: author’s own calculations)

operating expenses ratio, ratio of technical charges, net profitability ratio in non-life sector).

In the case of non-life insurance, several “jumps” in the loss ratio during the analysed period can be assessed, one of the most important years being 2009 and 2010 – flood damage. In case of premiums, an advanced jump can be made in the

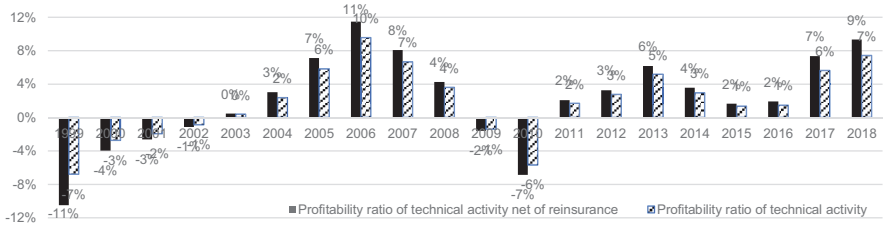


Fig. 3 Profitability ratios for non-life sector in Poland 1999–2018 (Source: author’s own calculations)

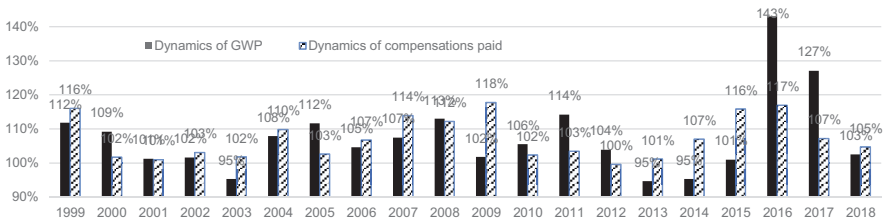


Fig. 4 Dynamics of gross written premiums and compensations paid for group 10 of non-life sector in Poland 1999–2018 (Source: author’s own calculations)

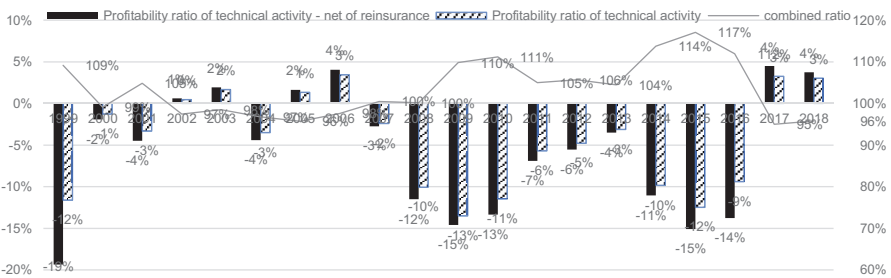


Fig. 5 Profitability (left axis) and combined ratio (right axis) for group 10 of non-life sector in Poland 1999–2018 (Source: author’s own calculations)

years 2004–2005 – an increase in premiums written in MTPL and AC insurance as a result of the import of a large number of cars (in 2004 Poland joined the EU – liberalization in importing cars). Another one took place in 2016, which was a consequence of a joint intervention of the Polish Financial Supervision Authority (circular letter from the PFSA 2015) persuading the insurers to verify the models and methods used in the calculation of premiums in MTPL insurance, counteracting the negative phenomena on the market long-term negative profitability of this group. The market reaction was to increase premiums, which also translated into improved profitability. In the case of MTPL insurance claims, no sharp jumps in the value of ratios were observed, but a systematic increase in the value of payments and a decline in profitability.

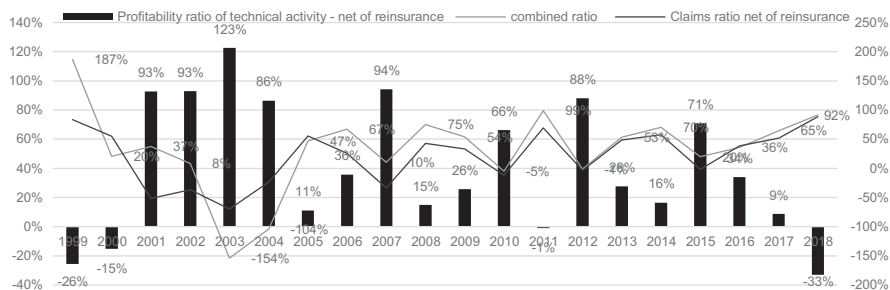


Fig. 6 Claims ratio net of reinsurance (left axis), profitability ratio of technical activity net of reinsurance, combined ratio (right axis) for group 12 of non-life sector in Poland 1999–2018 (Source: author's own calculations)

In the case of group 11, no cycles were found in any indicator except combined ratio, even in indicators that are their components. Probably the effects of cycles are poorly visible in the case of individual indicators that are combined ratio components, only after their addition, i.e. in the form of a combined ratio indicator, they become detectable.

In group 12, the occurrence of cycles in the ratios that are most often studied in the context of underwriting cycles, i.e. both claims ratios and profitability ratio (reference index) net of reinsurance and combined ratio (coincidence index), was observed – the data presented in Fig. 6.

In group 13, on the other hand, cycles occurred only in two dynamics ratios. This group is the most diverse when it comes to the products that are included in it; unfortunately no financial data on individual products are published, so it is not possible to examine them separately. Therefore, it is difficult to draw far-reaching conclusions about the cyclical nature of this group of insurance.

The comparison of the currently obtained results with those obtained in the author's previous studies allows to conclude that the extension of the time range of the data allowed observing the occurrence of underwriting cycles in a larger number of indicators. In addition, currently obtained results for individual indicators are more similar in terms of cycle length than those obtained in previous studies. For the 1999–2011 data, the length of cycles for group 10 ranged from 3.65 years for profitability ratio of technical activity net of reinsurance to 6.27 for dynamics of gross written premiums; in current studies cycle lengths are from 4–4.5 up to 6 years.

5 Conclusions

Due to the fact that the Polish insurance market is still a young, dynamic market, it is worth examining the occurrence of underwriting cycles. The research shows that these cycles are quite short, ranging from about 4.5 to about 6 years depending on the product group and types of indicators. Knowledge of their occurrence allows for

active consideration of their occurrence in the management of the insurance undertaking's policy. Therefore, it is important to analyse the behaviour of leading indicators, like dynamics of claims. Therefore, it is worth trying to analyse the factors that affect the level of premiums and the level of loss ratio, i.e. it is worth trying a bit more detailed research of this phenomenon on the Polish market. Liability insurance is very sensitive to changes in legislation, so the study of the occurrence of cycles is interesting in their case, due to the multitude of changes that have taken place and are taking place in Poland. With the exception of group 10, which is very uniform as regards products (only MTPL insurance) and comprising products are frequently purchased, others are more niche insurance groups (e.g. 11 and 12) or groups containing a variety of products (group 13). It would be worth analysing individual types of products, but such data are not published. Since the publication of Manikowski's monograph and several works, the topic of underwriting cycles on the Polish market has not been discussed. At that time, studies were limited by the scope of available data; refreshing research on this topic using longer time series is important. The literature rarely analyses niche insurance groups, which is one of the goals of this study.

The limitations of the conducted research result mainly from the method used and the quality of the available data. However, a time series of less than 20 elements does not allow the use of, for example, spectral analysis and other methods. However, it is worth extending the research with methods taking into account the analysis of individual factors that may affect the formation of underwriting cycles.

References

- Act of 11 September 2015 on insurance and reinsurance activities. Dz.U. 2015 poz. 1844.
- Act of 23 April 1964 - Civil Code. Dz.U. 1964 nr 16 poz. 93.
- Act of 23 October 2018 amending the Act on compulsory insurance, the Insurance Guarantee Fund and the Polish Motor Insurers' Bureau Dz.U. 2018 poz. 2448.
- Annual bulletin. Insurance market - for years 1999-2018, Polish Supervisory Authority, available at https://www.knf.gov.pl/en/REPORTS_AND_ANALYSIS/Insurance
- Boyer MM, Owadally I (2015) Underwriting Apophenia and cryptids: Are cycles statistical figments of our imagination? *Geneva Papers Risk Insurance – Issues Pract* 40(2):232–255. <https://doi.org/10.1057/gpp.2014.12>
- Boyer MM, Jacquier E, Van Norden S (2012) Are underwriting cycles real and forecastable? *J Risk Insur* 79:995–1015
- Chen R, Wong KA, Lee HC (1999) Underwriting cycles in Asia. *J Risk Insur* 66(1):29–47
- Circular letter from the Polish Financial Supervision Authority of 28 September 2015 (reference number DNU/606/6/2/1/AW/2015 available at: https://www.knf.gov.pl/knf/pl/komponenty/img/kalkulacja_wysokosci_skladki_ubezpieczeniowej_28-09-15_42937.pdf
- Cummins JD, Outreville JF (1987) An international analysis of underwriting cycles in property-liability insurance. *J Risk Insur* 54:246–262. <https://doi.org/10.2307/252856>
- Cwalińska-Weychert Z, Monkiewicz M, Sordyl G (2014) Działalność odszkodowawcza Ubezpieczeniowego Funduszu Gwarancyjnego na tle rozwiązań europejskich. *Prawo Asekuracyjne* 3(80):102–116

- Dąbrowski T, Pomarański S, Wiercioch K, et al (2017) Information on compulsory third party liability insurance for motor vehicle owners - changes in liability, amount of damages and premium amount UKNF Warszawa.
- De Witt G (1979) Cycles in insurance: A Review of past researches and proposals of further studies. *Etudes et Dossiers* 33
- Doherty NA, Garven JR (1995) Insurance cycles: Interest rates and the capacity constraint model. *J Bus* 68:383. <https://doi.org/10.1086/296669>
- Doherty NA, Kang HB (1988) Interest rates and insurance price cycles. *J Banking Finan* 12:199–214. [https://doi.org/10.1016/0378-4266\(88\)90035-0](https://doi.org/10.1016/0378-4266(88)90035-0)
- Dziechciarz J (ed) (2002) *Ekonometria: metody, przykłady, zadania*. Wyd. Akademii Ekonomicznej im. Oskara Langego, Wrocław
- Feng F, Powers M (2019) Ordinary and Markov-switching autoregressive models for firm-level underwriting data. *Asia-Pacific J Risk Insur* 13(2). <https://doi.org/10.1515/apjri-2018-0031>
- Grace MF, Hotchkiss JL (1995) External impacts on the property-liability insurance cycle. *J Risk Insur* 62:738. <https://doi.org/10.2307/253593>
- Haley J (2017) Using directional bit sequences to reveal the property-liability underwriting cycle as an algorithmic process. *Algorithmic Finance* 6(1–2):3–21. <https://doi.org/10.3233/AF-170172>
- Harrington SE, Niehaus G, Yu T (2013) Insurance price volatility and underwriting cycles. In: Dionne G (ed) *Handbook of insurance*. Springer, New York. https://doi.org/10.1007/978-1-4614-0155-1_23
- Helten E (1977) Business cycles and insurance. *Geneva Pap Risk Insur Issues Pract* 2:53–75. <https://doi.org/10.1057/gpp.1977.14>
- Jędrzychowska A, Kowalczyk-Rólczyńska P, Poprawska E (2013) Motor insurance market in Poland in connection to European trends. *Ekonomika: mokslo darbai / Vilniaus Universitetas* 92:3
- Lamm-Tennant J, Weiss MA (1997) International insurance cycles: Rational expectations/institutional intervention. *J Risk Insur* 64:415. <https://doi.org/10.2307/253758>
- Lei Y, Browne M (2015) Underwriting strategy and the underwriting cycle in medical malpractice insurance. *Geneva Papers Risk Insur – Issues Pract* 42:152–175. <https://doi.org/10.1057/gpp.2015.24>
- Lemkowska M. (2007) Wybrane determinanty wahań koniunkturalnych na rynku ubezpieczeniowym w Polsce w latach 1993–2006. *Wiadomości Ubezpieczeniowe* 9/10.
- Leng C, Meier UB (2006) Analysis of multinational underwriting cycles in property-liability insurance. *J Risk Finan* 7:146–159. <https://doi.org/10.1108/15265940610648599>
- Manikowski P. (2013) *Insurance cycles in market economy*. Poltext Warsaw.
- Manikowski P, Weiss MA (2013) The satellite insurance market and underwriting cycles. *Geneva Risk Insur Rev* 38:148–182. <https://doi.org/10.1057/grir.2013.2>
- Meier UB (2006) Multi-national underwriting cycles in property-liability insurance: Part I – Some theory and empirical results. *J Risk Finan* 7:64–82. <https://doi.org/10.1108/15265940610637816>
- Meier UB, François Outreville J (2006) Business cycles in insurance and reinsurance: The case of France, Germany and Switzerland. *J Risk Finan* 7:160–176. <https://doi.org/10.1108/15265940610648607>
- Meier UB, Outreville JF (2010) Business cycles in insurance and reinsurance: International diversification effects. *Appl Finan Econ* 20(8):659–668
- Mocek M (2009) Wahania koniunktury na polskim rynku ubezpieczeniowym w 2008 roku w świetle wyników testu koniunktury. *Wiadomości Ubezpieczeniowe* 2009(2). In: *Polska Izba Ubezpieczeń*.
- Mormino C (1979) Insurance cycles: An Italian experience. *Etudes et Dossiers* 33
- Owadally I, Zhou F, Otunba R, Lin J, Wright D (2019) Time series data mining with an application to the measurement of underwriting cycles. *North Am Actuarial J* 23(3):469–484. <https://doi.org/10.1080/10920277.2019.1570468>
- Poprawska E, Jędrzychowska A (2011) Business cycles in the Motor Insurance in Poland. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* *Ekonomia* 14:281–290

- Poprawska E, Jędrzychowska A, Kwiecień I (2020) The exhaustion of amounts of cover (guarantee sums) in the compulsory third party liability insurance of motor vehicle owners (MTPL) – The current problems. Presentation Wrocław Con Finance 22(09):2020
- The Act of May 22, 2003 on compulsory insurance, the Insurance Guarantee Fund and the Polish Motor Insurers' Bureau Dz.U. 2003 nr 124 poz. 1152.
- Venezian EC (1985) Ratemaking methods and profit cycles in property and liability insurance. *J Risk Insur* 52:477. <https://doi.org/10.2307/252782>
- Venezian EC (2006) The use of spectral analysis in insurance cycle research. *J Risk Finan* 7:177–188. <https://doi.org/10.1108/15265940610648616>
- Wang N, Murdock M (2019) A dynamic model of an insurer: Loss shocks, capacity constraints and underwriting cycles. *J Risk Finan* 20(1):82–93. <https://doi.org/10.1108/JRF-03-2018-0051>

Sustainable Business Models in Healthcare: A Scoping Review of the Quality and Quantity of Literature



Omar Rashdan and Gábor Csepy

1 Introduction

Sustainability as a concept has now been circulating in the scientific literature for almost 50 years after its first mention in *Nature Magazine* back in 1972 (Woodell 1972). The broad distribution across the sciences for the term itself made the definition decentralized. Basiago (1995) introduced a paper on the methods for defining sustainability. They agreed on five main realms for defining sustainability: biological, economical, sociological, planning, and ethical methods. Biologically speaking, sustainability can be associated with biodiversity protection. In economics, it favors accounting for natural resources. Sociologically, it indulges in the environmental defense force powers, while in planning it's about the process of urban revitalization. In environmental ethics, it's about preservation/conservation of natural resources. Consequently, sustainability can be defined not as a target, but as a governing principle shaping the activity of a system as a whole which will yield vitality.

Later on, the concept of sustainability started its way in business model design and implementation. Alexandre J. et al. portrayed a canvas of a triple-layered business model! They extended the original business model concept to include two more layers: an environmental layer taking a life cycle perspective and a social layer taking a stakeholder perspective (Joyce and Paquin 2016). In healthcare industries, sustainable business models were ought to be adopted fast by pharmaceutical industries in light of the increasing R&D costs which hindered the current business model's future financial sustainability. Hence, significant productivity improvements were required and the search for sustainable healthcare business models to maintain such giants sustainable on the long term (Booth and Zemmel 2004).

O. Rashdan (✉) · G. Csepy
Doctoral School of Business & Management, Corvinus University of Budapest,
Budapest, Hungary

Scimago Journal Ranking (SJR) system is a commonly used service to measure the scientific influence of scholarly articles and publications. It accounts for both the number of citations received by the journal and the importance of the journal in the field, giving an indicator of the overall quality of the journal. This also gives an indirect indicator of the quality of the articles published in the corresponding journal rank (Falagas et al. 2008). The use of bibliometric analysis techniques in examining sustainability of business models in healthcare – to our knowledge – does not exist in the literature. Our aim in this work is to identify and quantify peer-reviewed scientific literature focusing on sustainable business models in healthcare. Moreover, using a combination of qualitative and quantitative work, we withdraw the most highlighted disciplines and topics investigated in the field providing future researchers with a systematic research framework identifying research directions. Moreover, our bibliometric analysis will emphasize the leading journals and articles in the field. It will also help answer how deep sustainability of business models is investigated in the healthcare field and what are the most active research disciplines.

2 Methods

To achieve our aims, we applied a combination of systematic literature review methods and qualitative and quantitative content analysis tools. Our work started by systematically searching for related literature in multiple databases. Scopus and the EBSCO Discovery Service (EDS) were both used to extract the related literature. EDS is a comprehensive literature discovery service that utilizes a number of major databases to extract the most out of researched topics (Fu and Thomes 2014). In all databases, the same keywords and search criteria were used. In order to create the initial database of relevant articles, we used the following keywords “health care”/“healthcare”/“health-care” together with “sustainable”/“sustainability” and “business model.” The search was done on the seventh of October 2019 for English language articles from all previous years to date journal articles. There were 126 articles extracted from Scopus and 138 from the EDS. After eliminating duplicates, 146 articles remained. The search results were downloaded in CSV (comma-separated version) format and imported into Excel 365. The Excel table of journal article’s bibliographic data extracted was extended with the Scimago Journal Ranking (SJR) of the corresponding journal and year. Articles published in non-SJR ranked journals were excluded although all the articles extracted were SJR ranked. The final number of articles retrieved for our analysis is 146 articles. Figure 1 shows the inclusion and exclusion process.

Our quantitative analysis was targeting the bibliographic data of the articles and their corresponding journals. First, we examined the publishing trends of the articles in our database. Then, based on the Scimago rankings, the most influential journals were identified and the relevant journal disciplines assessment was created. Furthermore, the keyword frequencies were analyzed to help the researchers to identify the most relevant connecting keywords to the topic noting that the

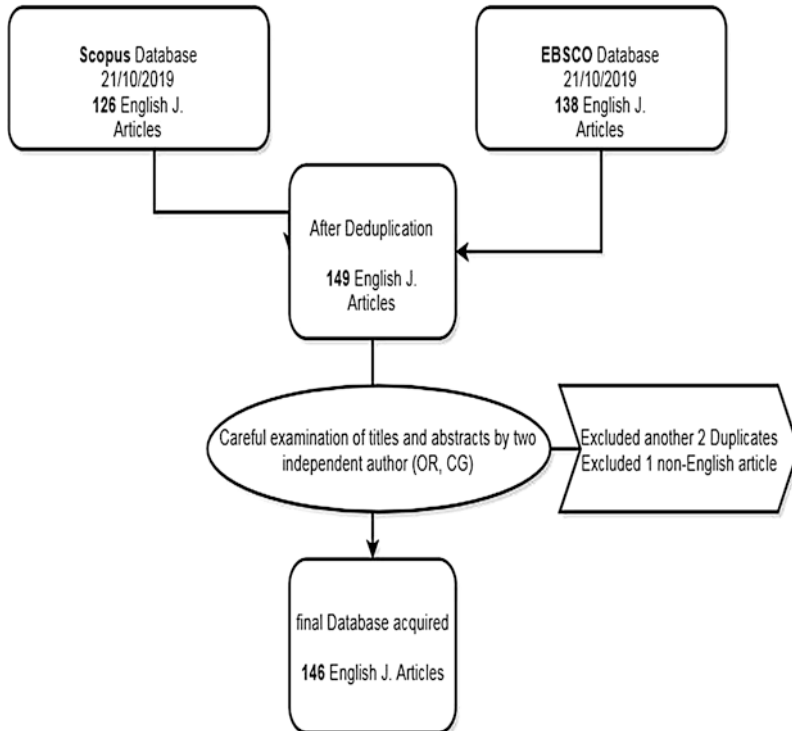


Fig. 1 Articles exclusion diagram

keywords used in the literature search (i.e., sustainability* and healthcare) were excluded from our results.

The qualitative analysis aimed to identify the most important current research directions and perspectives. The most important directions of current research were determined by qualitatively analyzing the abstracts of the articles ranked in the first quartile by Scimago (SJR Q1). The final number of abstracts for qualitative analysis was 72 paper abstracts published in the highest-quality journals (Q1). Our analysis categorized the articles within two dimensions: (1) what was the perspective of the study (governmental or industry) and (2) what was the main topic of the abstract (e.g., IT, bottom of the pyramid, general health, pharma, hospital, others). Articles were identified of governmental perspective if they addressed a topic for governmental/country-level action (e.g., healthcare system, health technology assessment), while articles of an industrial perspective had to be addressing a topic of an industrial interest (e.g., institutional business model, supply chain). All abstracts were read carefully, and judgment was done parallelly by two independent researchers (OR and GC), and any differences about results were resolved by consensus. Identification of most influential topics followed a similar analytical theme as determining the article's perspective. Figure 2 illustrates the analytical methods adopted in this work.

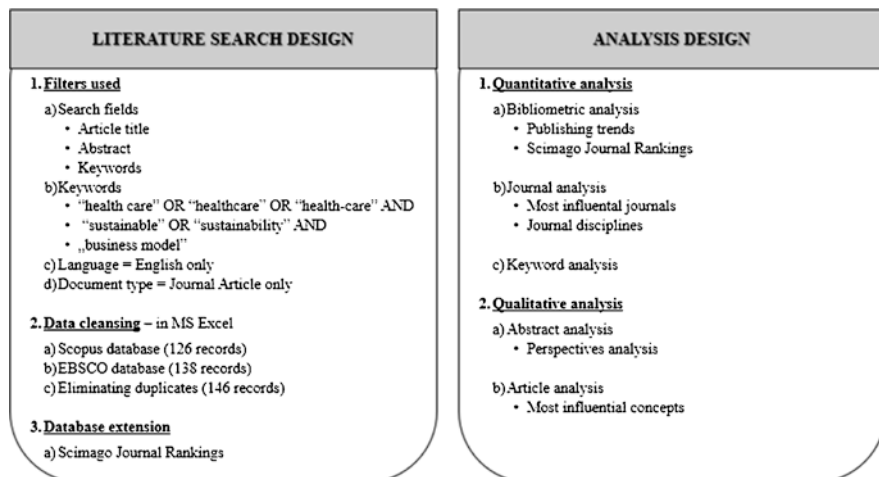


Fig. 2 Analysis methods diagram

3 Results

3.1 Quantitative Analysis

3.1.1 Bibliometrics and Publishing Trends

Figure 3 shows a bar chart of the publishing trends per year based on the article publishing date and corresponding SJR rank. The chart illustrates that the research trend started gaining more attention in the past 10 years. Up until 2009 (from 2002), only 18 articles were published in total, while among the past 10 years (2010–2019), 128 articles were published. Year 2017 had the highest total number of articles with a total of 19 articles of which 13 were published in high-quality journals (i.e., Q1 and Q2). Figure 4 similarly shows a pie chart for the articles grouped as per their SJR rank. Out of the total number of articles ($n = 146$), 49,3% were published in SJR Q1 journals, and 26%, 16,4%, and 8,2% were published in SJR Q2, Q3, and Q4 respectively.

3.1.2 Journal Analysis

The 146 articles were published in 113 journals (average of 1.3 articles per journal) with only 18 journals with 2 publications or more. The *International Journal of Integrated Care* and *Journal of the American Pharmacists Association: JAPhA* came up top with both publishing 6 articles (4% of total sample). It is also worth noting that two journals fell off the SJR ranking list in 2018, i.e., *Journal on*

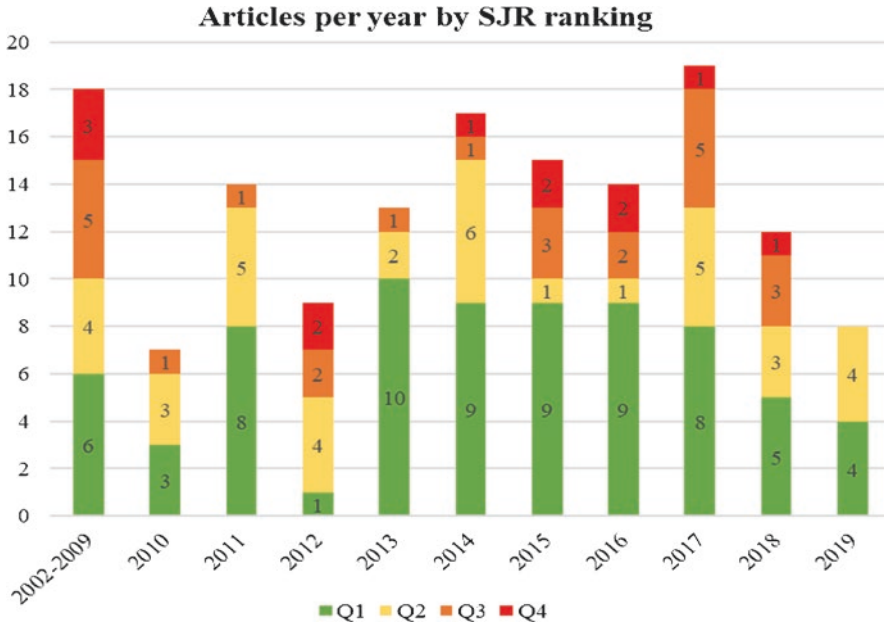
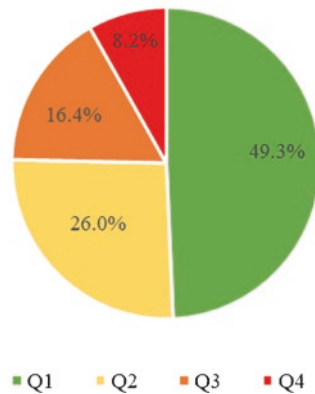


Fig. 3 Articles per year color coded by SJR rank

Fig. 4 Pie chart of articles distribution as per their SJR rank

Articles Distribution by SJR rank (%)



Information Technology in Healthcare and Assistive Technology Research Series. Table 1 shows the top seven journals discussing the field, in which 20% of the articles are published. The results suggest that there is no specific journal highlighted as the owner of sustainable business models in healthcare; however, any journal can be interested in the topic for a single occasion.

Table 1 Top journals publishing in the field comprising 20% of total publications to date

Journal name	SJR Rank	No. of articles
<i>International Journal of Integrated Care</i>	Q1	6
<i>Journal of the American Pharmacists Association: JAPhA</i>	Q1	6
<i>Telemedicine Journal and e-Health</i>	Q2	4
<i>Sustainability</i>	Q2	4
<i>Journal of Medical Marketing</i>	Q2	3
<i>Studies in Health Technology and Informatics</i>	Q3	3
<i>Health Research Policy and Systems</i>	Q1	3

**Fig. 5** Top journal disciplines in the field (50% of all listed journal disciplines)

3.1.3 Disciplines Analysis

In total, the articles were published in 113 journals covering 88 different disciplines. This high amount of disciplines means that journals publishing in the field are heavily multidisciplinary. Figure 5 shows the most frequently applied disciplines which are accountable for almost 50% of the overall mentions of disciplines. However, the most favored disciplines can be grouped into four main categories:

- 1 Healthcare-related disciplines (medicine, pharmacology, pharmacy)
- 2 Government-related disciplines (health policy, public health)
- 3 IT-related disciplines (health informatics, health information management)
- 4 Business-related disciplines (business and management, strategy and management)

Interestingly, sustainability-related disciplines are less frequently applied (e.g., renewable energy, sustainability, and the environment) to the journals subject to our analysis.

3.1.4 Top Articles Analysis

The number of citations was obtained from Scopus database. Table 2 shows the top articles in the field ranked by the number of citations. Altogether, these eight articles are responsible for 50% of total cites in the field. The article “Prospects for

Table 2 Top-cited articles in the field

Title	Authors	Journal title	Year	Cited by
Prospects for productivity	Booth B., Zimmel R.	<i>Nature Reviews Drug Discovery</i>	2004	191
Biobankonomics: Developing a sustainable business model approach for the formation of a human tissue biobank	Vaught J., Rogers J., Carolin T., Compton C.	<i>Journal of the National Cancer Institute. Monographs</i>	2011	111
Operational health information exchanges show substantial growth, but long-term funding remains a concern	Adler-Milstein J., Bates D.W., Jha A.K.	<i>Health Affairs</i>	2013	80
Communities' readiness for health information exchange: The national landscape in 2004	Overhage J.M., Evans L., Marchibroda J.	<i>Journal of the American Medical Association: JAMIA</i>	2005	78
Service science	Spohrer J., Anderson L.C., Pass N.J., Ager T., Gruhl D.	<i>Journal of Grid Computing</i>	2008	43
A systematic review of remuneration systems for clinical pharmacy care services	Chan P., Grindrod K., Bougher D., Pasutto F.M., Wilgosh C., Eberhart G., Tsuyuki R.	<i>Canadian Pharmacists Journal</i>	2008	41
A model for scale up of family health innovations in low-income and middle-income settings: A mixed-methods study	Bradley E.H., Curry L.A., Taylor L.A., Pallas S.W., Talbert-Slagle K., Yuan C., Fox A., Minhas D., Ciccone D.K., Berg D., Pérez-Escamilla R.	<i>BMJ Open</i>	2012	34
Health information exchange policy and evaluation	Marchibroda J.M.	<i>Journal of Biomedical Informatics</i>	2007	32

productivity” published in 2004 had the highest citation number with 191 citations followed by the article “Biobankonomics: Developing a sustainable business model approach for the formation of a human tissue Biobank” published in 2011 with 111 total cites. For instance, Vaught et al. (2011) build on a sustainable business model for a human tissue bank by implementing specific value chain factors to achieve financial sustainability, while Adler-Milstein et al. (2013) address the issue of maintaining a sustainable business model to support health information exchange toward improving the quality and efficiency of healthcare. The third article also addresses a similar IT issue (Overhage et al. 2005). These papers revolve mainly around financial sustainability of a specific health system concluding that financial sustainability of health systems is of importance.

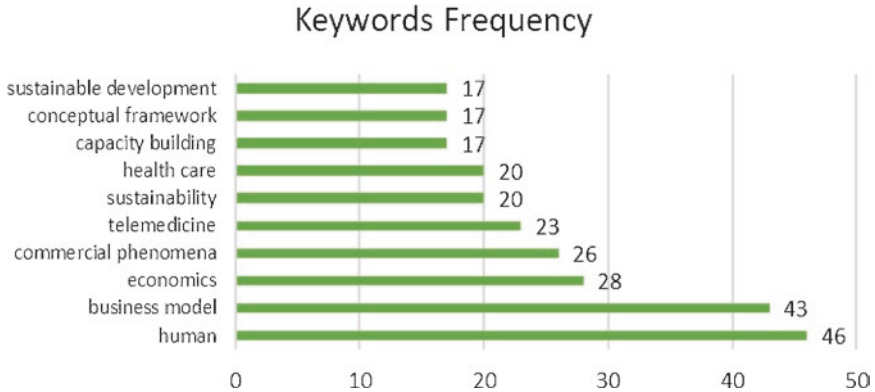


Fig. 6 Top 10 keywords by frequency

3.1.5 Keyword Analysis

Figure 6 shows the assessment of the most frequently used keywords indexed by authors and journals. The total number of keywords accumulated was 1005 of which 594 (59.1%) keywords were used only once. “Human” came out first with 46 repetitions, followed by “business model(s)” and “economics” with 43 and 28 repetitions, respectively. The keywords (commercial phenomena, telemedicine, healthcare, sustainability, capacity building, conceptual framework, and sustainable development) were also in the top 10 with repetitions ranging from 17 to 28. The most frequently used keywords can be grouped into five major categories:

1. Business and economics (business model, economics, commercial phenomena)
2. Healthcare (human, healthcare)
3. Sustainability (sustainability, sustainable development)
4. IT (telemedicine)
5. Academic study (conceptual framework)

From the keyword categories, it is confirmed that the research topic of this study is heavily multidisciplinary. Moreover, the importance of IT and business disciplines is further emphasized by the keyword frequencies. Moreover, and since our work is based on a systematic literature search strategy, it is obvious that academic study related keywords like “conceptual framework” appear in the top keywords list.

3.2 Qualitative Analysis

Topics and Perspectives Our qualitative analysis comprised two layers of categorization: perspective and field of study. The results were assessed in a summary table to identify the main streams of the current research. In the second part of the qualitative analysis, the most researched topics (most influential) were extrapolated

Table 3 Qualitative analysis results of Q1 SJR ranked articles. Numbers indicate article count frequency

Field/topic	Perspective		Total
	governmental	Industrial	
IT	18	6	24
Population health	17	3	20
Pharmacy and pharmacists	2	5	7
Hospital staff and physicians	1	1	2
BoP business models^a	1	1	2
Others/multidisciplinary	13	4	17
Total	52	20	72

^aBase of pyramid business models

by the authors. The qualitative analysis results in Table 3 clearly indicate a governmental perspective as the dominant perspective having 52 studies out of a total of 72 (72%). The most researched field has been identified to be information technology (33%), addressing topics such as telemedicine and the use of robotics in medical interventions. This is followed directly by the “population health” field (27.7%) where a specific sustainable solution for a general population of people is addressed. Table 3 illustrates our qualitative results.

4 Conclusions, Future Work, and Limitations

This work illustrates the available literature to date in the field of sustainable business models in healthcare. The most influential articles, journals, and topics were highlighted. More than two-thirds of the highest-quality articles addressed a governmental perspective rather than an industrial perspective. The field of research appears to be multidisciplinary which shows clearly in both the keyword and disciplines analysis. The limitations of this study come mainly from the literature search strategy and research design as articles written in English only were included in our analysis which excluded the knowledge of local research workshops conducted in other languages than English. Furthermore, databases besides Scopus and EBSCO can be involved in future studies, such as PubMed. Moreover, the perspective analysis can be extended to include non-Q1 journals as well, to create a more accurate research gap analysis.

References

- Adler-Milstein J, Bates DW, Jha AK (2013) Operational health information exchanges show substantial growth, but long-term funding remains a concern. *Health Affairs* 32:1486–1492
- Basiago AD (1995) Methods of defining ‘sustainability’. *Sustain Dev* 3:109–119

- Booth B, Zimmel R (2004) Prospects for productivity. *Nat Rev Drug Discovery* 3:451–456
- Bradley EH, Curry LA, Taylor LA, Pallas SW, Talbert-Slagle K, Yuan C, Fox A, Minhas D, Ciccone DK, Berg D, Pérez-Escamilla R (2012) A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study. *BMJ Open* 2(4)
- Chan P, Grindrod K, Bougher D, Pasutto FM, Wilgosh C, Eberhart G, Tsuyuki R (2008) A systematic review of remuneration systems for clinical pharmacy care services. *Can Pharm J* 141(2):102–113
- Falagas ME, Kouranos VD, Arencibia-Jorge R, Karageorgopoulos DE (2008) Comparison of SCImago journal rank indicator with journal impact factor. *FASEB J* 22:2623–2628
- Fu L, Thomes C (2014) Implementing discipline-specific searches in EBSCO discovery service. *New library world*
- Joyce A, Paquin RL (2016) The triple layered business model canvas: A tool to design more sustainable business models. *J Cleaner Prod* 135:1474–1486
- Marchibroda JM (2007) Health information exchange policy and evaluation. *J Biomed Info* 40(6):11–16
- Overhage JM, Evans L, Marchibroda J (2005) Communities' readiness for health information exchange: The National Landscape in 2004. *J Am Med Info Assoc* 12:107–112
- Spohrer J, Anderson LC, Pass NJ, Ager T, Gruhl D (2008) Service science. *J Grid Comput* 6(3):313–325
- Vaught J, Rogers J, Carolin T, Compton C (2011) Biobankonomics: Developing a sustainable business model approach for the formation of a human tissue biobank. *JNCI Monographs* 2011:24–31
- Woodell S (1972) Blueprint for survival. *Nature* 235:179–179

Inequality in the Distribution of Specialist Doctors: Evidence from Poland



Justyna Rój

1 Introduction

Health systems play a vital role in the significant rise in global life expectancy and in the improving health of most of the world's population (Anyangwe and Mtonga 2007). However, health systems face also many challenges as demographic changes, aging society, and new medical technology, which cause also the changes in health-care services. Thus, almost every country has been reforming their healthcare systems continuously also in the purpose to improve their equality, efficiency, quality, as well as access to health care (Rój 2009). Thus, a common goal of policy makers in most countries is ensuring equity and removing inequalities in access to health resources and in utilization of health services (Mobaraki et al. 2013).

The importance of equity implies from the fact that it refers to fair opportunity for everyone to attain their full health potential regardless of demographic, social, economic, or geographic status. It entails the minimization of differences in access, coverage, quality, use, and utility of health care between groups of the population categorized by above characteristics (Whitehead 2019). As inequalities in access to health services may lead to a low level of health (Bem et al. 2016), adequate access to the highest attainable health standard for everyone has been recognized also as a fundamental human right and a central component in reversing socioeconomic and health system inequities (Backman et al. 2008). Therefore equal access to health services is one of the priorities of health policy (Ucieklak-Jeż et al. 2015).

The health sector is comparatively more labor intensive than other sectors, and therefore the health workforce is treated as “the backbone of each health system, the lubricant that facilitates the smooth implementation of health action for sustainable

J. Rój (✉)

The Poznań University of Economics and Business, Poznań, Poland

e-mail: justyna.roj@ue.poznan.pl

socio-economic development” (Anyangwe and Mtonga 2007). So, health workforce is central to health system performance and thus to population health as the quality and quantity of healthcare services available in a country depend to a large extent on the size, knowledge, skills, geographical distribution and attitudes of them, and the right balance between the different types of health caregivers (Domagała and Klich 2018; Folland et al. 1993). Thus, the fair allocation of health human resources is one of the dimensions of equity. And the inequity in the access to health human resources might potentially not only decrease the access to health services but also lower the quality of provided services and thus health benefits (WHO 2019a).

At the same time, the equivalence between the idea of health and the idea of sustainable development is transitory (Rios-Osorio et al. 2012). The model of sustainable development implies such types of economic and social development, which ensured the protection and enhancement of the natural environment, social equity, and human well-being for the present and future generations (Diesendorf 2000; Ciegis et al. 2009). And the interaction between the three pillars of sustainable development – economy, society, and the environment – is a main determinant for creating healthy and sustainable society (Kickbusch 2010). Thus, the health is the outcome of sustainable development, but simultaneously, it is also a precondition of sustainable development (Pantyley 2017), as health is “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [WHO 1948]. It means that it is a state of being as well as a kind of “resource for living,” which then influences many human activities (McCartney et al. 2019). Good health contributes to development, economic growth, and the overall well-being of society as being healthy determines the ability to learn, study, and work and in general the range of opportunities and life plans. What is important is that health capital is one of the components of human capital and influences its quality. Healthy children have the ability to better learn, which will also determine their ability to work or pursue an education and in general the range of opportunities and life plans (Kabene et al. 2006). Healthy adults are better able to contribute not only socially but also economically (Dussault and Dubois 2003). Thus, good health has an impact on the human capital quality, which then can positively influence the economic growth (Rios-Osorio et al. 2012). Everyone inherits an initial stock of health at the moment of birth, but this capital depreciates with age and unfortunately at an increasing rate especially after some stage in the life cycle. However, it is possible to increase it by investment, among others also by the usage of health care (Pantyley 2017).

Therefore, health goals place a significant position in the United Nations 2030 Agenda for Sustainable Development which was adopted by many countries in 2015 (UN 2019). All 17 sustainable development goals should be achieved by 2030 (Klarin 2018). Health-related goals point out that equity is the cornerstone of the sustainable development goals (UN 2019). Not only UN but also the World Health Organization points out that sustainability development requires an efficient health system that provides the entire population with equitable access to good quality services, health workers, technologies, and medicines (WHO 2019b). Due to that,

sustainable development requires actions which would strengthen the equity in health human resources distribution (WHO 2019a).

Also, foregoing results suggest that the problem of inequities in distribution of human health resources seems to be a worldwide analyzed problem. Mantzavinis et al. (2003) identified the degree of inequality in the geographical distribution of general practitioners in Sweden. Then Theodorakis (2005) found some level of inequity in case of primary care physicians in Greece and Albania. Then, Matsumoto et al. (2010) examined the geographic distribution of the physicians in each specialty in Japan and the USA and found substantially higher inequities in the distribution of Japanese specialists than the USA. The problem of district inequities to access to health human resources has been also identified by Pallikadavath et al. (2013), Oyunchimeg et al. (2017), or Dan (2018). These surveys showed that many different countries from all over the world suffer from the inequities in health human resources distribution. Also, these researches present that country-specific lifestyle and culture should be taken into account when analyzing the distribution of health human resources and formulating the appropriate strategies. Also in Poland, the shortage of medical personnel was found (Kludacz-Alessandri 2014) as well as insufficient number of physicians with regional variability in the access to them (Zienkiewicz et al. 2018).

The research problem analyzed in this article is whether the distribution of specialist doctors in health care ensures sustainability. The aim of this study is to evaluate the equity of the distribution of specialist doctors and utilization of health services, provided by them in Poland from 2012 to 2018. The following hypotheses have been formulated: first, that the distribution of specialist doctors is characterized by inequities. It is assumed that specialist doctors in Poland are unequally distributed between voivodeships – there are some areas where specialist doctors are insufficient, according to their population needs and geographical size, and there are also areas well ensured in specialist doctors. The second formulated hypothesis refers to health service utilization, which both specialist outpatient and inpatient services are unevenly consumed. According to Eaves (1998), equal access is considered to be crucial, but rather as a certain opportunity to use services. Thus, it implies the analysis of healthcare service consumption. The equitable health service consumption is a consequence of even resource allocation.

As level and organization of health care is influenced by the social, economic conditions as well as by the health policies of the particular country, therefore, it varies across different countries, individuals, groups, etc. That's why there is argument in analyzing each country in a separate way. So, this article focuses on Poland, where health care is funded by the universal health insurance. Public funds dominate and they are managed by monopolistic payer's institution (National Health Fund [NHF]). Financial resources are allocated among voivodeships based on the number of insured persons, taking into account the demographic structure (Bem 2013). The major task of the NHF is to finance health services provided to the entitled population. It also manages the process of contracting health services with public and non-public service providers (setting their value, volume, and structure), monitors the fulfillment of contractual terms, and is in charge of contract accounting

(Kuszewski and Gericke 2005). The quality and accessibility of healthcare services are to a certain extent influenced by the negotiated terms (Rójs 2016). Thus, NHF creates incentives for healthcare providers by proper policy implementation.

2 Data and Method

Data related to specialist doctors used in this study was drawn from the Knowledge Database Health and Health Care of Statistic Poland for the period from 2012 to 2018. As Poland is divided into 16 voivodeships, thus, this study used voivodeship-level data on health workforce and each voivodeship was considered as a unit of analysis. This level of analysis corresponds to the NUTS2 level. Then, the study data consisting of the number of ten different types of specialist doctors (which are around 53% of total types of specialist doctors in 2018) were also collected. The range of analyzed specialist doctors was determined by the availability of data corresponding to specialist health service utilization. These numbers were then converted and expressed as number per 10,000 people and per square meter. Thus, this paper considers the distribution of one particular professional group – specialist doctors – who provide services in public outpatient department and specialist hospital ward. It means that the specialist doctors provide two types of specialist health services – outpatient and inpatient one. There is no separate data on the specialist doctors, which are employed in outpatient department and then in specialist hospital ward. Therefore, the number of total of each specialist doctors is compared with the utilization of both outpatient and inpatient specialist services provided by them. Outpatient services are expressed as outpatient visits and inpatient as the number of treated patients in the specialist hospital wards. Then these numbers were expressed as per capita and per square meter. Population and geographic area data were obtained from Polish Statistical Yearbook 2012–2018.

In purpose to exam the distribution of specialist doctors against population size and geographic size in Poland, the Gini coefficient calculated based on the Lorenz Curve was engaged. Because it is recognized as one of the most common measures of distribution and also as one of the superior tools for measuring inequity (Druckman and Jackson 2008). The Gini coefficient was developed by the Italian Statistician Corrado Gini as a summary measure of income inequality in society (Gini 2005). In this study, the Gini coefficient was calculated based on the Lorenz curve as a graphical representation (Lorenz 1905). The Gini coefficient is defined as the ratio where the numerator is the area between the Lorenz curve of the distribution and the uniform distribution line, while the denominator is the area under the uniform distribution line. Thus, the actual extent of inequality is presented by the area between Lorenz curve and the line of perfect equality. It means that more even distribution would be recognized in case of less deviation from the line of perfect equality (Zhang et al. 2017).

The ratio can vary from 0 to 1, where 0 corresponds to perfect human resources distribution (i.e., every unit has this same resources per 1 square km.) and 1 means

perfect human resources inequality (i.e., one has all the human resources, while everyone else has zero resources). Then Gini coefficient with the value less than 0.3 shows preferred equity status, and then between 0.3 and 0.4 means normal condition, while Gini coefficient with the value between 0.4 and 0.6 triggers an alert of inequity and the value exceeding 0.6 represents a highly inequitable state.

Two indicators were used for measuring inequity, reflecting the distribution of health human resources among populations and the second among geographical location. And the following formula was used:

$$G(y) = \frac{\sum_{i=1}^n (2i - n - 1)y_i}{n^2 y_{\text{mean}}}$$

where y_i = value of i -observation; n = number of observations

Microsoft Excel has been used in purpose to make calculation.

3 Results and Discussion

Based on the estimated values of Gini coefficient, the level of geographical and population equity in access to specialist doctors in Polish regions (voivodeships) was first identified. In case of specialist doctors of various fields of medicine, the Gini coefficients against population size ranged between 0.05 and 0.23, which indicates relatively good equality (Table 1). However, there are six types of specialist doctors for which the increase of the Gini coefficients was noticed, which means the decrease of equity in access to them (dermatologist, internist, obstetrics and gynecology, otolaryngology, ophthalmologist, and surgeon).

Table 1 Gini coefficients of population distribution of specialist doctors in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiologist	0.14	0.21	0.15	0.14	0.15	0.18	0.14
Dermatologist	0.12	0.15	0.12	0.12	0.13	0.12	0.16
Internist	0.10	0.10	0.12	0.12	0.12	0.12	0.12
Lung diseases	0.11	0.10	0.08	0.07	0.08	0.08	0.09
Neurologist	0.11	0.11	0.10	0.10	0.10	0.10	0.10
Obstetrics and gynecology	0.08	0.09	0.08	0.08	0.09	0.09	0.10
Oncologist	0.23	0.19	0.21	0.19	0.15	0.16	0.16
Ophthalmologist	0.11	0.13	0.12	0.12	0.12	0.10	0.14
Otolaryngology	0.09	0.10	0.09	0.08	0.09	0.11	0.10
Surgeon	0.05	0.06	0.06	0.06	0.06	0.06	0.07

Source: own calculation

Table 2 Gini coefficients of geographic distribution of specialist doctors in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiologist	0.37	0.37	0.37	0.38	0.37	0.37	0.36
Dermatologist	0.26	0.28	0.27	0.27	0.25	0.26	0.31
Internist	0.35	0.35	0.36	0.36	0.36	0.35	0.36
Lung diseases	0.29	0.30	0.28	0.28	0.29	0.30	0.30
Neurologist	0.32	0.31	0.32	0.32	0.31	0.31	0.31
Obstetrics and gynecology	0.27	0.26	0.26	0.26	0.26	0.26	0.26
Oncologist	0.39	0.36	0.38	0.38	0.35	0.33	0.34
Ophthalmologist	0.32	0.33	0.32	0.33	0.31	0.31	0.34
Otolaryngology	0.29	0.29	0.29	0.30	0.30	0.31	0.30
Surgeon	0.28	0.28	0.28	0.28	0.28	0.28	0.28

Source: own calculation

In case of specialist doctors, the Gini coefficients against geographic distribution ranged between 0.25 and 0.39 (Table 2), which triggers an alert of inequity. Also, there are five types of specialist doctors for which the increase of the Gini coefficients was noticed, which means the decrease of equity in access to them as for dermatologist, internist, lung diseases, ophthalmologist, and otolaryngology. The results show that the geographical distribution of different types of specialist doctors is less equitable than in case of population distribution. For each group of specialist doctors, the average value of the Gini coefficients for population distribution was below 0.19, while for geographical distribution, it was higher than 0.26.

In case of specialist outpatient services, provided by these specialist doctors, the Gini coefficients against population size ranged between 0.06 and 0.55 (Table 3), which indicated uneven consumption (utilization) of these services. For internal diseases services, the Gini coefficient had values higher than 0.5, which triggers an alert of inequity. It means that there is overuse of specialist services in some voivodeships and in other voivodeships there is underuse of specialist services. Also, it was an increase of inequity in consumption of specialist outpatient services. Only in case of cardiac and oncological services, the decrease of the Gini coefficients was noticed in analyzed period of time, which means the increase of equity in these service consumptions.

In case of specialist outpatient services, the Gini coefficients against geographic size ranged between 0.30 and 0.62 (Table 4). For internal diseases services, the Gini coefficient had values higher than 0.6, which triggers an alert of inequity. Only in case of oncological services, the improvement in the equity consumption was observed. The results showed that the geographical distribution of utilization of outpatient services is even less than in case of population distribution.

In case of specialist inpatient services, the Gini coefficients against population distribution ranged between 0.05 and 0.21 (Table 5), which indicates the equitable consumption of specialist inpatient services. Also, there are three types of specialist inpatient services for which the increase of the Gini coefficients was noticed as for dermatological, oncological, and ophthalmic.

Table 3 Outpatient visits per person in Poland in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiac	0.13	0.13	0.13	0.12	0.12	0.12	0.11
Dermatological	0.07	0.06	0.07	0.08	0.08	0.09	0.10
Internal diseases	0.50	0.51	0.54	0.55	0.53	0.52	0.51
Lung diseases	0.10	0.11	0.12	0.11	0.11	0.11	0.10
Neurological	0.12	0.11	0.11	0.11	0.11	0.12	0.12
Obstetric and gynecological	0.08	0.09	0.09	0.09	0.09	0.09	0.10
Oncological	0.14	0.13	0.12	0.12	0.11	0.13	0.12
Ophthalmic	0.10	0.08	0.09	0.10	0.10	0.11	0.12
Otolaryngology	0.08	0.08	0.08	0.08	0.08	0.08	0.09
Surgical	0.07	0.06	0.06	0.06	0.06	0.06	0.07

Source: own calculation

Table 4 Outpatient visits per 1 km in Poland in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiac	0.33	0.34	0.34	0.33	0.34	0.34	0.33
Dermatological	0.30	0.31	0.31	0.31	0.32	0.33	0.33
Internal diseases	0.60	0.60	0.62	0.62	0.61	0.60	0.60
Lung diseases	0.31	0.31	0.32	0.31	0.32	0.32	0.32
Neurological	0.35	0.34	0.35	0.34	0.35	0.35	0.36
Obstetric and gynecological	0.30	0.31	0.31	0.32	0.32	0.32	0.33
Oncological	0.34	0.32	0.31	0.33	0.33	0.34	0.33
Ophthalmic	0.33	0.33	0.34	0.34	0.34	0.35	0.35
Otolaryngology	0.31	0.32	0.32	0.32	0.32	0.33	0.33
Surgical	0.31	0.31	0.31	0.30	0.31	0.31	0.31

Source: own calculation

Table 5 Gini coefficient of specialist inpatient services per person in Poland in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiac	0.17	0.16	0.15	0.16	0.16	0.17	0.16
Dermatological	0.16	0.17	0.14	0.14	0.14	0.16	0.18
Internal diseases	0.07	0.08	0.08	0.08	0.08	0.08	0.07
Lung diseases	0.19	0.18	0.17	0.17	0.14	0.13	0.13
Neurological	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Obstetric and gynecological	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Oncological	0.19	0.14	0.15	0.15	0.16	0.20	0.21
Ophthalmic	0.15	0.16	0.14	0.14	0.14	0.16	0.18
Otolaryngology	0.11	0.10	0.10	0.10	0.09	0.09	0.10
Surgical	0.07	0.06	0.06	0.05	0.05	0.05	0.05

Source: own calculation

Table 6 Gini coefficient of specialist hospital services per square km in Poland in the years from 2012 to 2018

Year	2012	2013	2014	2015	2016	2017	2018
Cardiac	0.33	0.33	0.32	0.32	0.32	0.33	0.32
Dermatological	0.34	0.35	0.34	0.32	0.31	0.30	0.29
Internal diseases	0.28	0.28	0.28	0.27	0.27	0.27	0.26
Lung diseases	0.32	0.32	0.33	0.32	0.31	0.30	0.31
Neurological	0.35	0.35	0.34	0.35	0.35	0.35	0.34
Obstetric and gynecological	0.26	0.26	0.25	0.26	0.26	0.25	0.25
Oncological	0.38	0.34	0.33	0.32	0.32	0.37	0.38
Ophthalmic	0.33	0.36	0.34	0.34	0.35	0.36	0.35
Otolaryngology	0.28	0.28	0.28	0.28	0.28	0.27	0.28
Surgical	0.26	0.26	0.26	0.26	0.26	0.26	0.26

Source: own calculation

In case of specialist inpatient services, the Gini coefficients against geographic size ranged between 0.20 and 0.38 (Table 6). For oncological inpatient services, the Gini coefficient had values close to 0.4, which triggers an alert of inequity. In addition to it, there was an increase of inequity in utilization of oncological, otolaryngology, ophthalmic services in analyzed period. The results show also that the geographical distribution of utilization of different types of specialist inpatient services is less equitable than in case of population distribution. The average value of the Gini coefficients for population distribution was below 0.18, while for geographical distribution, it was higher than 0.21.

This study has several major findings and merits. On the basis of the Gini coefficient, this paper reported some slight inequality of specialist doctors distribution in Poland. The geographical distribution of all analyzed types of specialist doctors exhibited a slight level of inequality. It showed that the Gini coefficients by geographical area were apparently higher than those by population. It implied that there was a larger disparity in the geographic distribution of these specialist doctors than that in the population distribution. Probably, the sparsity of population is responsible for such difference, as such phenomenon has been already found by Ucieklak-Jeż and Bem (2017) in the context of Polish healthcare resources. It implies that most of the Polish specialists could be distributed within the developed provinces, especially in large cities of developing provinces. Of course, this problem would require some further analysis if the detailed data are available.

This research provided similar findings as the research made in Sweden, where the degree of inequality in the geographical distribution of general practitioners was also identified (Mantzavinis et al. 2003). Also, inequities in the access to general practitioners were found in England and Wales (Gravelle et al., 2001). Uneven distribution of primary care physicians and general practitioners was identified in Greece and in Albania, respectively (Theodorakis et al., 2005, Theodorakis et al. 2006). The inequities of geographical distribution of the physician in each specialty were found in Japan and the USA. From the bunch of research in the context of

China healthcare sector, it can be noticed that even the increase of different types of healthcare specialists took place, and different levels of inequity in the distribution of them still exist (Li et al. 2018; Wu and yang 2019; Lu and Zeng 2018).

The analyses of actual consumption of health services provided by these specialist doctors presented are more uneven in case of outpatient services than inpatient one. It could imply that most specialists are concentrated in hospitals. At the same time, the growth of inequity in the distribution of outpatient service consumption was significant indicating a relatively weaker outpatient health sector. Regional disparities exist in the health service utilization. The utilization of outpatient services has a much higher level of inequality compared with the hospital utilization. Thus, empirical evidence showed that both the overuse of services such as hospital and the underuse of services such as outpatient one could coexist in Poland. However, the inequality in utilization of outpatient services as well as in hospital services as indicated by Gini was actually growing, enlarging the regional gaps in service utilization and then maybe also the access to them.

The research showed that there is a problem of uneven population and geographical distribution of consumption of internal diseases outpatient service with the even utilization of these inpatient services. It could confirm that Poland was also handling with the problem of GP services as the result of shortage of doctors in the primary health care. Work in primary care is not attractive for doctors. As the results of it, most of them are doctors who are in the retirement age. If younger doctors decide to start working in the primary health care, then they choose the work in the large and developed cities. There is a problem with small cities and rural area. It could explain the uneven distribution of internists, who are allowed to work as general practitioners.

The decrease of equitable distribution of such specialist as dermatologist and ophthalmologist is accompanied by the increase of uneven utilization of both outpatient and inpatient services. While the decrease of equitable distribution of such specialist as internist, obstetrics, and gynecology and otolaryngology is accompanied by the increase of uneven utilization of outpatient services however by the improvement or no change in the equity of utilization of inpatient services. This may indicate that demand is not met. In case of the rest of analyzed specialist as cardiologist, lung diseases, neurologist, and oncologist, the improvement of equity in their distribution was noticed and accompanied also by more even utilization of both outpatient and inpatient services. However, it does not imply that the demand is met as it would require deeper analysis. But at least the regional differences have been leveled.

Those findings allowed to adopt both hypotheses that specialist doctors in Poland are unequally distributed between voivodeships and that specialist outpatient and inpatient services are unevenly consumed. The uneven health service consumption can be a consequence of resource allocation. It may indicate the limitation in the access to some health services.

This study has several policy implications. Firstly, more health resources especially internist should be allocated to outpatient department in order to narrow the capacity gap between hospitals and outpatient services. This could be done by

financial mechanism of NHF. Secondly, the level of access didn't change significantly during the period of analysis which is troublesome. It implies that no or not enough corrective actions, in this field, were undertaken by the health policy makers. Therefore, these results should be considered by health policy makers. Consequently, it is reasonable to suggest the Health Ministry (health policy maker) that it should pay more attention to the equality based on geographic area when making regional health planning, developing the allocation mechanism of specialist doctors in order to improve the equality status of health resources allocation.

Thus, the government should pay more attention to this problem as by elimination of such differences in the access to these health human resources can also improve the access to health benefits and reduce the length of average waiting time. It is also important to make this distribution sufficient enough in purpose to fulfill universal accessibility of health services and thus to lead to higher sustainability development.

Also, due to this inequity, policy regarding the medical workforce development in Poland is insufficient and inadequate, while according to WHO health workforce, planning should be a major subject of a health policy (NIK 2019). Thus, the results show the need to correct the healthcare policy conducted by the Ministry of Health as well as the contracting system conducted by National Health Fund in Poland. Thus, because of shortage of specialists, the Ministry of Health should retrieve the medical education policy as well as the aspect of medical professions regulations for which it is responsible. Thus, this research confirms that the Health Ministry should place the achievement and sustainment of a sufficient and skilled health workforce on high on the policy agenda.

Moreover, the Ministry of Health should analyze the problem of disparity (spatial), which should be expanded by, for example, the analysis of the availability based on actual consumption of healthcare services provided by the above human resources as well as making connection with health state to see what is its impact on health. In order to do this, the Ministry of Health should also extend the range of data collected.

The main limitation of this study arises from the limited access to data. Also there is no available data for conducting the powiat (counties) analyses. The direction of future research is to identify and investigate factors that could explain both the level and the trends in inequality in these healthcare resources and utilization across the country, focusing on factors to explain the shortage or inequity in the distribution of human resources.

4 Conclusion

It can be concluded that this research proved that the distribution of some specialist doctors in Polish regions is unequal. This unequal redistribution leads to differences in the utilization of specialist healthcare services. Although the distribution of healthcare resources (specialist doctors) was more adequate for the population size

with some little variation among the types of specialist doctors, a striking difference was found in terms of the distribution per area. Inequities in specialist doctors distribution are a serious threat to health care and sustainability. Geographical imbalances need to be taken into consideration when formulating the policy, rather than increasing simply the number of healthcare resources. Then this study can be used as the basis in the health policy formulation in order to correct the unequal geographical distribution of specialist doctors and then uneven utilization of specialist health services. The troublesome is that the level of access didn't importantly change during analyzed years, which shows that during this time, no corrective actions, in this field, were conducted. This study analyzed certain group of specialist doctors, the types of which were restricted by the availability of data. Additional studies can be conducted and they should incorporate other types of healthcare resources if they would be available.

References

- Anyangwe SCE, Mtonga C (2007) Inequities in the Global Health workforce: The greatest impediment to health in sub-Saharan Africa. *Int J Environ Res Public Health* 4(2):93–100
- Backman G, Hunt P, Khosla R, Jaramillo-Strouss C et al (2008) Health systems and the right to health: An assessment of 194 countries. *Lancet* 372(9655):2047–2085
- Bem A (2013) Public financing of health care services. *E-Finanse* 2:1–23
- Bem A, Ucieklak-Jeż P, Siedlecki R (2016) The spatial differentiation of the availability of health Care in Polish Regions. *Procedia Soc Behav Sci* 220:12–20
- Ciegis R, Ramanauskienė RJ, Martinkus B (2009) The concept of sustainable development and its use for sustainability scenarios. *Inżynieria i Ekonomika-Eng Econ* 2:28–37
- Dan L, Zhongliang Z, Yafei S et al (2018) Unequal distribution of health human resources in mainland China: What are the determinants from a comprehensive perspective? *Int J Equity Health* 17:29
- Diesendorf M (2000) Sustainability and sustainable development. In: Dunphy D, Benveniste J, Griffiths A, Sutton P (eds) *Sustainability: The corporate challenge of the 21st century*. Sydney, Allen & Unwin, pp 19–37
- Domagała A, Klich J (2018) Planning of Polish physician workforce – systemic inconsistencies, challenges and possible ways forward. *Health Pol* 122(2):102–108
- Druckman A, Jackson T (2008) Measuring resource inequalities: The concepts and methodology for an area-based gini coefficient. *Ecol Econ* 65(2):242–252
- Dussault G, Dubois CA (2003) Human resources for health policies: A critical component in health policies. *Hum Resour Health* 1:1
- Eaves D (1998) An examination of the concept of equity and the implications for health policy if equity is re-asserted as one of the key government objectives for the National Health Service. *J Nurs Manag* 6(4):215–221
- Folland S, Goodman AC, Stano M (1993) *The economics of health and health care*. Macmillan Publishing Company, New York
- Gini C (2005) On the measurement of concentration and variability of characters. *Metron Int J Statistics* LXIII 1:1–38
- Gravelle H, Sutton M (2001) Inequality in the geographical distribution of general practitioners in England and Wales 1974–1995. *J Health Serv Res Pol* 6:6–13
- Kabene SM, Orchard C, Howard JM, Soriano MA, Leduc R (2006) The importance of human resources management in health care: A global context. *Hum Resour Health* 4:20

- Kickbusch I (2010) The food system – A prism of present and future challenges for health promotion and sustainable development. Triggering debate – White Paper. Bern: Health Promotion, Switzerland
- Klarin T (2018) The concept of sustainable development: From its beginning to the contemporary issues. *Zagreb Int Rev Econ Bus* 21(1):67–94
- Kludacz-Alessandri M (2014), Availability of medical staff in Poland in comparison to other EU countries, *Economy & Business*, Volume 8.
- Knowledge Database Health and Health Care of Statistic Poland. Statistics Poland (2019). http://swaid.stat.gov.pl/ZdrowieOchronaZdrowia_dashboards/Raporty_predefiniowane/RAP_DBDZD_R_5.aspx Accessed 12 Nov 2019
- Kuszewski K, Gericke C (2005) Health systems in transitions Poland. WHO, Copenhagen
- Li D, Zhou Z, Si Y, Xu Y, Shen C, Wang Y, Wang X (2018) Unequal distribution of health human resources in mainland China: What are the determinants from a comprehensive perspective? *Int J Equity Health* 17:29
- Lorenz M (1905) Method of measuring the concentration of wealth. *J Am Stat Assoc* 9:209–219
- Lu L, Zeng J (2018) Inequalities in the geographic distribution of hospital beds and doctors in traditional Chinese medicine from 2004 to 2014. *Int J Equity Health* 17:165
- Mantzavinis G, Theodorakis PN, Lionis C, Trell E (2003) Geographical inequalities in the distribution of general practitioners in Sweden. *Lakartidningen* 100(51–52):4294–4297
- Matsumoto M, Inoue K, Bowman R, Kajii E (2010) Self-employment, specialty choice, and geographical distribution of physicians in Japan: A comparison with the United States. *Health Pol* 96(3):239–244
- McCartney G, Popham F, McMaster R, Cumbers A (2019) Defining health and health inequalities. *Pub Health* 172:22–30
- Mobaraki H, Hassani A, Kashkalani T et al (2013) Equality in distribution of human resources: The case of Iran's Ministry of Health and Medical Education. *Iran J Pub Health* 42(Supple 1):161–165
- NIK (2019) Kształcenie i przygotowanie zawodowe kadr medycznych [Training and professional development of medical staff]. Warsaw: Najwyższa Izba Kontroli [The Polish Supreme Audit Office] 2016. <https://www.nik.gov.pl/plik/id,10242,vp,12565.pdf>. Accessed 10 Nov 2019.
- Oyunchimeg EO, Paramita SA, Yamazaki C, Koyama H (2017) Distribution of health care resources in Mongolia using the Gini coefficient. *Hum Resour Health* 15:56
- Pallikadavath S, Singh A, Ogollah R et al (2013) Human resource inequalities at the base of India's public health care system. *Health Place* 23:26–32
- Pantyley V (2017) Health inequalities among rural and urban population of eastern Poland in the context of sustainable development. *Ann Agric Environ Med* 24(3):477–483
- Polish Statistical Yearbook. Statistics Poland. <https://stat.gov.pl/obszary-tematyczne/ludnosc/powierzchnia-i-ludnosc-w-przekroju-terytorialnym-w-2018-roku,7,15.html>. Accessed 12 Nov 2019.
- Ríos-Osorio LA, Zapata WAS, Ortiz-Lobato M (2012) Concepts associated with health from the perspective of sustainable development. *Saúde e Sociedade* 21(3):735–746
- Rój J (2009) The cost efficiency of hospitals in Poland. In: Boutsoli Z (ed) *Themes on health care: Challenges and future actions*. ATINER, Athens, pp 306–320
- Rój J (2016) Competition measurement of hospitals in Poland: The Herfindahl-Hirschman index approach. *Ekonomika* 95(1):166–181
- Theodorakis P, Mantzavinis G (2005) Inequalities in the distribution of rural primary care physicians in two remote neighboring prefectures of Greece and Albania. *Rural Remote Health* 5:457
- Theodorakis P, Mantzavinis G, Rumbullaku L, Lionis C, Trell E (2006) Measuring health inequalities in Albania: A focus on the distribution of general practitioners. *Hum Resour Health* 4:5
- Ucieklak-Jeż P, Bem A (2017) Dostępność opieki zdrowotnej na obszarach wiejskich w Polsce (Availability of health care in rural areas in Poland). *Problemy Drobnych Gospodarstw Rolnych (Problems of Small Agricultural Holdings)* 4:117–131

- Ucieklak-Jeż P, Bem A, Prędkiewicz P (2015) Effectiveness of allocation of health system non-financial resources. STRATEGICA International Academic Conference – Third Edition-Local versus Global, SNSPA, Faculty of Management, Bucharest, Romania, pp.647–656.
- United Nation (2019). <https://www.un.org/sustainabledevelopment/development-agenda/>. Accessed 5 Oct 2019
- Whitehead M (2019) The concepts and principles of equity and health. http://salud.ciee.flacso.org.ar/flacso/optativas/equity_and_health.pdf. Accessed 8 Sep 2019.
- WHO (1948) Constitution of the World Health Organization
- WHO (2019a) A universal truth: No health without a workforce. Third Global Forum on Human Resources for Health Report. <https://www.who.int/workforcealliance/knowledge/resources/hrhreport2013/en/>. Accessed 11 Sep 2019.
- WHO (2019b). Arguing for Universal Health Coverage. <https://apps.who.int/iris/handle/10665/204355>. Accessed 10 Nov 2019.
- Wu J, Yang Y (2019) Inequality trends in the demographic and geographic distribution of health care professionals in China: Data from 2002 to 2016. *Int J Health Plann Manag* 34:e487–e508
- Zhang T, Xu Y, Ren J, Sun L, Liu C (2017) Inequality in the distribution of health resources and health services in China: Hospitals versus primary care institutions. *Int J Equity Health* 16:42
- Zienkiewicz E, Zienkiewicz T, Dziaduch S (2018) Regional differences in access to health care in Poland from the perspective of health care resources. *Ann Agric Environ Med* 25(1):77–81

Sustainable Investments as Real Options



Elżbieta Rychłowska-Musiał

1 Introduction

In the face of climate change and resources scarcity, the global economic development should be sustainable. In modern economy, sustainability is an emerging megatrend of a great importance for the development of both economies and societies. Sustainable finances must play a special role in this sustainable development. Due to Report of EC: Financing a Sustainable European Economy (2018), sustainable finance is about two imperatives: to improve the contribution of finance to sustainable and inclusive growth and the mitigation of climate change and to strengthen financial stability by incorporating environmental, social, and governance (ESG) factors into investment decision-making. You can ask if and how the ESG concept differs from the well-known CSR (corporate social responsibility) idea, which of the possibility turned into necessity for a successful business and also is connected with the sustainable development. According to CSR concept companies take into account social interests and environmental protection, as well as relations with various groups of stakeholders in the decision-making process. There are, therefore, many factors common to both concepts, but the ESG concept seems to be financial market oriented, while CSR idea refers rather to corporates' stakeholders.

In the paper we are going to consider as sustainable these investments in which factors connected with social interests and environmental protection can be incorporated.

Sustainable investments despite of their role in modern economy bring a lot of problems to entrepreneurs. How to slot sustainable investment in corporate investment portfolio? How to evaluate them? In what a way to finance them? A lot of

E. Rychłowska-Musiał (✉)

Poznań University of Economics and Business, Poznań, Poland

e-mail: elzbieta.musial@ue.poznan.pl

modern sustainable investments require to engage new technologies. However, the technology changes rapidly and a horizon of experience with new technologies is rather short. Thus, one of the most important challenges for firms' managements seems to be ensuring project flexibility. Another difficulty in this type of activities is their evaluation and financing. Investors may not be sure if sustainable investment provides them with the required rate of return. Traditional evaluation methods (as NPV) usually neglect the project flexibility, future opportunities, and other "soft" properties of the project, which are difficult to assess. In the paper, as a suitable tool to capture the whole (tangible and intangible) value of the project and as a support in decision-making process, the real option analysis (ROA) has been suggested.

Although the use of real options for the valuation of sustainable projects is an interesting and important challenge that has been undertaken so far by only a few researchers, it is not the main goal of the paper. Admittedly, we analyze approaches which can be useful to find an appropriate value of the sustainable projects and formulate recommendation. However, the main part of the paper is devoted to characterization of features of sustainable projects in terms of real options. So, the main aim of the paper is to show that a number of features of investment projects considered as sustainable ones encourage us to analyze these projects as real options. The paper provides an overview of the real options concept which can be useful in the appraisal of sustainable investments. It also provides with author's original remarks on a risk impact direction on a real option value.

The remaining parts of the paper cover the following content: Sect. 2 characterizes in terms of sustainable investment the main features of real options such as the term of investment, multiplicity of risk sources, the risk impact direction, the multi-stage nature of the project, possibility of switching or abandoning a project, and soft properties of a project. In Sect. 3 we discuss a few useful real option valuation concepts and recommend two of them. Section 4 summarizes the analysis.

2 Features of Real Options in Terms of Sustainable Investments

The European Commission in March 2018 published three main objectives for sustainable finance:

- "Reorient capital flows towards sustainable investment, in order to achieve sustainable and inclusive growth,
- Manage financial risks stemming from climate change, environmental degradation and social issues,
- Foster transparency and long-termism in financial and economic activity."

However one of the partial tasks is to determine a unified classification system for sustainable activities to provide clarity on which activities can be considered "sustainable."

Real options can be a helpful solution in this task. Real options are not only a tool supporting valuation but also a way of thinking about development prospects. Leslie and Michaels (1997) and Luehrman (1998) have written about that. Thinking in terms of real options allows us to organize concepts and introduces a common, precise language of communication. Luehrman writes about a strategy of firm as a portfolio of real options: “A business strategy is much more like a series of options than it is like a series of static cash flows.” This sentence well characterizes sustainable investments. Therefore, the use of a certain catalog of real options in relation to sustainable investments could help identify the features that a sustainable investment must have.

Therefore, it is worth looking at which features of sustainable projects are a premise for using the concept of real options and what real options can be identified in projects considered sustainable.

2.1 The Term of Investment

Sustainable investments are long-term investments. Their effects are intended to be particularly important for future generations. According to the most quoted definition of the concept from the Report of the World Commission on Environment and Development, *Our Common Future*, 1987: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Unfortunately, nowadays, managers are focusing rather on short-term financial performance because of a capital market pressure (COM (2018) 97). According to a study by World Business Council for Sustainable Development, managers take the 2–5-year horizon, sometimes 5–10-year horizon as typical to analyze the risk and effects of their decisions, while, in sustainable development, the analysis horizon should cover 10, 20, or even 30 years (WBCSD 2018, p.26).

Real options are a very good tool for the analysis and valuation of investment projects in the long term. However, we have to remember the concept of real options involves two types of time horizon. The first is the lifetime of the option, the time to make a decision. Within this horizon, a decision is made whether or not to exercise the investment option. The length of this horizon depends on many factors, including the following: the type of technology to which the investment relates, market competition, patents owned by a company, and concessions. Two opposite factors operate here: on the one hand, these investments are needed immediately (shortening the horizon); on the other hand, there are high uncertainty and many sources of risk (lengthening the horizon). The concept of real options allows us to consider the optimal timing problem.

The second type of horizon is the operational horizon, the lifetime of the project. For sustainable investments (especially for environmental and social ones), this horizon will be relatively long.

If there are tools enabling market participants to make a long-term, reliable assessment of value creation by enterprises implementing sustainable investments, then investors' decisions will be made with greater awareness. The communication of EC (COM [2018] 97) indicates that corporate transparency is a base which helps firms to develop in more sustainable and long-term direction.

2.2 Multiplicity of Risk Sources

In most ESG projects, although it seems that especially in those related to environmental protection and energy policy, risk and uncertainty concern many fields. Mainly two of them are both economic and technological area. If we identify two or more sources of risk in a project, we say about rainbow option (evaluation in the ROA, e.g., Dockendorf and Paxon [2013]).

Moreover, the immanent feature of the option, including the real option, is that the decision to exercise it may be postponed. Then there may also be a risk regarding investment expenditures. This is especially important for sustainable investments with a long operational horizon and high multistage outlays. This type of risk occurs especially in real options (the investment outlay in real options is equivalent to an option exercise price in financial options, which is usually determined). The risk scaling options (RSO) concept by Blenman and Clark (2014) is an example of incorporating the risk associated with capital expenditure into the analysis and valuation of real options. Authors consider situation when an option exercise price (investment expenditures) uncertainty is tied to the value of the asset upon exercising the option. That means that in project development the parties agree that increases in perceived project value should drive the costs of buying into the project. In a RSO concept, there are also different forms of sharing on the cost as well as benefits sides because the main idea of RSOs is based on the premise that parties involved in real options (generally non-traded contracts) want to reduce their risks.

2.3 The Risk Impact Direction

In the world of financial options, the greater volatility (the higher risk) of an underlying asset, the higher the option value. This is one of the reasons why real options still enjoy limited trust among managers. But in the world of real options, the higher risk of the investment project does not necessarily mean the higher the value of an investment option. In the concept of real options, the impact of risk should be taken into account in two ways. First is in a classical way: as a volatility in a stochastic process describing the movement of the underlying asset. In this approach an increase in the project risk increases this value. Second is in a way specific to real options: through the interest rate to discount future project-related cash flows and determine the present value of the project benefits. Project benefits are the

underlying asset in the real option, so the higher the rate, the lower the project benefits and the option value. Thus, in this approach, the increase in the project risk reduces the option value.

To illustrate the risk impact direction, let us look at a hypothetical investment project, which requires expenditures in the amount of I , and the GBM is used to describe movement of project cash flows Y_t (with drift α and volatility σ). The lifetime of the project is infinite and the present value of the project benefits is $V(Y_0) = \frac{Y_0}{\delta}$, $Y_0 > 0$, where $\delta > 0$ means a convenience yield (Dixit and Pindyck 1994, 181). We assume the link between model parameters based on the Dixit and Pindyck framework (Dixit and Pindyck 1994, 148–150, 178–179, see also Rychłowska-Musiał 2019):

$$\alpha + \delta = r + (r_m - r) \cdot \frac{\sigma \cdot \rho_m}{\sigma_m}, \tag{1}$$

where additionally r is a risk-free rate, r_m is the expected return on the market, σ_m is the standard deviation of r_m , and ρ_m is the correlation of the underlying asset with the market portfolio.

The investment project can be exercised immediately or can be deferred for time T . So a value of the project can be calculated as a real option value. The Black Scholes Merton formula will be used to find it.

Figure 1 presents the dependence between the investment option value (ROV) and the volatility of the project cash flows (project risk) for three values of drift. The α value is interpreted as the average growth rate of the project value, so the higher α value means growth projects, and α equal to zero means a project without a growth trend. For the latter ($\alpha = 0\%$), we actually observe only the classical (positive) impact direction of increased risk on the project value. However for the formers

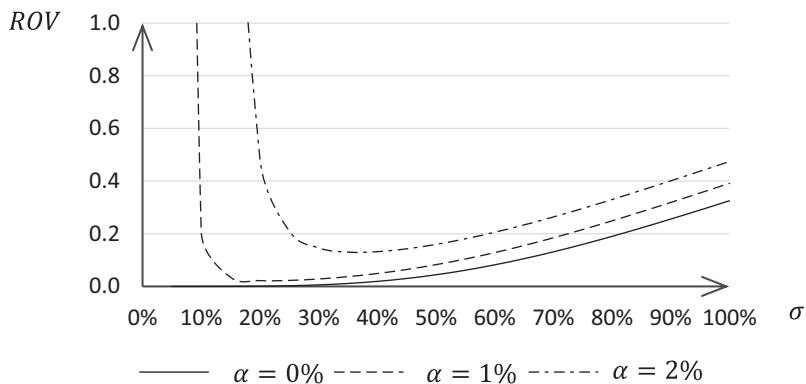


Fig. 1 The investment option value (ROV , based on the Black Scholes Merton formula) as a function of the volatility (σ) for three values of drift (α (0%, 1%, 2%). $Y_0 = 1$, $r = 2\%$, $r_m = 6\%$, $\sigma_m = 14\%$, $\rho_m = 0, 5$, $T = 2$, $I = 50$)

($\alpha > 0\%$), when the project risk is not very high, the impact of its increase on the value of the real option is negative. In this case, the prevailing fact is that the greater project risk, the higher the discount rate and the lower the present value of the project benefits. When project risk is high, its classic impact direction on the real option value prevails.

Thus, we see that the impact of increased risk on the value of the project in real options world is not as clear-cut as in financial options world, which may prompt managers to use this tool more often.

2.4 The Multistage Nature of the Project

Many sustainable development projects are multistage ones, when the implementation of the next stage depends on the result obtained in the first stage. This can be interpreted as series of “options on options”, i.e., the implementation of the first option gives its holder the right to get in the future another option.

Compound real options are the most common in the energy sector, which requires extremely high outlays. Bednyagin and Gnansounou (2011) analyze the whole complex research, development, demonstration, and deployment program on thermonuclear fusion technology as the series of options. This approach opens the possibility to gain additional economic benefits through commercial deployment at the optimal moment or gives the owner of the compound option the right to proceed to further R&D stages in the case of more complex projects. Another example of compound option in the energy sector was given by Yu et al. (2006). As the real compound option, the authors model the flexibility of switching tariff for wind generators. Their results identify the optimal switching strategies and the impact of the switchable tariff on sitting criteria and the values of wind generation assets.

The real options approach allows to consider and describe an investment as a sequence of stages, i.e., continue or abandon the project or reduce or increase the investment. An example for biotech and med-tech projects was given by Büchi et al. (2014). The authors apply the real option analysis and argue this approach more than others can guarantee the businesses' sustainability.

2.5 The Possibility of Switching or Abandoning a Project

The possibility of switching may relate to a change in production inputs or used technology. Nowadays it seems to be of particular importance for the energy sector. Green energy is one of the priorities for EU, and huge funds will be allocated for this purpose (e.g., through the Just Transition Fund); thus, investments in this trend should be intensified. One of such proposals may be projects in which production inputs can be changed for the energy production process. Adkins and Paxson (2011)

give a formal analysis of this possibility and cite many examples of these opportunities such as switching between palm and rape oil in biodiesel production, or gas-oil-hydro-coal in electricity generation, or gas-electricity-coal-wood in residential heating. For sustainable energy investments in terms of switching/changing in technology, an important issue is the ability to switch between incineration and gasification (see, e.g., Ruiz et al. [2013]). This topic is usually considered in relation to biomass, but in Poland recently also to coal (mining or gasification). All these issues can be analyzed as switching options.

A very special type of switching option is an option to abandon a project (Kulatilaka and Trigeorgis 1994). The option to abandon can be considered as the a separate option or as a part of the combination of the other options (examples given by Durica et al. 2018). The possibility of withdrawal from the project or temporarily pausing it is of particular importance especially for multistage projects mentioned in the previous point and can add an extra value to the project, which usually is not captured by the classical methods (like the NPV technique).

However, abandonment of a project may also be considered as non-execution of the project. Real options similarly like financial options give the management the right but not the obligation to execute them. If an investment project is a multistage one, at the end of each stage of the project, the management obtains new information and may decide to continue or abandon (example given by Büchi et al. 2014).

2.6 “Softness” of a Project

Social significance is a hallmark of sustainable projects. There is no need to say how difficult it is to evaluate “social significance.” A lot of sustainable projects with social significance when to analyze them in terms of cash flows, using traditional techniques of valuation, will be rejected because of negative value of their NPV. Sustainable project benefits are often less tangible and difficult to capture. The real options approach enables to include these intangible benefits in project valuation.

We can also consider “social significance” as a separate real option, so Husted (2005) did. He suggested that CSR is a form of a real option and discussed its value in the risk management process. Kuo-Jung Lee (2018) provides a real options viewpoint on the valuation and decisions of investing in CSR.

3 Sustainability in the Real Option Analysis

The term of sustainability has a very broad meaning, even if we refer to the narrow area of research combining this concept with the real options.

Some authors call the real option value as a sustainable value (Durica et al. 2018), or the real option valuation method as a sustainable business evaluation

method (Büchi et al. 2014). An example of pricing of the sustainable option itself can be found in paper by Pedol (2018). She uses the real options approach for evaluating the opportunity to invest in covering the risks correlated with ESG factors in the oil sector. In the case described in the paper, managers can choose a basic, standard project (without incorporating ESG factors) or a project enhanced for preventing or avoiding loss from adverse events. The description of the problem is very simple, based on the one-stage lattice tree, but the idea is promising.

One of the main problems for real option valuation is the assumption about the existence of a replicating portfolio and a listed asset perfectly correlated with the value of an investment project (a twin security). For investments in ESG areas with high technological and economic uncertainty, this is mostly impossible. The valuation concepts that go around the twin security existence problem and the lack of correlation between the underlying real asset and a traded financial asset are:

- The Market Asset Disclaimer concept, where the twin security is the NPV of the project without flexibility (Copeland and Antikarov 2003)
- The Datar-Mathews method: simulation of the distribution of cash flows related to the project based on three scenarios, the most likely, optimistic, pessimistic (Mathews et al. 2007)
- The fuzzy pay-off method based on the fuzzy logic and fuzzy numbers (Collan et al. 2009)
- The utility indifference pricing which is based on fundamental properties of utility function (Henderson 2007; Grasselli 2011)

Each of these methods can be successfully used to value real options identified in sustainable investments. However, it is worth paying special attention to two of them: the utility indifference pricing approach and the Datar-Mathews method.

The utility indifference pricing approach is interesting for its risk hedging properties. In insurance this is one of the approaches used to calculate an insurance premium. The nature and practice of sustainable investment show that one of their key tasks is to mitigate risks associated with ESG areas. In this context the indifference pricing methodology seems very promising. For the (exponential) utility function, Grasselli proposes finding a value of the opportunity to invest in the project under assumption that an investor adds project discounted payoff to his discounted wealth and then continues to invest optimally until the end of horizon. “Optimally” means the need to solve a problem of maximization of expected utility. It is worth mentioning that Grasselli proposes also a binominal approximation to compute the indifference value of the real option. This approach can therefore be used to create development strategies focused on risk mitigation in ESG areas, study properties of these strategies, and determine the optimal strategy.

In valuation practice, however, simulation methods, including Datar-Mathews method, seem to be more useful. The DMM was established and patented by the Boeing team. It is based on data that are naturally collected in the discounted cash flow analysis and on three scenarios (most likely, optimistic, and pessimistic) that are built on them. These scenarios make a frame for a random variable (with triangular or normal distribution) of project future benefits (operating profits) obtained

by MC simulations. Launch costs are modeled by a random variable too. All values are discounted; however, various discount rates are used for operating profits and launch costs. The expected value of the positive difference between these two random variables is a real option value. It is worth to mention that it is one of the few real options pricing methods that provides real-world analysis instead of the risk-neutral world valuation. It can therefore also be a risk management tool for an investment project. This is a very strong distinguishing feature of this method and its huge advantage.

4 Conclusions

Sustainable investment is our economic and moral obligation. Increasingly, the idea of CSR is not only a possible way to achieve a success in business but actually an essential one. Growing awareness of consumers, producers, and governments enforces the necessary direction of changes on both the micro- and macro-level. Finding the right value of an investment project is always difficult. However, the need to incorporate into it, the ESG aspects make the sustainable projects valuation additionally complicated. In the paper we discussed the idea of using real options in the analysis and valuation of sustainable investment projects. We analyzed the main features of real options such as the term of investment, multiplicity of risk sources, the risk impact direction, the multistage nature of the project, possibility of switching or abandoning a project, and soft properties of a project. We showed that the real options approach takes into account the specificity of sustainable projects well. We also proved that contrary to financial options, in the concept of real options, an increase in project risk does not always mean an increase in the value of the investment option. This is an important argument for using this tool to value investment projects. We also considered a few concepts of option pricing that may be useful in the valuation of sustainable investments. Our special recommendation was made to two of them: the utility indifference pricing approach and the Datar-Mathews method. However, even if we do not use the concept of real options to value a sustainable project, just thinking about the project in terms of the real option allows us to achieve deeper understanding of it.

References

- Adkins R, Paxson D (2011) Reciprocal energy-switching options. *J Energy Mark* 4(1):1–25
- Bednyagin D, Gnansounou E (2011) Real options valuation of fusion energy R&D programme. *Energy Policy* 39:116–130
- Blenman LP, Clark SP (2014) Exercise price uncertainty, risk scaling options and payoff allocations, working paper
- Büchi G, Casalegno C, Conicella F, Dayon A, Pellicelli M, Schiesari R (2014) Real options as sustainable business evaluation method in the biotech and med-tech industry. A qualitative

- and empirical approach. In: 2nd international symposium “SYSTEMS THINKING FOR A SUSTAINABLE ECONOMY. Advancements in economic and managerial theory and practice” Rome 23–24, 2014
- Collan M, Fullér R, Mezei J (2009) Fuzzy pay-off method for real option valuation. *J Appl Math Decis Sci* 2009. <https://doi.org/10.1155/2009/238196>
- COM (2018) 97 final communication from the commission: action plan: financing sustainable growth. Brussels 8(3):2018. <https://ec.europa.eu/transparency/regdoc/rep/1/2018/EN/COM-2018-97-F1-EN-MAIN-PART-1.PDF>
- Copeland T, Antikarov V (2003) Real options. A Practitioner’s Guide, Cengage Learning
- Dixit AK, Pindyck RS (1994) Investment under uncertainty. Princeton University Press, Princeton
- Dockendorf J, Paxon D (2013) Continuous rainbow options on commodity outputs: what is the real value of switching facilities? *Eur J Financ* 19(7–8):645–673. <https://doi.org/10.1080/01351847X.2011.601663>
- Durica M, Guttenova D, Pinda L, Svabova L (2018) Sustainable value of investment in real estate: real options approach. *Sustain For* 10(12):4665. <https://doi.org/10.3390/su10124665>
- Grasselli MR (2011) Getting real with real options: a utility-based approach for finite-time. Investment in Incomplete Markets. *J Bus Financ Acc* 38(5) & (6):740–764., June/July 2011, 0306-686X; <https://doi.org/10.1111/j.1468-5957.2010.02232.x>
- Henderson V (2007) Valuing the option to invest in an incomplete market. *Math Finan Econ* 1:103–128. <https://doi.org/10.1007/s11579-007-0005-z>
- Husted BW (2005) Risk management, real options, corporate social responsibility. *J Bus Ethics* 60:175–183. <https://doi.org/10.1007/s10551-005-3777-1>
- Kulatilaka N, Trigeorgis L (1994) The general flexibility to switch: real options revisited. *Int J Financ* 6(2):778–798
- Kuo-Jung Lee (2018) Valuations and decisions of investing in corporate social responsibility: a real options viewpoint. *Sustain For* 10(10):3532. <https://doi.org/10.3390/su10103532>
- Leslie K, Michaels M (1997) The real power of real option. *McKinsey Q* 3:4
- Luehrman TA (1998) Strategy as a portfolio of real options. *Harv Bus Rev* 76(5):89–99
- Mathews S, Datar V, Johnson B (2007) A practical method for valuing real options: the Boeing approach. *J Appl Corp Financ* 19(2):95–104
- Pedol M (2018) Sustainability option: application to BP’s Deepwater Horizon Case. In: 22nd annual international conference real options, 21–23 June 2018, Dusseldorf
- Ruiz JA, Juárez MC, Morales MP, López-Ochoa LM, Doménech J (2013) Biomass gasification or combustion for generating electricity in Spain: review of its current situation according to the opinion of specialists in the field. *J Renew Sustain Energy* 5(1):012801. <https://doi.org/10.1063/1.4792605>
- Rychłowska-Musiał E (2019) Investment decision rules in a competitive market and in the case of co-opetition. The real options games approach. *Argumenta Oeconomica* 2(43):329–350
- WBCSD (2018) Sustainability and enterprise risk management: the first step towards integration. World Business Council for Sustainable Development, Switzerland
- Yu W, Sheble G, Lopes J, Matos M (2006) Valuation of switchable tariff for wind energy. *Electr Power Syst Res* 76:382–388

Quantitative Easing and Green Bonds – Should a Central Bank Be Involved in Fostering Transition Towards Low-Carbon Economy?



Klaudia Zielińska-Lont

1 Introduction

The global financial crisis of 2008 has made financial system stability a top priority of governments around the world. New recommendations of the Basel Committee on Banking Supervision (BCBS) have substantially increased the prudential requirements that credit institutions have to be compliant with in an attempt to make them capable of absorbing losses they might incur. As the situation on the market stabilised though, that priority started playing a secondary role, and the issue of global warming has started becoming the main driver of regional, national and supranational policies. Seemingly unrelated, these two issues have started becoming more interconnected, both in the political sphere and in the business operations of financial institutions themselves.

On one hand, growing public pressure on the subjects of sustainability, environment and air quality has led to a situation where financial institutions have started emphasising these issues as their core corporate values, consequently refusing to credit investment in polluting technologies and solutions. As a result, the drive towards low-carbon economy has started affecting the economics of credit institutions directly, through the inclusion of noneconomic factors in the credit scoring process.

On the other hand, the pressure on the financial system to support the “green transition” can also come from the politicians at different levels, driven by the same demands from the society. In 2019 came a strong call for preferential treatment of “green bonds” – debt instrument that are issued by the private sector in order to

K. Zielińska-Lont (✉)

Department of International Business and Trade, Faculty of Economics and Sociology,

University of Lodz, Lodz, Poland

e-mail: klaudia.zielinska@uni.lodz.pl

amass funds to finance investment in environmentally-friendly endeavours. The new concept envisages allowing the acceptance of green bonds as part of the central bank reserves, under repo operations, as well as under the quantitative easing programmes of the European Central Bank (ECB). Similarly, there were voices to treat green bonds as highly liquid capital components by the prudential authorities, to make them more attractive to the financial institutions. The aim of this article is to assess the impact that preferential treatment of green bonds may have on stability of the financial sector.

2 Prudential Supervision Before and After the Financial Crisis

The international standards for banking supervision are primarily set by the Basel Committee on Banking Supervision, an international forum composed of the heads of central banks and representatives of financial authorities from 28 countries around the world. Basel Committee on Banking Supervision (2014) issues technical standards and recommendations that are then followed and implemented in most developed countries in order to reinforce the stability of the banking system. The main sets of recommendations of the BCBS are known as Basel Capital Accord, and their provisions are implemented into national laws, setting the standards for credit institutions, compliance with which is then monitored according to the committee's recommendations.

So far there have been four editions of the Basel Capital Accord, and at the time of financial crisis of 2008, Basel II was under implementation already since 2004 (Basel Committee on Banking Supervision 2001). Apart from capital requirements, the Accord has also introduced additional reporting requirements on risk exposure and has set the standards for efficient internal risk management models. Basel II was further revised and reinforced in 2006, yet it has still proved to be insufficient to prevent a financial crisis that followed 2 years later. It is worth to point out that the "New Capital Accord" was criticised by the academic environment for its procyclicality (Andersen, 2011), inability to model and monitor risk exposures properly due to insufficient data granularity (Lall 2009) and a generalised approach to credit institutions irrespectively of their business model (Blundell-Wignall, et al. 2014).

The risk of bank failures in different parts of the EU in 2008 has given the signal to intensify works on very strict prudential requirements that could ensure bank's extended capacity to incur losses without the need to bail them out using public funds. Third Basel Capital Accord (Basel III) was published 2 years later and addressed the major points of criticism towards its predecessor. The scale of changes introduced through Basel III was very large and had to be implemented gradually so as not to cause another shock to the banking system. Among others, it has introduced short- and long-term liquidity requirements, further increased the thresholds

for maintaining most liquid capitals and has included tools for the financial authorities (buffers) that allowed adjusting capital requirements at times of financial turmoil and according to the pace of economic growth.

Most recent revision of the third Basel Capital Accord was done in 2017 and is often referred to as Basel IV. The revision has substantially limited credit institution's liberty in terms of applying internal risk models in order to ensure that comparisons of credit institutions solvency can deliver a reliable picture on the relative condition of different entities (Neisen and Röth 2017). Consequently, in 2020 all the major credit institutions were under strict prudential requirements, consisting of minimum levels of own funds calculated against their risk-weighted assets, liquidity requirements set according to their exposures and clear rules on what type of instruments can be treated as safe and highly liquid.

Another project that was implemented in response to the financial crisis in the euro area was the banking union, which was to further integrate the financial systems of the member states. It was to do so through centralising the supervision over credit institutions (pillar I), establishing a common mechanism for restructuring and resolving insolvent banks (pillar II) and creating a joint deposit guarantee scheme (pillar III). All three pillars of the envisaged banking union were to reinforce the society's trust in the euro area banking system and ensure that public funds would no longer be used to bail out failing banks (Zielińska-Lont 2020). In practice, until 2020 only the first two pillars have been established, while only a limited degree of harmonisation was ensured in terms of guaranteeing the deposits. The Single Supervisory Mechanism (SSM) is functioning as part of the European Central Bank and coordinates the supervision over the major credit institutions in the euro area. Single Resolution Mechanism (SRM) is an international body that decides on admitting funds for restructuring credit institutions or manages their resolution if they are insolvent. No common deposit guarantee scheme was established primarily because of the fear that shared funds would finance the failure of banks that were insolvent already before the third pillar of the banking union was established, or due to the insolvency of their sovereign (Deutsche Bundesbank 2015).

To sum up, the decade after the financial crisis of 2008 was a time of building strict supervision over credit institutions around the world and in the euro area. In Europe, the determination to strengthen regulatory oversight over banks was particularly strong immediately after the crisis, where substantial amounts of public funds were allocated to prevent bank failures. As the situation stabilised and new mechanisms under the banking union started functioning, the focus has moved towards the issues around sustainable economy.

3 Sustainable Finance and Green Bonds

The definition of sustainable development comes from a report for the World Commission on Environment and Development (1987) and describes it as development that "(...) meets the needs of the present without the compromising the ability

of future generations to meet their own needs". It is therefore a very broad concept that addresses three different aspects of growth: social, economic and environmental (Schoemaker, Schramade 1999). Bringing this definition onto a contemporary corporate management ground, the principle is fairly straightforward – economic growth and return on equity should no longer be seen as a goal in itself, as companies should move their focus onto long-term value creation, where all the social and environmental costs of their activities are duly taken under consideration (Fatemi and Fooladi 2013).

The importance of the financial system for a modern economy cannot be overestimated, and it is therefore often seen as the main driver for transition towards sustainability (Ryszawska 2016). The relationship between the financial system and development in general is known and widely accepted, since an underdeveloped system (be it bank or capital based) does not allow sufficient access to financing, optimisation of capital allocation or diversification of risk (Schmidt and Hryckiewicz 2006). The role of institutions of the financial systems in providing access to capital places them in a position that allows influencing investment directions.

When considering the role of the financial system in sustainable development, it is important to highlight that not only commercial banks activity is to be considered but also the activities of regulatory authorities, consultants and non-governmental organisations that promote long-term value creation. It is also crucial to note that it is ultimately the investor's preferences that need to change and that this process can be bottom-up, where the demand for sustainable financial services affects the services' portfolio.

Despite the time that has passed since the call for sustainability from the United Nations in 1987, concrete action in the spirit of sustainable finance is fairly recent (Lagoarde-Segot and Paranke 2019). Prime movers in this field have typically refused to finance investment in fossil fuels or have made financial commitments to dedicate substantial funds to supporting environmentally-friendly projects (see Fig. 1).

According to the data presented in Fig. 1, only few of EU-based largest credit institutions have defined and quantified commitments towards sustainable finance (World Resources Institute 2019). According to the World Resources Institute (WRI) typology, these commitments can be either defined as transaction value ("flow" commitments – Société Générale, Lloyds, BBVA, Standard Chartered, BNP Paribas), net value of investment in sustainable finance ("stock" commitments – Crédit Agricole, ING), or a combination of both (HSBC).

On the more recent initiatives to deliver sustainable finance comes the issuance of the so-called green bonds – debt securities issued to finance environmentally-friendly investment. The market for green bonds has over 12 years at the time of preparing this article, since the first "Climate Awareness Bond" of the European investment bank has been issued in 2007 (Reichelt and Keenan 2017). In order to be recognised as green, bonds need to meet a set of criteria that ensure that the proceeds are used in a sustainable manner – e.g. the criteria set forth by the World Bank for its green bonds issuance:

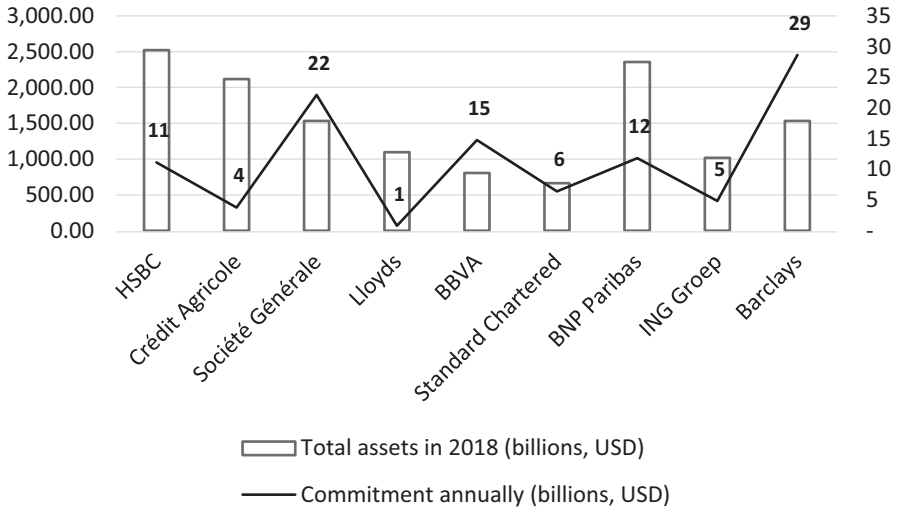


Fig. 1 European Union’s largest bank’s sustainable finance commitments (in USD billions) (Source: own elaboration based on data from World Resources Institute)

- Eligibility criteria that have to be met by an investment applying for financing from the issuance of bonds
- Description of projects that will be financed
- Providing investors with a report on how the funds have been allocated

As of 2013 the number of issuers has been on the rise, as private companies, corporations and governments have started offering green bonds to investors as well. The author argues that this can be seen both as an advantage and a threat. The advantage is that it gives investors a choice, since the issuing bodies have varying views on what types of investment can be considered green and sustainable. The downside is that the quality of eligibility criteria introduced by some issuers can be insufficient to ensure the long-term accountability of the social and environmental impact in the supported investment and can therefore affect the credibility of the entire endeavour.

Increased social pressure on taking concrete actions that would facilitate transition towards low-carbon economy has also resulted in a number of initiatives at a political level and from public institutions. The European Investment Bank (2019) has publicly announced that under its new strategy, it shall cease financing investment in fossil fuels by the end of 2021. Earlier in July 2018, the European Commission has set up a technical Expert Group on Sustainable Finance (TEG) (2019a) with a task of developing:

- Common taxonomy on sustainable finance
- Climate benchmarks
- Guidance notes on climate-related information disclosure
- EU green bond standard

These goals have been previously announced as part of the March 2018 Action Plan on Financing Sustainable Growth (European Commission 2018). From the perspective of this article, the last priority is of utmost importance. The final report from TEG on the EU green bond standard (EU-GBS) has been issued in June 2019 and delivered a set of recommendations including (Expert Group on Sustainable Finance 2019a):

- Making the standard voluntary to use and part of the broader scheme along the lines proposed under the abovementioned action plan
- Designating a body tasked with accrediting compliance with the standard – TEG recommended the European Securities and Markets Authority (ESMA) as best positioned to perform this task
- Encouraging enhanced demand for EU-GBS through (among others) implementing a preference for the EU standard-issued green bonds by the central banks

The report also includes a detailed template for both the information to be disclosed in an EU green bond and the information to be reported back by the issuer. The type of projects that can be financed under the scheme is referenced against the recommendations provided under the TEG report on EU Taxonomy (Expert Group on Sustainable Finance 2019b).

The shift towards sustainability has started picking up, which can be observed when looking at the scale of the market for green bonds by 2018, where the total value of instruments issued in nine countries was nearly 110 billion EUR (see Fig. 2) (Climate Bonds Initiative 2018). The ambitions of the EU signalled under the action plan are, however, far larger, and further increase should be expected along with the implementation of the EU-GBS, especially if the member states choose to follow the TEG recommendations to encourage demand for sustainable instruments.

4 Green Bonds and Asset Purchasing Programmes

Year 2019 was also a time of electing a new European Commission, and the campaign has clearly shown that climate has become a top priority of the EU agenda. Newly elected authorities have only confirmed this tendency through the announcement of the so-called Green Deal (European Commission 2019). The core issue from the perspective of this article, though, was the proposal from the new president of the European Central Bank to give preference to green bonds under the central bank's asset purchasing programmes (Committee on Economic and Monetary Affairs 2019).

It should be noted right at the beginning that this idea was previously discussed under a study performed for the European Commission (2016). In fact, as highlighted by De Santis et al. (2018), Eurosystem's operations aimed at increasing gross demand have already included green debt securities as eligible instruments, although with no preference attached to them. Back in 2016, the consultants

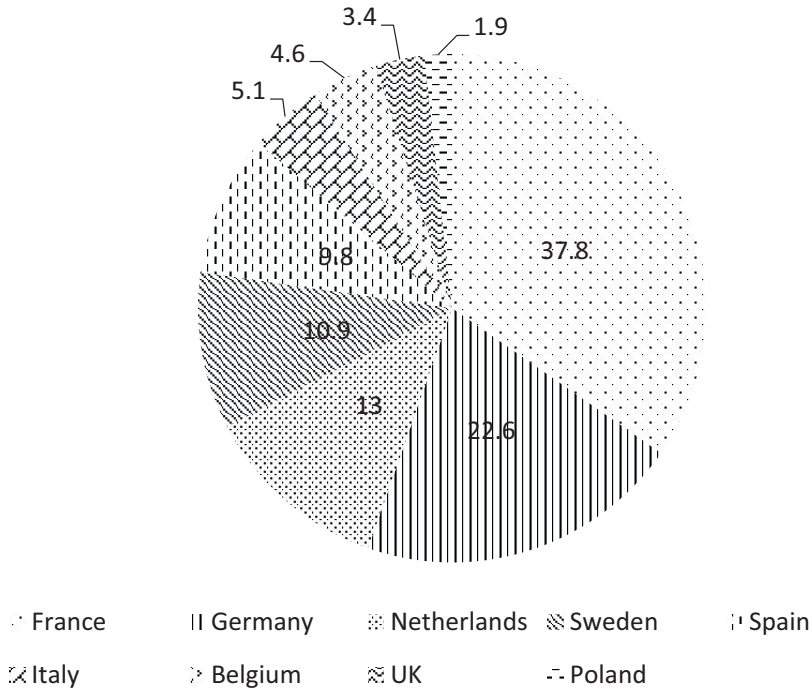


Fig. 2 European Union’s largest bank’s sustainable finance commitments (in EUR billions) (Source: own elaboration based on data from the Climate Bonds Initiative)

consortium in their report to the Commission on sustainable financing of resource-efficient investment has highlighted the option of giving preference to green bonds under quantitative easing (QE) programmes as well, but has seen it as a solution in the medium term. They have argued that risk weighting of green bonds might change over time as non-sustainable investments become increasingly penalised for their impact on the environment and the underlying bonds lose their competitive advantage. Under such scenario, central banks would not compromise their ultimate goal of retaining financial stability and would increase the demand for green bonds.

General critique of the idea of preferring green bonds under the asset purchase programmes (APP) focused on the potential impact on financial stability. The guiding principle of the APP is market neutrality that prevents giving preference to or discriminating any of the eligible securities (Andrade et al. 2016). While the principle has been primarily established to ensure impartiality of the programmes, which is of particular importance for the European Central Bank that buys the debt instruments issued by different companies and sovereigns, it should still apply in all instances. Nevertheless, some arguments can be found in literature that the neutrality principle can also affect the efficiency of the APP, as they prevent moving the focus onto long-term securities exclusively (Andrade et al. 2016).

A report by BCBS's Ingo Fender et al. (2019) quotes green bonds as instruments that may potentially serve as eligible securities under different operations performed by the central banks, including foreign reserves management. The authors of the report note, however, that the market size and liquidity of green bonds make them relatively unattractive for such purposes at the time of preparing the report. Similar issues have been raised by different high-level officials from the world of finance, where they have highlighted that a spike in demand for green bonds would trigger a risk of issuing them without proper supervision over the standard they offer (Buchelet and Becchetti 2019).

The author would like to agree with the statement that a major shift in demand for green bonds can create a risk of losing the quality of the security. This could have its consequence for the stability of the entire financial system – loss of trust in the sustainability features of the green bonds could damage the value of the entire portfolio on offer. Loss of liquidity would, in turn, lower the value of these debt instruments as collateral, creating a major shock to the banking sector.

5 Green Bonds as Bank's Capital Components

When issued, green bonds constitute capital components of the credit institution that may be written off at times of financial distress to cover for the losses incurred. By default, bank's capital components should be as liquid as possible so that they can ensure the institution's loss absorbing capacity. This at least has been the case until now, as no preferential treatment is granted to instruments with sustainability features just yet. Such neutral approach makes sense from the perspective of financial stability, as these characteristics say nothing about the debt instrument's rating or liquidity. Nonetheless, sustainability parameters remain a driver of these bonds' value, which makes their credibility as tools facilitating the transition towards a low-carbon economy an important factor that may influence financial stability.

As the green bonds market started picking up, it has attracted researchers wishing to evaluate the impact of their issuance on carbon intensity. A study by Ehlers, Mojon and Packer (2020) has evaluated how firm-level emissions have changed after an entity has issued green bonds in accordance with the acknowledged standards. The authors have considered emissions in three scopes: firm's own emissions resulting from its operations (scope 1), emissions associated with the energy the entity has consumed (scope 2) and all the other indirect emissions related to its business operations (scope 3). They have concluded that in a broad perspective (scope 1+2+3), green bonds issuance had marginal or no impact on carbon intensity of companies. While this does not imply that these entities did not deliver on the bond-financed investments, their efficiency as a transition-fostering tool may be questioned over time. This can impact the demand for green bonds and undermine their liquidity.

Another interesting area of risk is the very fact that green bonds issued by credit institutions constitute part of their regulatory capital. When issued, green bonds are

being labelled as “green” precisely because the proceeds they bring are to finance sustainable investment. This means that when a bank is forced to use underlying funds to cover for the losses incurred, the sustainability characteristics of the debt instrument are no longer valid. While the traceability of the proceeds in such an event would be at least challenging, this is yet another risk area, through which entire tranches of green bonds may suffer from sudden value losses resulting from credibility loss.

Although not directly related to green bonds at such, a study by Cevik and Jalles (2020) makes two important remarks from the perspective of this article. First points to the fact that climate change already creates a systemic risk to the global economy. That risk needs to be managed also by credit institutions, and that very fact gives good grounds for having sustainability parameters included in credit scoring and risk management done by these institutions. Second stems from the study results that prove the existence of a link between the resilience to climate change and bond yields. Since the sustainability features of green bonds should by default be of value to the investors, the better they are evidenced, the lower interest they should need to offer to attract demand. Both remarks show that the green bonds should already be an attractive option to the world of finance and beyond. It is therefore questionable whether the demand for these instruments should be encouraged further through preferential treatment by either central banks or prudential supervisors, if this could be done at the expense of financial stability.

6 Conclusions

To conclude, once the economic situation steadied after the financial crisis of 2008, subject of sustainability has become more important than the previously prioritised matter of financial stability. Institutions of the financial systems are now often evaluated on the basis of their sustainability commitments, which can equally become an opportunity and a threat to their profitability, as new, noneconomic factors are beginning to influence their business operations. The fact that sustainability criteria have become of significance to financial stability demands special attention to the subject of standardisation of the taxonomy and criteria that would allow unambiguous classification of investment as sustainable regardless of jurisdiction it is done under.

One of the new sustainable finance tools, green bond, has the potential to amass substantial funds to finance the transition towards low-carbon economy, yet it needs standardisation and regulatory oversight, if it is to be treated as a high-quality and safe security. Excess demand for green bonds can result in issuing low-quality instruments that are characterised by high risk and have little to do with financing sustainable investments. Reputation loss of green bonds as tools for financing the transition towards a low-carbon economy can harm the value of entire tranches of these instruments, potentially affecting bank’s capitalisation levels. At the same time, if properly supervised, green bonds should attract significant demand even if

they offer lower yields to the investors. Therefore, the author would argue for non-preferential treatment of green bonds by either the central banks or prudential supervisors. Further enhancement of already high demand, potentially at the expense of financial sustainability, can prove to be very risky and offer little gains.

References

- Andersen H (2011) Procyclical implications of Basel II: Can the cyclical of capital requirements be contained? *J Financial Stability* 3:138–154. <https://doi.org/10.1016/j.jfs.2010.05.001>
- Andrade P, Breckenfelder J, De Fiore F, Karadi P, Tristani O (2016) The ECB's asset purchase programme: an early assessment. Available via ECB. <https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1956.en.pdf>. Accessed 19 Dec 2019
- Basel Committee on Banking Supervision (2001) The New Basel Capital Accord: an explanatory note. Basel
- Basel Committee on Banking Supervision (2014) A brief of the Basel Committee. Basel
- Blundell-Wignall A, Atkinson P, Roulet C (2014) Bank business models and the Basel systems: Complexity and interconnectedness. Available via OECD. <https://www.oecd.org/finance/Bank-Business-Models-Basel-2013.pdf>. Accessed 14 Dec 2019
- Buchelet MJ, Becchetti MS (2019) The green bonds premium puzzle: the role of issuer characteristics and third-party verification. *Sustainability* 11(4). <https://doi.org/10.3390/su11041098>
- Cevik S, Jalles JT (2020) This Changes Everything: Climate Shocks and Sovereign Bonds. Available via IMF. <https://www.imf.org/en/Topics/climate-change/green-finance>. Accessed 8 Nov 2020
- Climate Bonds Initiative (2018) The Green Bond Market in Europe. <https://www.climatebonds.net>. Accessed 15 Dec 2019
- Committee on Economic and Monetary Affairs (2019) Appointment of the President of the European Central Bank. Public Hearing with Christine Lagarde, Candidate for the Post of President of the European Central Bank. Available via EC EUROPA. http://www.europarl.europa.eu/cmsdata/187086/CRE_lagarde_EN-original.pdf. Accessed 14 Dec 2019
- De Santis R, Hettler K, Roos M, Tamburrino F (2018) Purchases of green bonds under the Eurosystem's asset purchase programme. Available via ECB. https://www.ecb.europa.eu/pub/economic-bulletin/focus/2018/html/ecb.ebbox201807_01.en.html. Accessed 19 Dec 2019
- Deutsche Bundesbank (2015) Deposit protection in Germany. <https://www.bundesbank.de/en>. Accessed 15 Dec 2019
- Ehlers T, Mojon B, Packer F (2020) Green bonds and carbon emissions: exploring the case for a rating system at the firm level. *BIS Quarterly Review* September 2020 Available via BIS. https://www.bis.org/publ/qtrpdf/r_qt2009c.htm. Accessed 8 Nov 2020
- European Commission (2016) Study on the potential of green bond finance for resource-efficient investments. Available via EC EUROPA. <https://ec.europa.eu/environment/enveco/pdf/potential-green-bond.pdf>. Accessed 17 Dec 2019
- European Commission (2018) Communication from the Commission. Action Plan: Financing Sustainable Growth. COM(2018) 97 final. Available via EUR-LEX. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0097>. Accessed 15 Dec 2019
- European Commission (2019) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee of the Regions. The European Green Deal. COM(2019) 640 final. Available via EUR-LEX. https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf. Accessed 15 Dec 2019
- European Investment Bank (2019) EU Bank launches ambitious new climate strategy and Energy Lending Policy. <https://www.eib.org>. Accessed 15 Dec 2019

- Expert Group on Sustainable Finance (2019a) Report on EU Green Bond Standard. Available via EC EUROPA. https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf. Accessed 15 Dec 2019
- Expert Group on Sustainable Finance (2019b) Taxonomy Technical Report. Available via EC EUROPA. https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-taxonomy_en.pdf. Accessed 15 Dec 2019
- Fatemi AM, Fooladi IJ (2013) Sustainable finance: A new paradigm. *Global Finance J* 24:101–113. <https://doi.org/10.1016/j.gfj.2013.07.006>
- Fender I, McMorrow M, Sahakyan V, Zulaica O (2019) Green bonds: the reserve management perspective. Available via BIS. https://www.bis.org/publ/qtrpdf/r_qt1909f.pdf. Accessed 15 Dec 2019
- Lagoarde-Segot T, Paraque B (2019) Finance and sustainability: from ideology to utopia. *Int Rev Financial Analysis* 55:80–92. <https://doi.org/10.1016/j.irfa.2017.10.006>
- Lall R (2009) Why Basel II failed and why any Basel III is doomed. Available via ECONSTOR. <https://www.econstor.eu/bitstream/10419/196313/1/GEG-WP-052.pdf>. Accessed 14 Dec 2019
- Neisen M, Röth S (2017) Basel IV. BCBS finalises reforms on Risk Weighted Assets (RWA). Available via PWC. <https://www.pwc.com/gx/en/advisory-services/basel-iv/booklet-toolbox.pdf>. Accessed 14 Dec 2019
- Reichelt H, Keenan C (2017) The Green Bond Market: 10 years and looking ahead. Available via World Bank. <http://pubdocs.worldbank.org/en/554231525378003380/publicationpensionfundservicegreenbonds201712-rev.pdf>. Accessed 14 Dec 2019
- Ryszawska B (2016) Sustainability Transition Needs Sustainable Finance. *Copernican J Finance Accounting* 5(1):185–194. <https://doi.org/10.12775/CJFA.2016.011>
- Schmidt RH, Hryckiewicz A (2006) Financial systems – importance, differences and convergence. Available via ECONSTOR. <https://www.econstor.eu/handle/10419/97758>. Accessed 14 Dec 2019
- Schoenmaker D, Schramade W (1999) *Principles of Sustainable Finance*. Oxford University Press, London
- The World Commission on Environment and Development (1987) Report of the world commission on environment and development: Our common future. Available via United Nations <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>. Accessed 14 Dec 2019
- World Resources Institute (2019) Green targets: A tool to compare private sector banks' sustainable finance commitments. <https://www.wri.org>. Accessed 14 Dec 2019
- Zielińska-Lont K (2020) Unia bankowa i jej znaczenie dla funkcjonowania sektora bankowego Unii Europejskiej. Wydawnictwo Uniwersytetu Łódzkiego, Łódź

Investment in the Polish Real Estate Market – Housing “Beta” Coefficient



Karolina Siemaszkiewicz

1 Introduction

The real estate market is not only an important element of the national economy, but it is also a place for meeting the fundamental needs for the functioning of households. The structure of real estate markets and their performance are mainly driven by local and national factors. This emerges from the accuracy of real estate (mostly from its immobility), historical factors, economic conditions, as well as from the institutional environment. However, in the process of integration of the European economies, one can see a growing trend toward the unification of the housing markets (Żelazowski 2018).

Investors with real estate in their portfolios are often not informed or even do not know of the risk involved in their investments. It is not uncommon for them to estimate the level of risk based on their own experience or opinions, which may lead to incorrect evaluation. The measurement of risk with the use of the beta coefficient is getting additional importance. As there are problems connected with risk assessment, the methodology of such estimations has been ignored. In the measurement using the sensitivity measure – the beta coefficient – the basic problem is the fact that the CAPM model is not used in the real estate market. The theory related to this model indicates the rate of return for the entire market as the benchmark for calculating the level of systematic risk. This is a problem, because although a suitable index may be found for the equity market, or generally for the market of enterprises, which for Poland will be the broadest market index – WIG – such an index may fail to work for real estate. This is mainly because the index does not include any assets

K. Siemaszkiewicz (✉)

Department of Applied Mathematics, Poznań University of Economics and Business,
Poznań, Poland

e-mail: karolina.siemaszkiwicz@ue.poznan.pl

related to direct real estate investments, which may result in an incorrect estimation of the level of risk and, in consequence, making wrong investment decisions (Wolski 2014). Therefore, we compare betas coefficients for the WIG–real estate index and National Bank of Poland index.

The aim of this study is to compare beta coefficients for 17 Polish cities published by the National Bank of Poland. The comparison is made for WIG, WIG–real estate stock exchange indices, and NBP index so that investors can have a more accurate risk premium beta or benchmark for their decisions.

2 Literature Review

The Capital Asset Pricing Model (CAPM), as a relatively elementary structure both from the theoretical point of view and where its application is concerned, creates a temptation to apply it randomly, even where the conditions restricting its use have not been fulfilled. This raises questions concerning correctly applying the beta coefficient in the real estate market. Examples of the practical application of systematic risk measures made into indirect real estate investment markets can be found in the literature.

Earlier studies showed that real estate investments consistently improved portfolio performance due to their low correlation with other asset classes (Flavin and Nakagawa 2008; Grissom et al. 1987; Kuhle 1987; Webb and Rubens 1987; Goetzmann and Ibbotson 1990; Giliberto 1993; Froot 1995; Hudson-Wilson and Elbaum 1995; and Eichholtz 1996). Moreover, with the increase in capital market integration, the diversification benefit of various asset classes is declining over time. Conover et al. (2002) argue that real estate markets are more segmented due to the physically immovable and local nature of the real estate and offer investors improved mean-variance portfolio efficiency. Likewise, housing is the main source of private wealth and consumption around the world (Flavin and Yamashita 2002; Cocco 2005; Yao and Zhang 2005; Piazzesi et al. 2007; Gan 2010; and Chu 2010). Besides, rising house prices may stimulate consumption by increasing households' perceived wealth or by relaxing borrowing constraints (Campbell and Cocco 2007). Hurst et al. (1998) also showed that housing is by far the largest single non-pension asset in a household's portfolio, comprising over 35% of the median household's wealth. Moreover, about two-thirds of US households own their primary residence and home value accounts for 55% of total assets according to the 2001 Survey of Consumer Finance

Baulkaran et al. (2019) proposed the housing beta and test whether the housing beta was a significant determinant for stock returns in a multifactor framework. They hypothesized that the housing market is a systematic risk factor given the impact of the housing market on the overall economy and economic growth of most countries, as well as the effect of homes on the overall wealth of individual investors. The housing market directly affects GDP growth through residential fixed

investment and housing services. Also, the housing market indirectly impacts economic activities via consumption. Their results showed that the housing beta is positive and significant in explaining stock returns after controlling several other factors from the prior literature. This relationship is stronger, as expected, during the financial crisis period.

Breidenbach et al. (2006) transformed the CAPM in such a way so that it may be successfully applied to calculate meaningful betas. Model based on the CAPM allowed investors to derive their required rate of return for individual property types in specific markets, which is an important component in achieving risk-adjusted returns. Both private and public risks (measured as the beta) were compared to other asset classes, as represented by the S&P 500 and the Wilshire 5000. In consequence, they noted the need to create a model that will enable the investors to correctly estimate the cost of capital for investments in the private real estate market. Thus, scientists have undertaken efforts to determine the required rate of return on individual investors' investments in the private real estate market. They agreed that the CAPM may be applied in the real estate market on condition that an appropriate index encompassing real estate is used as a benchmark.

Voicu and Seiler (2013) addressed the problem of the diversification of the level of systematic risk in real estate depending on its geographical location within the USA. This diversification allowed for the creation of an investment portfolio, which was more effective than the analysis of the real estate market index would indicate. One of the observations which seems particularly interesting is the use of the real estate market index for the calculation of the beta coefficient. It should be considered whether a classically calculated beta coefficient may be applied in a market for which rates of return are not included in the benchmark used for the calculation of systematic risk. Voicu and Seiler (2013) decided that the real estate market index would be a more adequate index rather than the S&P500 index, most frequently used in the USA. This is a bold statement, going against the theory describing the Capital Asset Pricing Model. As stated among others by Sharpe (1964), market equilibrium in the CAPM is determined using the rate of return from all assets listed in the given market. In this context, both the S&P500 index and the real estate market index will not constitute benchmarks with enough range of described investments. So, it may be true that a different rate of return should indeed be used for the real estate market than for the equity market. However, this causes a serious problem in Poland. First and foremost, there is no index available which would satisfactorily describe the changes of prices in all markets, not just in the capital market.

The problems addressed in the mentioned articles inspired the author to assess whether the beta coefficient based on the wide market index describes the risk related to investing directly in the residential real estate market sufficiently well under Polish conditions. In the research as the benchmark was taken WIG, WIG–real estate, and the hedonic index of the residential real estate market calculated by the National Bank of Poland index (NBP index).

3 Capital Asset Pricing Model

The static Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965), and later generalized by Black et al. (1972), states that expected returns on individual assets should be linear functions of their systematic risk. The systematic risk of an asset is summarized by its beta, which is defined as the covariance of the asset's return with the return on the market portfolio normalized by the variance of the market portfolio returns. In the absence of a risk-free asset, Black's version of the static CAPM can be written as:

$$E[R_{it}] = \gamma_0 + \gamma_1 \beta_i \quad \text{for all assets } i = 1, \dots, N, \quad (1)$$

where R_{it} is the return on asset i , γ_0 and γ_1 are constants, and β_i is defined as:

$$\beta_i = \frac{\text{cov}(R_i, R^M)}{\text{Var}(R^M)} \quad (2)$$

where

$\text{cov}(R_i, R^M)$ – is covariance between rates of return from the investment portfolio R_i and the entire market R^M .

$\text{Var}(R^M)$ – is variance of the market rate of return.

In Eq. 1, γ_0 represents the unconditional expected zero-beta return, and γ_1 is the unconditional market risk premium.

The CAPM is unrealistic in some respects; the beta parameter is widely used to characterize investments. Beta describes the amount of systematic risk. The higher the value of beta, the greater the systematic risk being taken and the greater the extent to which returns are dependent on the performance of the market (Hull 2015).

In their 2004 review, economists Fama and French (2004) argue that the failure of the CAPM in empirical tests implies that most applications of the model are invalid.

The traditional CAPM model is using historical data, as the inputs, to solve a future return of asset i . However, history may not be enough to use for predicting the future, and modern CAPM approaches have used betas that rely on future risk estimates (French 2016a).

Most practitioners and academics agree that risk is varying (nonconstant). A critique of the traditional CAPM is that the risk measure used remains constant (non-varying beta). Recent research has empirically tested time-varying betas to improve the forecast accuracy of the CAPM (French 2016b).

Moreover, the model assumes that the variance of returns is an adequate measurement of risk. This would be implied by the assumption that returns are normally distributed or indeed are distributed in any two-parameter way, but for general return distributions, other risk measures (like coherent risk measures) will reflect

the active and potential shareholders' preferences more adequately. Indeed, risk in financial investments is not variance, but rather it is the probability of losing; it is asymmetric in nature. Barclays Wealth has published some research on asset allocation with non-normal returns which shows that investors with very low-risk tolerances should hold more cash than CAPM suggests (Barclays 2019).

4 Data and Application of CAPM in the Real Estate Market in Poland

A test based on the test performed in the American capital market by Black et al. (1972) was conducted to test the adequacy of the beta coefficient as a risk measure. However, certain modifications were made in the test methodology, adapting the research to the possibilities and specific nature of the Polish market.

A database of house prices in 17 Polish cities published by the National Bank of Poland was used for the research. The database is published quarterly. The database includes hedonic indices of house prices on the secondary real estate market from the third quarter of 2006 to the first quarter of 2019 in individual cities. The cities included in the database are Białystok, Bydgoszcz, Gdańsk, Gdynia, Katowice, Kielce, Kraków, Lublin, Łódź, Olsztyn, Opole, Poznań, Rzeszów, Szczecin, Warszawa, Wrocław, and Zielona Góra. The rates of return from the WIG and WIG–real estate stock exchange indices were calculated in the same way for those quarters, so the data for indices are also quarterly. Information about the value of indices was obtained from the Warsaw Stock Exchange. In all calculations, we use quarterly percentage logarithmic returns defined as $r_t = 100 \ln \frac{P_t}{P_{t-1}}$, where P_t denotes the price of an asset at time t .

The WIG–real estate is a sub-sector index, and its portfolio includes WIG constituents belonging to the “real estate” sector. Weightings in the index are the same as in the WIG index portfolio. The WIG–real estate index base date is June 15, 2007. The initial value was 6543.82 points. It is an income-based index, and thus when it is calculated, it accounts for both prices of underlying shares and dividend and pre-emptive rights income. A database of risk-free rates, calculated as the average return on 10-year bonds, was created for each of the quarters. The data were taken from the database provided by the Ministry of Finance (GPW) and from web portal stooq.pl. The data of the house process was taken from the database provided by the National Bank of Poland.

Using the hedonic indices for housing in all 17 cities, quarterly percentage changes in these indices were calculated. A similar process was used for the WIG, WIG–real estate, and NBP house price indices. Next, beta coefficients were calculated for each of the indices, including market indices and the NBP hedonic index. The period covers the date from the third quarter of 2006 to the first quarter of 2019. There are only 51 quotations. In Poland, the house prices are published from the third quarter of 2006. There is no such database for the earlier period.

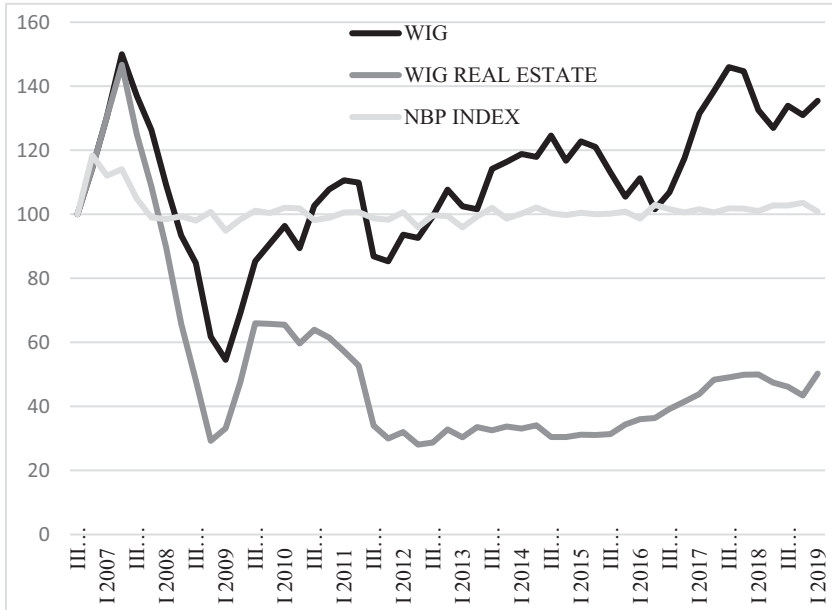


Fig. 1 WIG, WIG–real estate, and NBP normalized quotations indices during Q3.2007–Q1.2019

Figure 1 presents WIG, WIG–real estate, and NBP house prices normalized quotations indices during Q3.2006–Q1.2019. From Fig. 1 we can observe that the shape of WIG and WIG–real estate is rather the same, but at the end of the considered period, we can see a significant difference between values of those indices.

The effect of the research conducted was obtaining 17 beta coefficients in terms of the WIG, NBP index, and WIG–real estate index. We can observe that the benchmark used is important, as betas take on quite different values, sometimes even describing extreme responses to market changes. Table 1 presents the level of systematic risk in all over considered periods of the research.

The risk of investment in the real estate market in Białystok, Poznań, and Warszawa can serve as an example of obtaining different results. For example, for Poznań, the sensitivity to changes of the WIG index becomes positive at 0.09896, and sensitivity to changes of WIG–real estate is 0.06200, but systematic risk calculated for the NBP index is negative at -0.31272. We can observe the same situation for Białystok and Warszawa. The different situation is for Kielce, where the sensitivity to changes of the WIG and NBP index is positive at levels 0.00962 and 0.38855, but systematic risk calculated for the WIG–real estate is negative at -0.00982. For other considered cities, the systematic risk has the same positive or negative sign, choosing the right benchmark to become an important issue. Incorrect estimation of the level of risk involved in their investment may lead to making bad decisions.

Table 1 Beta coefficient in the market of real estate, for all considered period

Beta coefficient	WIG	WIG–real estate	NBP index
Białystok	0.08431	0.07726	-0.50103
Bydgoszcz	0.16049	0.07834	0.67222
Gdańsk	0.16456	0.09667	0.54218
Gdynia	0.30900	0.17814	0.52729
Katowice	-0.00525	-0.01783	-0.21930
Kielce	0.00962	-0.00982	0.38855
Kraków	0.10236	0.06903	0.66536
Lublin	-0.02204	-0.02650	-0.31167
Łódź	0.11409	0.05935	0.64868
Olsztyn	0.10682	0.04357	0.34445
Opole	-0.06760	-0.04289	-0.50247
Poznań	0.09896	0.06200	-0.31272
Rzeszów	0.10034	0.05402	0.44063
Szczecin	0.13271	0.06250	0.05559
Warszawa	0.02680	0.01871	-0.30073
Wrocław	0.15927	0.11221	0.50998
Zielona Góra	0.12965	0.04359	0.28874

Table 2 presents the dynamic changes of the beta coefficient calculated in relation to the WIG–real estate index. In the presented results, the warning should be attracted to the significant volatility of the beta coefficient. Moreover, investors cannot be sure that by investing in real estate in each city, they will keep a similar level of systematic risk for the duration of the investment. For example, the calculation of beta in the first quarter of 2016 is calculated from the third quarter of 2006 till the first quarter of 2016. The calculation of dynamic beta for the first quarter of 2019 is taken from Q3.2009 till Q1.2019.

In general, if the beta coefficient is negative or near zero (the bold number), we can say that for investment in real estate in a considered city, we can recognize the investment as a hedging instrument for the discussed WIG–real estate index. For Lublin we can observe that all beta coefficients are negative, so for the investor in Poland, buying houses in Lublin may bring a diversification effect. The same behavior we can watch for Zielona Góra.

Table 3 shows correlation coefficients for considered cities with WIG, WIG–real estate, and NBP index for period Q3.2006–Q1.2019. We can see that the correlation coefficient is negative for cities like Katowice, Lublin, and Opole for all considered indices. It only proves that for real estate investors in Poland, investing in those cities may bring a diversification effect for their investment portfolio.

Table 4 shows correlation coefficients between considered cities for the period Q3.2006–Q1.2019. We can see that the correlation coefficient is negative between city Poznań and cities like Białystok, Bydgoszcz, Gdańsk, Gdynia, Katowice, Rzeszów, and Warszawa. It means that if prices of houses rise in those cities, in

Table 2 Beta coefficient (benchmark: WIG–real estate) in farther quarters

Beta coefficient	I 2016	II 2016	III 2016	IV 2016	I 2017	II 2017	III 2017	IV 2017	I 2018	II 2018	III 2018	IV 2018	I 2019
Białystok	0.088	0.091	0.025	0.009	-0.002	0.016	0.023	0.056	0.026	-0.033	-0.066	0.035	0.009
Bydgoszcz	0.085	0.059	0.042	0.009	-0.006	-0.008	-0.003	0.004	-0.003	-0.002	0.0001	0.008	0.002
Gdańsk	0.108	0.079	0.073	0.044	0.045	0.042	0.042	0.099	0.109	-0.062	-0.066	-0.092	-0.019
Gdynia	0.200	0.197	0.170	0.125	0.116	0.112	0.115	0.135	0.114	0.054	0.061	0.081	0.069
Katowice	-0.013	-0.016	-0.032	-0.052	-0.029	-0.023	-0.028	-0.012	-0.029	0.004	0.008	-0.018	0.077
Kielce	-0.001	-0.027	-0.025	-0.045	-0.025	-0.027	-0.026	0.020	0.032	0.017	0.021	0.020	0.020
Kraków	0.070	0.031	0.023	0.027	0.032	0.034	0.031	0.034	0.038	0.029	0.029	0.034	0.055
Lublin	-0.024	-0.017	-0.026	-0.047	-0.035	-0.024	-0.027	-0.019	-0.022	-0.015	-0.018	-0.008	-0.052
Łódź	0.056	0.017	-0.005	-0.016	-0.024	-0.022	-0.023	-0.030	0.003	-0.019	-0.019	0.028	-0.002
Olsztyn	0.037	0.011	0.008	0.025	0.028	0.025	0.022	0.023	0.034	0.014	0.021	0.036	0.078
Opole	-0.045	-0.044	-0.048	-0.048	-0.001	0.003	0.003	0.005	0.006	0.012	0.010	0.008	0.004
Poznań	0.064	0.065	0.004	0.002	-0.007	0.005	0.005	0.004	0.001	-0.006	-0.004	-0.012	0.028
Rzeszów	0.055	0.032	0.031	0.005	0.003	0.016	0.008	0.009	0.027	-0.044	-0.038	-0.004	0.036
Szczecin	0.056	0.038	-0.0002	-0.009	-0.007	0.022	0.023	0.021	0.014	0.009	0.013	0.015	0.056
Warszawa	0.018	0.013	-0.017	-0.028	-0.016	-0.004	-0.006	-0.008	-0.010	0.036	0.032	0.038	0.052
Wrocław	0.116	0.091	0.080	0.083	0.087	0.069	0.077	0.114	0.090	0.011	0.013	0.011	-0.016
Zielona Góra	0.045	0.041	0.042	-0.009	-0.007	-0.012	-0.013	-0.012	-0.011	-0.042	-0.027	-0.030	-0.023

Table 3 The correlation coefficient for considered cities in relation to WIG, WIG–real estate, and NBP index for period Q3.2006–Q1.2019

Correlation coefficient	WIG	WIG–real estate	NBP index
Białystok	0.10973	0.14877	-0.22619
Bydgoszcz	0.30402	0.21956	0.44168
Gdańsk	0.24293	0.21113	0.27762
Gdynia	0.40579	0.34610	0.24018
Katowice	-0.00948	-0.04762	-0.13734
Kielce	0.02070	-0.03125	0.28992
Kraków	0.23431	0.23377	0.52829
Lublin	-0.06162	-0.10964	-0.30230
Łódź	0.21606	0.16628	0.42611
Olstyn	0.25651	0.15479	0.28690
Opole	-0.12532	-0.11762	-0.32309
Poznań	0.16558	0.15347	-0.18149
Rzeszów	0.21303	0.16968	0.32447
Szczecin	0.27533	0.19183	0.04000
Warszawa	0.06391	0.06602	-0.24878
Wrocław	0.32997	0.34392	0.36648
Zielona Góra	0.24273	0.12074	0.18750

Poznań we can observe a decline in prices of real estate and in another way. In most cases, the correlation coefficient is positive, which means that changes in prices are made in the same direction.

5 Conclusions

Research shows that the behavior of the beta coefficient – the measure of sensitivity – may bring important concerns as to the correctness of the methodology applied, especially in the context of limitations imposed by the CAPM. Accordingly, an idea was founding the benchmark which will be much better adjusted to the real estate market than the broad market index usually applied in such cases (S&P500 in the USA or WIG in Poland).

For developed economies, there can be found examples of indices that might be used in the real estate market analysis, and the lack of such indices is on the Polish real estate market. We cannot find in Poland such an index, which would describe the real estate market, as a whole, but the NBP established a database of housing real estate prices, together with the hedonic index of house prices throughout Poland. It was assumed that this index could be a benchmark for the measurement of the level of systematic risk in the housing investment market in Poland. This research shows that not all cities are adequate to use the NBP index as a benchmark.

Table 4 The correlation coefficient between considered cities for period Q3.2006-Q1.2019

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	0.1097	1.0000													
3	0.3040	0.4398	1.0000												
4	0.2429	0.2163	0.5632	1.0000											
5	0.4058	0.5026	0.6137	0.4313	1.0000										
6	-0.0095	0.1700	0.1854	0.1504	0.1812	1.0000									
7	0.0207	-0.0684	0.3098	0.6358	0.2304	0.4048	1.0000								
8	0.2343	0.0452	0.3612	0.4162	0.2009	0.1134	0.5038	1.0000							
9	-0.0616	0.3355	0.1209	0.0405	0.2507	0.4107	0.2770	-0.1073	1.0000						
10	0.2161	0.3298	0.6530	0.4248	0.3782	-0.0068	0.3655	0.6664	0.0797	1.0000					
11	0.2565	0.0608	0.2041	0.2288	0.0747	0.0765	0.1814	0.5503	-0.2350	0.4811	1.0000				
12	-0.1253	-0.1861	-0.3541	-0.0442	-0.1687	0.4077	0.4400	0.1060	0.3808	-0.1342	0.0973	1.0000			
13	0.1656	0.7912	0.3488	0.0304	0.3899	0.2153	-0.2087	0.1233	0.2701	0.3884	0.1976	-0.1417	1.0000		
14	0.2130	0.1426	0.5074	0.4958	0.3813	0.1976	0.4372	0.4065	0.1590	0.4880	0.2983	0.0241	0.0588	1.0000	
15	0.2753	0.6623	0.5003	0.2563	0.3687	0.3356	0.1213	0.4307	0.3098	0.5018	0.3267	-0.0116	0.7668	0.3374	1.0000
16	0.0639	0.5425	0.2648	0.0519	0.2693	0.4820	0.1289	0.1474	0.5768	0.3052	0.1508	0.2348	0.6797	0.1182	0.6310
17	0.3300	0.1467	0.3495	0.5209	0.2786	0.0759	0.4371	0.5427	-0.1253	0.4594	0.5240	0.0618	0.0997	0.2450	0.1988
															-0.0041

Note: The number is for considered cities 1, Białystok; 2, Bydgoszcz; 3, Gdańsk; 4, Gdynia; 5, Katowice; 6, Kielce; 7, Kraków; 8, Lublin; 9, Łódź; 10, Olsztyn; 11, Opole; 12, Poznań; 13, Rzeszów; 14, Szczecin; 15, Warszawa; 16, Wrocław; 17, Zielona Góra

We can observe that choosing different benchmark in some cases may bring different values of systematic risk (positive or negative). Also, the correlation coefficient affirmed that Lublin might be considered as a diversification for the real estate investment portfolio.

This research should be important to portfolio managers and investors, as this model allows for an alternative method of determining the required rate of return for a new investment compared to the use of traditional investor surveys. Investors should set their return requirements before selecting a property for purchase as many may have been caught up in hot market pricing and thus risk overpaying for their investments.

References

- Barclays (2019). <https://www.barclays.co.uk/wealth-management/news-and-insights/>. Accessed 10 Dec 2019
- Baulkaran V, Jain P, Sunderman M (2019) Housing “beta”: Common risk factor in returns of stocks. *J Real Estate Finan Econ*, Springer 58(3):438–456
- Black F, Jensen MC, Scholes M (1972) The Capital Asset Pricing Model: Some Empirical Tests. In: *Studies in the Theory of Capital Markets*. Praeger, New York, pp 79–124
- Breidenbach M, Mueller GR, Schulte K (2006) Determining Real Estate Betas for Markets and Property Types to Set Better Investment Hurdle Rates. *J Real Estate Portfolio Manag* 12(1):73–80
- Campbell JY, Cocco JF (2007) How do house price affect consumption? Evidence from micro data. *J Monet Econ* 54(3):591–621. <https://doi.org/10.1016/j.jmoneco.2005.10.016>
- Chu Y (2010) An intertemporal capital asset pricing model with owner-occupied housing. *J Financ Econ* 38(3):427–465
- Cocco J (2005) Portfolio choice in the presence housing. *Rev Financ Stud* 18(2):535–567. <https://doi.org/10.1093/rfs/hhi006>
- Conover M, Friday HS, Sirman S (2002) Diversification benefits from foreign real estate investments. *J Real Estate Portfolio Manag* 8(1):17–25
- Eichholtz PM (1996) Does international diversification work better for real estate than for stocks and bonds? *Financ Anal J* 52(1):56–62. <https://doi.org/10.2469/faj.v52.n1.1967>
- Fama EF, French KR (2004) The Capital Asset Pricing Model: Theory and Evidence. *J Eco Persp* 18(3):25–46
- Flavin M, Nakagawa (2008) A model of housing in the presence of adjustment costs: A structural interpretation of habit persistence. *Am Econ Rev* 98(1):474–495. <https://doi.org/10.1257/aer.98.1.474>
- Flavin M, Yamashita T (2002) Owner-occupied housing and the composition of the household portfolio. *Am Econ Rev* 92(1):345–362. <https://doi.org/10.1257/000282802760015775>
- French J (2016a) Back to the Future Betas: Empirical Asset Pricing of US and Southeast Asian Markets. *Int J Financial Stud* 4(3):15
- French J (2016b) Estimating Time-Varying Beta Coefficients: An Empirical Study of US & ASEAN Portfolios. *Res Finance* 32:19–34
- Froot KA (1995) Hedging portfolios with real assets. *J Portfolio Manag* 21(4):60–77. <https://doi.org/10.3905/jpm.1995.409527>
- Gan J (2010) Housing wealth and consumption growth: Evidence from a large panel of household. *Rev Financ Stud* 23(6):2229–2267. <https://doi.org/10.1093/rfs/hhp127>
- Giliberto SM (1993) Measuring real estate returns: The hedged REIT index. *J Portfolio Manag* 19(3):94–99. <https://doi.org/10.3905/jpm.1993.409443>

- Goetzmann WN, Ibbotson RG (1990) The performance of real estate as an asset class. *J Appl Corporate Finance* 3(1):65–76. <https://doi.org/10.1111/j.1745-6622.1990.tb00196.x>
- GPW, www.gpw.pl/indeksy. Accessed 10 Dec 2019
- Grissom TV, Kuhle JL, Walther CH (1987) Diversification works in real estate, too. *J Portfolio Manag* 13(2):66–71. <https://doi.org/10.3905/jpm.1987.409095>
- Hudson-Wilson S, Elbaum BL (1995) Diversification benefits for investors in real estate. *J Portfolio Manag* 21(3):92–99. <https://doi.org/10.3905/jpm.1995.409517>
- Hull J (2015) *Risk management and financial institutions — Fourth Edition*. Wiley, Hoboken
- Hurst E, Luoh MC, Stafford F (1998) Wealth dynamics of American families, 1984–1994. *Brook Pap Econ Act* 98:267–338
- Kuhle JL (1987) Portfolio diversification and return benefits—common stock vs. real estate investment trusts (REITs). *J Real Estate Res* 2(2):1–9
- Litner J (1965) Security Prices, Risk and Maximal Gains from Diversification, *Journal of Finance*, December:587–615
- Piazzesi M, Schneider M, Tuzel S (2007) Housing, consumption and asset pricing. *J Financ Econ* 83(3):531–569. <https://doi.org/10.1016/j.jfineco.2006.01.006>
- Sharpe W (1964) Capital Asset Prices: A Theory of Market Equilibrium Under Condition of Risk, *Journal of Finance*, September:425–442.
- Voicu C, Seiler MJ (2013) Understanding Systematic Risk in Real Estate Markets. *J Housing Res* 22(2):165–201
- Webb JR, Rubens JH (1987) How much in real estate? A surprising answer. *J Portfolio Manag* 13(3):10–14. <https://doi.org/10.3905/jpm.1987.10>
- Wolski R (2014) Application of beta coefficient in the market of direct residential real estate investments. *Real Estate Manag Valuation* 22(2):13–21
www.stooq.pl. Accessed 10 Dec 2019
- Yao R, Zhang H (2005) Optimal consumption and portfolio choices with risky housing and borrowing constraints. *Rev Financ Stud* 18(1):595–633
- Żelazowski K (2018) Convergence of Housing Markets: European Perspective. *Folia Oeconomica Stetinensia* 18(2):190–202

Factors Affecting Bankruptcy Depending on the Size of the Company



Martina Sponerová, Miroslav Svoboda, and Miroslav Sponer

1 Introduction

The prediction of bankruptcy and the quantification of credit risk are the subject of interest of many studies, scientific articles and publications. The ability to predict the bankruptcy is the factor which eliminates credit risk of a bank. Academics and practitioners have focused their research on improving the performance of existing bankruptcy models, and they are still developing new models and methods to precisely predict business failure. The abundance of bankruptcy prediction models gives rise to the idea that these models are not in compliance with the changing business conditions in the market and do not meet the increasing complexity of business tasks.

Business failure is closely connected with credit risk, which is one of the most significant risks of financial institutions. Hence, there is pressure on financial institutions to improve their credit risk management systems still to predict bankruptcy as accurately as possible.

The aim of this article is to find out if there exist different factors that could predict bankruptcy depending on the size of the company and compare the differences. Considering the research objective, the following hypotheses were set:

H1: The usually used financial indicators in financial analysis are the most important for bankruptcy prediction. H2: The application of a model created on the grounds of company size improves the reliability of bankruptcy prediction.

M. Sponerová (✉) · M. Svoboda
Masaryk University, Brno, Czechia
e-mail: martina.sponerova@econ.muni.cz

M. Sponer
Czech Technical University in Prague, Prague, Czechia

This paper focuses on SMEs because they are reasonably considered as the most crucial segment of the economy in many countries. For OECD members, the percentage of SMEs out of the total number of firms is higher than 97%. SMEs employ approximately two-thirds of employees and create more than half of the added value in EU – 28 (Eurostat 2019). Thanks to their simple structure, they can respond quickly to changing economic conditions and meet local customers' needs, sometimes growing into large and powerful corporations or failing within a short time of the firm's inception.

We have decided to reach as accurate as possible results to split our database into three groups respecting the size of companies to micro-enterprises, small enterprises and medium-sized enterprises. The micro-enterprises are very new, beginning companies, without stable contracts with partners, but with significant potential to grow. On the other hand, they face many different risks. The small enterprises are relatively stable, established companies, with a potential to grow, still facing bankruptcy risk. The medium-sized companies are stable, established, with low potential to grow and low probability of bankruptcy.

After performing the analysis of scientific literature, we identified that various scientists who have studied bankruptcy prediction models under different perspectives still could not indicate the most reliable model as it can be observed by brief preview of the history.

Many authors during the last 50 years have examined several possibilities to predict default or business failure. The seminal works in this field were Beaver (1967) and Altman (1968). The researcher William Beaver was the first to apply several ratios, which could discriminate between failed and non-failed companies up to 5 years before the bankruptcy. Altman improved Beaver's method and assessed a complete financial profile of firms. Altman examines 22 potentially helpful financial ratios and selects 5 that provide, when combined, the best overall prediction of corporate bankruptcy. The variables are classified into five standard ratio categories – liquidity, profitability, financial leverage, activity and solvency. Being the first person to successfully develop multiple discriminate analysis (MDA) prediction model with a degree of 95.0% rate of accuracy, he is considered the pioneer of insolvency predictors. Altman's model has been applied successfully in many studies worldwide concerning the subjects of capital structure and strategic management, investment decisions, asset and credit risk estimation and financial failure of publicly traded companies (Lifschutz and Jacobi 2010).

For many years after that, MDA was the prevalent method applied to the default prediction models. Many authors used it, for example, very often cited in the research literature is the Taffler model developed in Great Britain in 1977 (Taffler and Tishaw 1977). However, in most of these studies, authors pointed out that two basic assumptions of MDA are often violated – the independent variables included in the model are multivariate normally distributed; the group of variance-covariance matrices is equal across the failing and non-failing group (Barnes 1982).

Inka and Ivan Neumaier have developed another MDA model in 1995 known as IN95. This model was constructed especially for the Czech market and was updated

in the next years. We use the last version, IN05 model, which was developed in 2005 (Neumaierová and Neumaier 2005).

Considering these MDAs' problems, Ohlson (1980), for the first time, applied the conditional logit model to the default prediction's study. The practical benefits of logit methodology are that they do not require the restrictive assumptions of MDA and allow working with disproportional samples. After Ohlson, most of the academic literature used logit models to predict default. Next, very often cited model, which uses conditional probability, is a model by Mark E. Zmijewski (1984). He was the pioneer in applying probit analysis to predict default, but, until now, logit analysis has given better results in this field. A probit approach is the same as in the logit approach; the only difference is the distribution of random variables.

As Waqas and Md-Rus (2018) research shows, almost all bankruptcy research is based on financial indicators, as are the majority of traditional models. Meanwhile, non-financial variables are rarely used and constitute a minority of all research on bankruptcy prediction according to Lawrence et al. (2015).

Grunert et al. (2005) also highlight the significance of qualitative information such as business type, industrial sector, location, age and more in the understanding of firms' credit risk behaviour. Altman et al. (2010) took account this issue and studied about 5.8 million SMEs, of which 66,000 failed during the observed period 2000–2007. They reported that the prediction performance of Altman and Sabato (2007) model improved by about 13% when qualitative information is added. They found that data relating to legal action by creditors to recover unpaid debts, company filing histories, comprehensive audit report/opinion data and firm-specific characteristics make a significant contribution to the increase of the default prediction power of risk models built specifically for SMEs (Altman et al. 2010).

From the recent literature, we can mention Tomczak and Radosinski (2017). They highlight that the increase in the number of indicators used in the model probably has no positive impact on its total results. The most effective models are based on three or five indicators (Tomczak and Radosinski 2017; Karas and Reznakova 2017). On the other hand, the worst models cover six to eight indicators. It is worth mentioning that the most effective models are those that are specially developed and adapted for a specific economic sector (Fedorova et al. 2016; Barbuta-Misu and Codreanu 2014). This statement could be similar to our hypothesis that the application of a model created on the grounds of company size improves the reliability of bankruptcy prediction. The greater the similarity of the selected companies, the more accurate is the prediction of bankruptcy.

We witness a substantial increase in the number and complexity of default prediction studies due to the rapid advancement in technology and methodology. Above all, we can mention artificial neuron networks used by Angelini et al. (2007), decision trees method used by Gulnur and Fikret (2011) and hazard models used by Shumway (2001). Some scientists (Salehi and Davoudi Pour 2016; Zieba et al. 2016; Belas et al. 2017; Karas and Reznakova 2017) claim that company insolvency information retrieved by artificial neural networks is superior to the information

obtained when applying traditional statistical models. According to Alaka et al. (2018), although traditional statistical models based on discriminant analysis are not completely precise when compared to non-linear complex artificial intelligence methods, due to their simple calculation and accuracy, they are much simpler and more efficient than artificial intelligence models. However, Glezakos et al. (2010) present a different evaluation and claim that logistic regression models are amongst the most efficient ones. The analysed scientific research proves contrary to opinions regarding neural network models' applicability when identifying companies' bankruptcies.

Meanwhile, other authors (Abdipoor et al. 2013; Bredart 2014) saw a contrary phenomenon and suggest that the application of neural networks model alone reduces the accuracy of predictions. Besides, alternative models are difficult to apply due to their complexity and difficulty, and these models require broad databases and time resources. Often these models have to be integrated and adapted to a specific company.

Assessing the performed analysis of the alternative bankruptcy prediction models, we can state that their application in scientific research is becoming increasingly popular. However, due to the models being challenging to adapt to companies, it is unlikely that they will be applied in practice. In order to make a more precise prediction of a company's bankruptcy likelihood, it is reasonable to apply several models or to adapt one model according to the company's internal and external environments, area of activity, size and the like.

2 Methodology and Data

Our dataset consists of a sample of 2799 SMEs that survived in the period 2010–2017, out of which 638 companies failed in this period. This data was exclusively gained from a bank database by a random selection of SMEs that survived and all of SMEs that failed during the above-mentioned period. The dataset was sorted out first, so the final number of the sample is then really 2799 SMEs from the original 6381 SMEs.

In our previous research, we have compared the prediction power of the bankruptcy models, which are used very often in many scientific papers – the Altman Z-score, the Ohlson O-score, the Zmijewski model, the Taffler model and the IN05 model. We found that the performance of these models reached from 69% to 55%. Next step in our research was determined to re-estimate coefficients for analysed companies and develop a new model, which should provide the best possible results (Plíhal et al. 2018).

2.1 Dataset

We have decided to reach as accurate as possible results to split our database into three groups respecting the size of companies. These groups represent a distribution of SMEs according to Commission Regulation (EC) No 800/2008 into micro-enterprises, small enterprises and medium-sized enterprises (EUR-Lex 2020).

The category of micro-, small- and medium-sized enterprise is made up of enterprises which employ fewer than 250 persons, which have an annual turnover not exceeding EUR 50 million and/or annual balance sheet total not exceeding EUR 43 million.

The micro-enterprise is defined as an enterprise which employs fewer than ten persons and whose annual turnover and/or annual balance sheet total does not exceed EUR two million.

The small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR ten million.

According to a study by WH Beaver (1966), the bankruptcy of a company could be predicted up to 5 years in advance. Altman's studies prove that the best models are with a prediction of 1 to 2 years in advance. So, we kept from the database of bankrupt companies only statements of companies 1 year before bankruptcy. As a bankrupt company, we consider companies in real bankrupt or companies in liquidation according to Czech law.

Sorting of our database according to criteria is mentioned in Table 1.

We used 16 financial indicators (see Table 2). We took the variables from the models, which are used in Altman's Z-score, the Ohlson O-score, the Zmijewski model, the Taffler model and the IN05 model as we have compared the prediction power of these models in our previous research. They measure most of all leverage and profitability as it can be seen in Table 2. Most of these indicators are not often used in financial analysis; they have been used in known bankruptcy models which we have been examined in our previous research (Plíhal et al. 2018).

Table 1 Database sorting

Size	Healthy	Bankrupt	Total
Micro-enterprises	764	229	993
Small enterprises	704	220	924
Medium-sized enterprises	693	189	882
Total SMEs	2161	638	2799

Source: own processing

Table 2 List of financial indicators

Coding	Formula
Leverage	
L003	Equity/liabilities
L006	Current assets/liabilities
L007	Short-term payables/total assets
L008	Total assets/liabilities
L010	Short-term liabilities/current assets
L012	Liabilities/equity
L013	Liabilities/total assets
L015	Equity/long-term assets
L016	Equity + reserves + long-term liabilities/ long-term assets
Liquidity	
I001	Working capital/total assets
I014	Current assets/short-term liabilities
Profitability	
P002	Retained earnings/total assets
P005	EBT/short-term liabilities
P009	EBIT/interest cost
P011	EAT/total assets
Activity	
P004	Sales/total assets

Source: own processing

2.2 Model Specification

Logistic regression is the appropriate regression analysis to conduct when the dependent variable is dichotomous (binary). Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables. The dependent variable should be dichotomous (e.g. in our case bankrupt or non-bankrupt companies). There should be no outliers in the data, no high correlations (multicollinearity) amongst the predictors. Tabachnick and Fidell (2013) suggest that as long correlation coefficients amongst independent variables are less than 0.90, the assumption is met. Mathematically, logistic regression estimates a multiple linear regression function defined as:

$$\pi(x) = \frac{\exp(\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n)}{1 + \exp(\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n)} \quad (1)$$

3 Results and Discussion

We have tested each group and all the dataset separately. The results are mentioned in Tables 3, 4, 5, 6, 7, 8, 9 and 10.

Variables mentioned in Table 1 are entered into logistic regression with the below-mentioned result.

The model developed for the segment of micro-enterprises shows that it is necessary to pay attention to many factors of a company's financial situation. We can say that all significant indicators are usual indicators of bankruptcy. It measures most of all leverage and profitability. Even Tomczak and Radosinski (2017) and Karas and Reznakova (2017) state in their researches that the worst models are that with six or eight indicators; the predictability of the model for micro-enterprises reached 77,5%.

Surprisingly, the model developed for the segment of small enterprises has fewer indicators and measures, most of all, leverage. The predictability of the model for small enterprises reached 78,9%.

The model developed for the segment of medium-sized enterprises has six indicators and measures, most of all, leverage. Even this model has six indicators; the model for medium-sized enterprises reached the highest predictability 79,8%.

The result if we do not distinguish the size of the company is a mixture of all previous models. It measures most of the leverage again. The predictability of the model for all data reached 77,2%, which is the lowest predictability. The result confirms our hypothesis H2 when we develop a bankruptcy model; it is necessary to sort companies according to size (Table 11).

The total comparison shows that when we assess micro-enterprises, we have to focus on leverage and profitability, while small enterprises could have problems with leverage, profitability and liquidity. When assessing the financial situation of the medium-sized enterprises, we have to focus on leverage, liquidity and activity. The most important indicators are these which are used very often when analysing a company's financial situation. They are indebtedness like indicator L013, current

Table 3 Variables predicting bankruptcy for micro-enterprises

Coding	Coefficient B	p-value
Constant	-2932	0,000
A004	0,071	0,000
L007	0,845	0,081
L013	0,022	0,001
L015	0,006	0,054
P002	-1532	0,006
P009	-0,002	0,065
P011	-1607	0,095

Source: own processing

Table 4 Correlation matrix for micro-enterprises

Coding	A004	L007	L013	L015	P002	P009	P011
A004	1	-0,019	-0,010	-0,030	0,020	0,037	-0,265
L007	-0,019	1	-0,563	-0,082	-0,049	-0,032	-0,094
L013	-0,010	-0,563	1	0,116	0,489	-0,032	0,398
L015	-0,030	-0,082	0,116	1	-0,040	0,024	-0,001
P002	0,020	-0,049	0,489	-0,040	1	0,097	0,299
P009	0,037	-0,032	-0,032	0,024	0,097	1	-0,326
P011	-0,265	-0,094	0,398	-0,001	0,299	-0,326	1

Source: own processing

Table 5 Variables predicting bankruptcy for small enterprises

Coding	Coefficient B	p-value
Constant	-1891	0,001
I014	-0,449	0,004
L007	1217	0,042
L013	0,023	0,001
P002	-2002	0,002

Source: own processing

Table 6 Correlation matrix for small enterprises

Coding	I014	L007	L013	P002
I014	1	0,246	0,234	-0,036
L007	0,246	1	-0,484	-0,097
L013	0,234	-0,484	1	0,419
P002	-0,036	-0,097	0,419	1

Source: own processing

Table 7 Variables predicting bankruptcy for medium-sized enterprises

Coding	Coefficient B	p-value
Constant	-3498	0,001
A004	-0,372	0,000
I001	2308	0,001
I014	-0,247	0,006
L008	0,120	0,003
L013	0,046	0,000
L016	0,059	0,014

Source: own processing

Table 8 Correlation matrix for medium-sized enterprises

Coding	A004	I001	I014	L008	L013	L016
A004	1	-0,136	0,106	-0,063	-0,303	-0,350
I001	-0,136	1	-0,523	0,385	0,504	-0,308
I014	0,106	-0,523	1	-0,573	-0,072	0,000
L008	-0,063	0,385	-0,573	1	0,473	-0,028
L013	-0,303	0,504	-0,072	0,473	1	-0,064
L016	-0,350	-0,308	0,000	-0,028	-0,064	1

Source: own processing

Table 9 Variables predicting bankruptcy for the whole dataset

Coding	Coefficient B	p-value
Constant	-2612	0,000
A004	0,029	0,020
I014	-0,178	0,001
L003	0,101	0,001
L013	0,029	0,000
L015	0,009	0,001
P002	-1197	0,000
P011	-1123	0,038

Source: own processing

Table 10 Correlation matrix for the whole dataset

Coding	A004	I014	L003	L013	L015	P002	P011
A004	1	-0,010	0,008	-0,126	-0,066	0,040	-0,225
I014	-0,010	1	-0,454	0,166	-0,080	-0,045	-0,070
L003	0,008	-0,454	1	0,402	0,060	-0,009	0,115
L013	-0,126	0,166	0,402	1	0,028	0,376	0,277
L015	-0,066	-0,080	0,060	0,028	1	-0,099	-0,038
P002	0,040	-0,045	-0,009	0,376	-0,099	1	0,141
P011	-0,225	-0,070	0,115	0,277	-0,038	0,141	1

Source: own processing

liquidity like indicator I014, a little modification of ROA like indicator P002 and ROS like indicator A004. It confirms our hypothesis H1 that the usually used financial indicators are the best one, and it is not necessary to devise any other indicator.

4 Conclusions

This study analysed if there are various factors to predict bankruptcy for different size of Czech SMEs. We have investigated financial data for the years from 2010 to 2017. The whole dataset was divided into three groups – micro-enterprises, small

Table 11 Result comparison of all models

Coding	Micro-enterprises	Small enterprises	Medium-sized enterprises	Total SMEs
Constant	-2932	-1891	-3498	-2612
Leverage				
L003				0,101
L006				
L007	0,845	1217		
L008			0,120	
L010				
L012				
L013	0,022	0,023	0,046	0,029
L015	0,006			0,009
L016			0,059	
Liquidity				
I001			2308	
I014		0,449	-0,247	-0,178
Profitability				
P002	-1532	-2002		-1197
P005				
P009	-0,002			
P011	-1607			-1123
Activity				
A004	0,071		-0,372	0,029
Categorisation rate	77,5%	78,9%	79,8%	77,2%

Source: own processing

enterprises and medium-sized enterprises. The analyses were done separately for each group and for the whole dataset to capture different characteristics of companies with a different size. We used 16 financial indicators. We took the variables from the models, which are used in Altman's Z-score, the Ohlson O-score, the Zmijewski model, the Taffler model and the IN05 model as we have compared the prediction power of these models in our previous research. Most of these indicators are not often used in financial analysis.

We have found that when we assess micro-enterprises, we have to focus on leverage and profitability, while small enterprises could have problems with leverage, profitability and liquidity. When assessing the financial situation of the medium-sized enterprises, we have to focus on leverage, liquidity and activity. The most critical indicators are these which are used very often when analysing a company's financial situation. They are indebtedness like indicator L013, current liquidity like indicator I014, a little modification of ROA like indicator P002 and ROS like indicator A004. It confirms our hypothesis H1 that the usually used financial indicators are the best one, and it is not necessary to devise any other indicator.

Our findings confirm our hypothesis, and some suggestion arises from it. When we develop a bankruptcy model, it is necessary to sort companies according to size and exploit commonly used financial indicators to assess the probability of bankruptcy precisely.

Acknowledgements The support of the Masaryk University internal grant MUNI/A/1120/2018 – Vybrané aspekty rizik na finančních trzích is gratefully acknowledged.

References

- Abdipoor S, Nasser A, Mojtaba A, Parsian H, Zamani S (2013) Integrating neural network and colonial competitive algorithm: A new approach for predicting bankruptcy in Tehran security exchange. *Asian Econ Financ Rev* 3:1528–1539
- Alaka HA, Oyedele LO, Owolabi HA, Kumar V, Ajayi SO, Akinade OO, Bilal M (2018) Systematic review of bankruptcy prediction models: Towards a framework for tool selection. *J Expert Syst Appl* 94:164–184
- Altman EI (1968) Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *J Finance* 23(4):589–609
- Altman EI, Sabato G (2007) Modeling credit risk for SMEs: Evidence from the U.S. market. *J Ab* 43(3):332–357
- Altman EI, Sabato G, Wilson N (2010) The value of non-financial information in small and medium-sized enterprise risk management. *J Cr R* 6(2):1–33
- Angelini E, Tollo di G, Roli A (2007) A neural network approach for credit risk evaluation. *J Ec* F:733–755
- Barbuta-Misu N, Codreanu ES (2014) Analysis and prediction of the bankruptcy risk in Romanian building sector companies. *J Ekonomika* 93:131–146
- Barnes P (1982) Methodological implications of non-normality distributed financial ratios. *J Bus F A* 9:51–62
- Beaver W (1966) Financial ratios as predictors of failure. *J Account Res* 4:71–111, ISSN 0021-8456
- Belas J, Misankova M, Schonfeld J, Gavurova B (2017) Credit risk management: Financial safety and sustainability aspects. *J Secur Sustain* 7:79–93
- Bredart X (2014) Bankruptcy prediction model using neural networks. *J Account Financ Res* 3:124–128
- EUR-Lex (2020) Digital reports. <http://eurlex.europa.eu>
- EUROSTAT (2019) Manuals and guidelines. <http://ec.europa.eu/eurostat/>
- Fedorova EA, Dovzhenko SE, Fedorov FY (2016) Bankruptcy-prediction models for Russian enterprises: Specific sector-related characteristics. *J Stud Rus Econ Dev* 27:254–261
- Glezakos M, Mylonakis J, Oikonomou K (2010) An empirical research on early bankruptcy forecasting models: Does logit analysis enhance business failure predictability? *Eur J Financ Bank Res* 3:1–15
- Grunert J, Norden L, Weber M (2005) The role of non-financial factors in internal credit ratings. *J B F* 29(2):509–531
- Gulnur D, Fikret G (2011) Knowledge discovery using neural approach for SME's credit risk analysis problem in Turkey. *J E S A* 38:9313–9318
- Karas M, Reznakova M (2017) Predicting the bankruptcy of construction companies: A CART-based model. *J Eng Econ* 28:145–154
- Lawrence JR, Pongsatit S, Lawrence H (2015) The use of Ohlson's O-score for bankruptcy prediction in Thailand. *J Appl Bus Res* 31:2069–2078
- Lifschutz S, Jacobi A (2010) Predicting bankruptcy: Evidence from Israel. *J Int J M* 5(4):133–141

- Neumaierová I, Neumaier I (2005) Index IN05. In: European Financial Systems, Masaryk University, Brno 2005
- Ohlson JA (1980) Financial ratios and the probabilistic prediction of bankruptcy. *J Ac R* 18:109–131
- Plíhal T, Sponerová M, Sponer M (2018) Comparative analysis of credit risk models in relation to SME segment. *J FAI* 9(1):35–50
- Salehi M, Davoudi Pour M (2016) Bankruptcy prediction of listed companies on the Tehran stock exchange. *Int J Law Manag* 58:545–561
- Shumway T (2001) Forecasting bankruptcy more accurately: A simple hazard model. *J B* 74(1):101–124
- Taffler R, Tishaw H (1977) Going, going, gone – Four factors which predict. *J Account* 3:50–54
- Tomczak SK, Radosinski E (2017) The effectiveness of discriminant models based on the example of the manufacturing sector. *J Op Res Decis* 27:81–97
- Waqas H, Md-Rus R (2018) Predicting financial distress: Applicability of O-score and logit model for Pakistani firms. *J B E H* 14:389–401
- Zieba M, Tomczak SK, Tomczak JM (2016) Ensemble boosted trees with synthetic features generation in application to bankruptcy prediction. *Expert Syst Appl* 58:93–101
- Zmijewski M (1984) Methodological issues related to the estimation of financial distress prediction models. *J Acc R* 22:59–82

The Competitiveness of Regions in Poland in 2009–2016



Agnieszka Wojtasiak-Terech and Ewa Majerowska

1 Introduction

The competitiveness of regions constitutes a field of analysis for scholars, policy-makers as well as business representatives. Over the last few decades, the academic discussion on the issues associated with defining, measuring and comparing regional competitiveness has been intensifying. Regional authorities have been increasingly interested in construction of local competitiveness indices or indicators, so as to compare the relative standing of their localities (cities, towns, etc.) with that of others, as well as in development of adequate policy strategies to move their localities up the ‘competitiveness league table’ (Martin 2005). Regions have to be competitive in order to attract companies and inhabitants as well as to survive, facing globalization and the new information technologies, on the new marketplace.

The purpose of this paper is to contribute to the debate surrounding the comparison of regions in Poland, based on selected aggregate measures of competitiveness. The term region relates to a voivodeship. Sixteen voivodeships in Poland are analysed. The annual data used in the analysis was obtained from the Central Statistical Office and covers the years 2009–2016.

In the existing body of the literature, several approaches to competitiveness analysis of regions can be found. Researchers suggest different indicators for comparing competitiveness of regions, and on the base of them, they construct indicators. We suggest application of five selected variables in order to build overall

A. Wojtasiak-Terech (✉)

Wroclaw University of Economics and Business, Wroclaw, Poland

e-mail: agnieszka.wojtasiak-terech@ue.wroc.pl

E. Majerowska

University of Gdansk, Gdańsk, Poland

e-mail: ewa.majerowska@ug.edu.pl

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

A. Bem et al. (eds.), *Sustainable Finance in the Green Economy*, Springer

Proceedings in Business and Economics, https://doi.org/10.1007/978-3-030-81663-6_18

237

competitiveness indicator. Additionally, our contribution is that on the basis of created indicator, we are able to indicate if the discrepancies between levels of competitiveness change in time.

In the first part, an overview of the literature on the issues referring to regional competitiveness is presented. In the following section, two general approaches to measurement of regional competitiveness are described. Next, the regional-competitiveness measures to be used in the analysis are selected (the level of GDP per capita, the average monthly gross salary, business density, labour productivity and employment rate). Based on these variables, a general competitiveness indicator is determined for each voivodship. To design the general indicator, the method of zero unitarization and construction of the Human Development Index (HDI) were applied.

2 Literature Overview of the Issues on Regional Competitiveness

There is neither a commonly accepted definition of regional competitiveness nor strong agreement regarding its measurement. This results from the fact that much of the literature on regional competitiveness is rooted in different theories of competitiveness. From the perspective of the analysis conducted, the most important implications, in terms of the understanding regional competitiveness, must be inferred from economics and economic-geography theories, such as the export-base theories, the endogenous growth theory, the neo-Schumpeterian theory, the cluster theories, the institutionalist theory, the cultural theory and the evolutionary theory. Although the term ‘competitiveness’ may have an earlier predecessor and has been present in public policy for at least 500 years (Reinert 1995), it actually entered economic parlance in the 1980s (Martin 2005). Michael Porter’s *Competitive Strategy* (1980), *competitive advantage* (1985), *Competition in Global Industries* (1986) and *The Competitive Advantage of Nations* (1990) played a key role in the transformation of the notion into a concept of national and regional scale (Budd and Hirmish 2004; Martin 2005). Following Porter’s (1990) early studies linking national competitiveness to productivity and principally to a nation’s ability to innovate, attention turned to the competitiveness at a more regional level. From this special perspective, Porter (2000) contributed by taking the micro-level understanding of the conditions determining company competitiveness, such as the capacity to innovate, and applied it to a territorial unit, a region or a nation (Huggins et al. 2013). A broad overview of the theories defining and explaining regional competitiveness was conducted by Martin (2005), Siudek and Zawojcka (2014), Szafranek (2010), Huggins et al. (2013), Budd and Hirmish (2004).

The difficulty in defining regional competitiveness and its measures also derives from the fact that this notion is neither a macroeconomic (national) nor a microeconomic (firm-based) one, since a region is neither a simple aggregation of firms nor

a scaled version of nations (Cellini and Soci 2002). At the company level, a reasonably clear and straightforward understanding of the notion of competitiveness exists, based on the capacity of companies to compete, grow and become profitable (Martin and Cambridge Econometrics and Ecorys-Nei 2003). The macroperspective is related to a nation's and a macro-region's competitiveness, while the concept of competitiveness is much more poorly defined and more strongly contested. Countries compete by creating proper conditions for business development, conduction of internal policy and application of structural changes accordingly with the processes of globalization. They also support entrepreneurship, create conditions for higher employment and improvement of qualifications (Łaźniewska et al. 2012). The label 'meso-level' is used to indicate the intermediate level between the individual and the aggregate macro levels.

It must be underlined that two phenomena had significant impact on the increased interest in research on regional competitiveness: globalization and attention to neoliberalism. The fundamental concepts characterizing globalization entail the width (the scope) and the depth (the intensity) of changes; the multitude of links and conjugations between countries and societies as well as between states and societies; unity; economic interdependence; cultural homogeneity of the world; and transnational corporations creating global financial and industrial networks. The essence of globalization consists, therefore, in the increase of the intensity of international economic links, including the accompanying social, political and cultural transformations, as well as the increase in the importance of international institutions (Tuziak 2018). Neoliberalism, in turn, connected with decentralization, deregulation and privatization, focused on regions and cities which were viewed as the key places of wealth creation.

Taking into the account the different theories underlying the concept of regional competitiveness, plenty of definitions attempting to explain its meaning exist. Only some definitions, which are most significant for the analysis conducted, will be presented. Malecki understands regional competitiveness as the possibility to ensure growth of the living standards for the local economy and society (Malecki 2000). Storper (2008) defines regional competitiveness as the region's capability to attract and keep companies exhibiting stable or raising share in the market while maintaining stable or increasing standards of living for those who participate in it. Annoni et al. (2017) add the dimension of sustainability to the definition. Regional competitiveness is defined as the ability to offer an attractive and sustainable living and working environment for both companies and residents. In this definition, the word 'sustainable' is not used in a purely ecological-environmental sense but in the sense of a region's capacity to provide an attractive environment, both in the short and the long term. Krugman (2003) suggests that the competitiveness of a region is based on its ability to provide sufficiently attractive wages and/or employment prospects as well as return on capital. Some approaches to the definition of regional competitiveness underline that it is related to the ability to adopt to the changes in the environment (Klasik and Kuźnik 2001; Martin 2005; Ponikowski 2004; Winiarski 1999) or the ability to constantly develop (Strahl 2004). A comprehensive definition of regional competitiveness, taking into account the drivers of competitiveness and its

outputs, has been proposed by Parkinson et al. (2006). They defined it as the region's ability to continually upgrade its business environment and skill base as well as the physical, the social and the cultural infrastructures, in order to attract and retain high-growth, innovative and profitable companies as well as educated, creative and entrepreneurial workforce, and thus to achieve high rates of productivity and employment, high wages, high gross value added (GVA) per capita as well as low levels of income inequality and social exclusion. This definition of competitiveness will be applied in this paper, because it comprises the most important aspect of regional competitiveness and indicates certain measures of competitiveness.

3 Approaches to Regional-Competitiveness Measurement

There are two distinguishable approaches to regional-competitiveness analysis and measurement (Martin and Cambridge Econometrics and Ecorys-Nei 2003):

1. Studies that analyse it as a cumulative outcome of various factors presented as competitiveness indices
2. Studies that focus on particular drivers of competitiveness and identify aggregate measures

The development of regional-competitiveness indices stems from the initial establishment of composite indices used for comparison of national competitiveness, such as the Global Competitiveness Index included in the Global Competitiveness Report published by the World Economic Forum and the World Competitiveness Ranking provided by the Institute for Management Development World Competitiveness Center. These indices combine a number of variables, to produce a single composite measure of competitiveness (Huggins et al. 2013). On a regional level, the following indices can be distinguished: the EU Regional-Competitiveness Index created by the DG for Regional and Urban Policy (Annoni et al. 2017); the UK Competitiveness Index developed by Robert Huggins at Cardiff University (2003); the Regional Innovation Scoreboard prepared for the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs; and the Atlas of Regional Competitiveness published by Eurochambres. A detailed overview of some of the regional-competitiveness indices (almost 50 indices) is included in Berger's (2011) survey. The task of building a competitiveness index, to compare Polish regions, was undertaken, for instance, by Bronisz (2013). Employment of development indices was also proposed, *inter alia*, by Strahl (2006) and Kompa (2009).

Selection of the regional-competitiveness drivers and the aggregate measures to be used depends on the purpose of the study. Usually the drivers of regional competitiveness are related to economic conditions, social conditions and the level and the quality of both life and the natural environment (Szafranek 2010). Porter (2001) lists four drivers of regional competitiveness: factor conditions (labour, land natural resources, capital, infrastructure), the conditions related to the nature of the demand

emitted by local entities and the households in the region, presence of related and supporting industries and the factors associated with company strategy, structure and rivalry on the local market. Winiarski (1999) identified the following drivers of regional competitiveness: a developed and diverse structure of the economy, developed infrastructure, presence of institutions supporting innovations, presence of higher education institutions, business support organizations, good condition of the natural environment and availability of investment locations. According to Pessoa (2013), the primary elements comprising the idea of regional competitiveness are enterprises and the six focus areas (environmental resources, the local milieu, the factor market and the global market, as well as the legal and the physical infrastructure), which drive the behaviour of companies. Comparison of Polish regions, based on selected competitiveness measures, was made, for instance, by Strahl (2002), Szafranek (2010) and Łaźniewska (2013). Classification of voivodships, in terms of economic development, using taxonomic methods, was carried out by Murawska (2010). Using data from 2008, she applied the k-medium method and agglomeration methods, and identified four voivodship categories of high, medium, low and very low levels of economic development. Markowska et al. (2015) provided a dynamic classification of EU regions according to the structure of the labour market. The dynamic taxonomy applied allowed the authors to capture the changes in the allocation of regions to the groups formed according to the employment structure in economic sectors, with regard to time and space.

Commonly used models, which have been used to explore particular drivers of competitiveness and aggregate measures of regional competitiveness, include ‘the pyramid model’ of regional competitiveness and the regional competitiveness ‘hat’ model suggested by (Kitson et al. 2004; Łaźniewska 2013; Łaźniewska et al. 2012).

‘The pyramid model’ of regional competitiveness comprises several different levels. The most aggregate measure of regional competitive advantage refers to the standard of living in a region, conventionally captured by the gross domestic product (GDP) or the GVA per capita. Intermediate performance indicators – namely, productivity, employment rate, wage levels and profit rates – are under the aggregate performance measure. These in turn result from the key ‘drivers’ of regional competitive performance – innovation, investment, human capital, economic structure, connectivity, the quality of life and the structures of decision-making. The model was initially created in 1997 by the European Commission (Łaźniewska et al. 2012), then applied, upgraded and modified for the purpose of several surveys (Begg 1999; Lengyel 2004; Parkinson et al. 2006).

The regional competitiveness ‘hat’ model comprises regional outcomes, outputs and throughputs as well as the determinants of regional competitiveness. In other words, the determinants of regional competitiveness (grouped by infrastructure and accessibility, human capital and productive environment) can be discovered by ‘opening’ the hat, layer by layer. One common indicator of regional competitiveness is the GDP per capita, which provides a rather incomplete indication of the population’s average well-being. The aggregate indicator can be decomposed into key intermediate measures of regional competitiveness: the productivity and the

employment rates (Łaźniewska et al. 2012; Martin and Cambridge Econometrics and Ecorys-Nei 2003).

Kitson et al. (2004) consider the human, the socio-institutional, the cultural, the infrastructural, the productive and the knowledge capital as the main drivers of regional competitiveness, which is measured by regional productivity, employment and the standard of living.

Regional competitiveness can be considered from three perspectives (Łaźniewska 2013):

1. The region's competitive position in the past
2. The region's competitive potential
3. The region's competitive strategy

The analysis presented in the paper focuses on the competitive position of a region, which is assessed based on selected aggregate measures. The aggregate measures of regional competitiveness are adopted from the above-described models and other theoretical and empirical studies on regional competitiveness (see, e.g. (Berger 2011; Gardiner et al. 2004; Golejewska 2012; Łaźniewska et al. 2012; Martin 2005; Porter 2003; Szafranek 2010)). The following are used as the measures of voivodeship competitiveness:

1. An outcome indicator (the most aggregated measure) – regional GDP per capita
2. Intermediate performance indicators:
 - Labour productivity – regional GDP/the employed
 - Employment rate – the employed/the working population
 - Average monthly salary
 - Business density – the number of registered entities per 10,000 inhabitants

4 Data and Methodology

For the purpose of the empirical analysis, yearly data from 2009 to 2016 was selected, concerning 16 Polish voivodships. Based on the literature review, five factors characterizing the economic situation of each voivodeship were adopted. As mentioned above, these factors include:

- X_1 – the level of GDP per capita
- X_2 – the average monthly gross salary
- X_3 – business density, measured as the number of the national-economy entities entered in the REGON register
- X_4 – labour productivity, measured as the ratio of the gross GDP level to the total number of the employed
- X_5 – employment rate, estimated as the share of the total number of the employed in relation to the number of working-age persons

All data was obtained from the Central Statistical Office. The variables were then standardized, in accordance with the zero unitarization method, using the following formula:

$$I_{ij} = \frac{X_{ij} - \min_j X_{ij}}{\left(\max_j X_{ij} - \min_j X_{ij} \right)} \quad (1)$$

where j is the voivodship number, with $j = 1, \dots, 16$, while i is the number of the variable, with $i = 1, \dots, 5$. This allows estimation of the measure of linear ordering in a closed range, from zero to one.

In the next step, based on these standardized variables, the general competitiveness indicator is determined for each voivodeship. Similarly to the construction of the Human Development Index (HDI), the following formula was used:

$$I_j = \frac{1}{5} \sum_{i=1}^5 I_{ij} \quad (2)$$

The values of the synthetic indicators determined for each voivodship allow synthetic assessment of the level of voivodship competitiveness, on a cross-sectional basis. At the same time, they allow assessment of the changes in the position of voivodships, relative to others, on a time basis. If the differences between the values of the synthetic indices of selected voivodships were decreasing, it would signify a decreasing divergence between those voivodeships.

5 Empirical Results

Using the procedure described above, the values of the synthetic competitiveness indicators for each voivodship were determined with regard to subsequent years. Table 1 shows the results.

As can be seen, the Masovian Voivodeship clearly is the leader. The Warmian-Masurian Voivodship came last, just before the Podlaskie Voivodship. In general, the voivodship ranking did not change significantly over time. This conclusion is confirmed by the following charts, presented as Figs. 1, 2 and 3.

The above graphs (Figs. 1, 2 and 3) show the indicator values in selected years (2009, 2012, 2016). It is clear that the shape of the graphs is very similar. This means that, despite the passage of time and the inflow of financial resources, diversity in the levels of voivodship competitiveness still exists. Such results confirm the conclusions presented by the other authors. Szafranek (2010) showed that at the lowest competitive position Subcarpathian Voivodeship is located. Then Świętokrzyskie and Lublin Voivodeships were placed. At the top of the competitiveness ranking, Masovian Voivodeship was placed and next Lower Silesia and

Table 1 Values of the synthetic indicator

Voivodeship	2009	2010	2011	2012	2013	2014	2015	2016
Lower Silesian	0.490	0.495	0.504	0.498	0.490	0.498	0.504	0.503
Kuyavian-Pomeranian	0.235	0.221	0.215	0.208	0.207	0.205	0.208	0.203
Lubusz	0.187	0.223	0.220	0.221	0.223	0.212	0.204	0.192
Lublin	0.200	0.189	0.183	0.181	0.170	0.182	0.186	0.191
Łódź	0.325	0.340	0.340	0.343	0.341	0.340	0.349	0.342
Lesser Poland	0.348	0.359	0.364	0.360	0.357	0.357	0.374	0.374
Masovian	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Opole	0.206	0.208	0.200	0.189	0.181	0.189	0.196	0.186
Subcarpathian	0.142	0.192	0.189	0.184	0.190	0.184	0.183	0.171
Podlaskie	0.178	0.173	0.171	0.161	0.164	0.156	0.152	0.141
Pomeranian	0.408	0.375	0.379	0.385	0.374	0.374	0.382	0.386
Silesian	0.533	0.532	0.546	0.526	0.514	0.504	0.502	0.486
Świętokrzyskie	0.213	0.212	0.203	0.194	0.178	0.171	0.175	0.156
Warmian-Masurian	0.127	0.116	0.113	0.108	0.099	0.101	0.101	0.100
Greater Poland	0.463	0.451	0.454	0.454	0.456	0.453	0.463	0.465
West Pomeranian	0.283	0.253	0.248	0.244	0.230	0.234	0.245	0.243

Source: Own calculation based on the data from www.stat.gov.pl

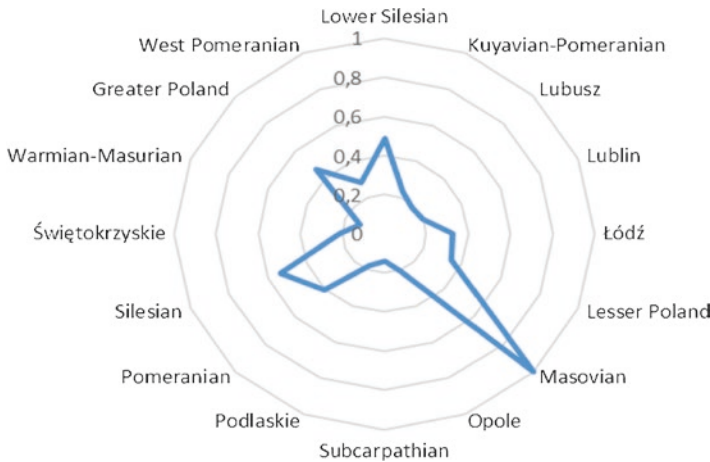


Fig. 1 Values of the synthetic indicator in 2009. (Source: own calculation based on the data from www.stat.gov.pl)

Pomeranian regions. The analysis was conducted for 1999–2008. Research presented by Kondratiuk-Nierodzińska (2013) and Surówka (2014) shows the same results. Insignificant differences can appear because the indicators were calculated for each year separately.

An attempt was then made to answer the question of whether the discrepancies between the levels of voivodeship competitiveness decrease as the years go by. For

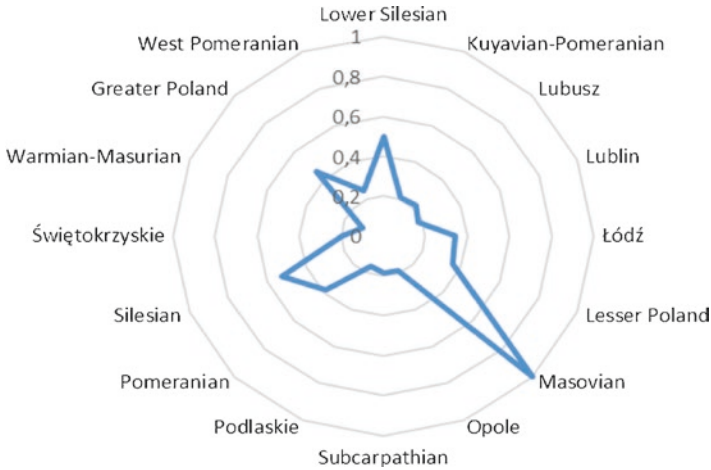


Fig. 2 Values of the synthetic indicator in 2012. (Source: own calculation based on the data from www.stat.gov.pl)

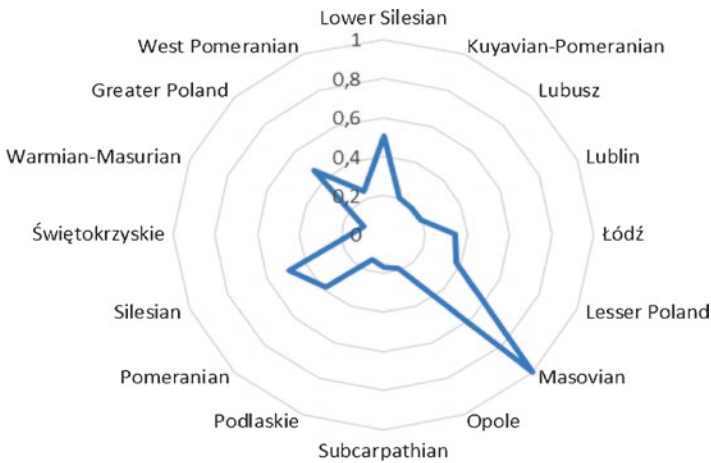
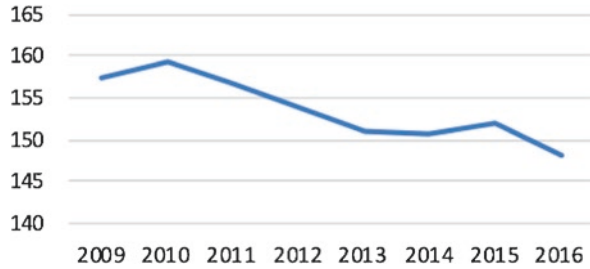


Fig. 3 Values of the synthetic indicator in 2016. (Source: own calculation based on the data from www.stat.gov.pl)

this purpose, volatility coefficients (expressed in percentage) were determined for the values of the synthetic competitiveness indicators, with regard to subsequent years. Their values are shown in Fig. 4. Generally, a decreasing trend can be observed in the volatility coefficients. This indicates a decreasing divergence between the levels of voivodship competitiveness. This is an optimistic fact, which confirms effectiveness of the actions aimed at the balancing of the level of economic development in the entire country.

Fig. 4 Values of the volatility coefficient of the synthetic indicator (%)



6 Conclusions

The analysis carried out, aimed at assessment of the state and the tendency of the changes in the competitiveness level of individual voivodships in Poland, allows a statement that the voivodship with the highest level of competitiveness, according to the measures selected, is the Masovian Voivodeship. It has been a model for other voivodships. Second, similar in terms of competitiveness, is a group of three voivodships: the Silesian, the Lower Silesian and the Greater Poland voivodships. These voivodships have large urban agglomerations with high levels of development. In addition, they are characterized by a more diverse structure of the economy, favourable location, better communication accessibility and richer resources. The least-developed group includes the Warmian-Masurian, the Podlaskie and the Lublin voivodships. These voivodships are three out of the five voivodships belonging to the so-called Eastern Poland. They are characterized, in comparison with other voivodships, by a lower standard of living, lower dynamics of economic development, less developed and improperly oriented communication infrastructure, depopulation and a shortage of growth factors.

The main reason of the inequalities among voivodships is related to historical division of the country. As a consequence eastern regions are still undeveloped in comparison with the other parts. This underdevelopment is seen in poor infrastructure and low density of businesses. It results in young, educated people migration to richer regions and reluctance of the new investors to open their companies or branches there. Additionally geographical factors such as lack of natural sources are not favourable. Some of the disparities between voivodships can be eliminated by the government policy. However it requires time and financial sources.

The position in voivodship rankings has changed insignificantly over time. The only thing worrying is the decline in the ranking of the Świętokrzyskie Voivodeship (from 10th position in 2009 to 14 in the last 3 years). Comparing the value variability of the synthetic competitiveness indicators over the years, a decreasing divergence between the levels of voivodship competitiveness can be noted. This is a positive phenomenon, which means that, despite the large economic diversification of voivodships, they strive for development and become similar the pattern exhibited by the Masovian Voivodeship. Growth of the economic potential occurs in these voivodships, which results in the improvement of the living standards of and an

increase in competitiveness. The narrowing of differences in the level of regional development indicates successful implementation of the National Strategy for Regional Development 2010–2020, in terms of the measures undertaken to reduce the disparities between the regions, positive impact of the State aid provided for peripheral regions and proper application of the instruments supplied by the cohesion policy and the structural policy of the European Union.

In successive studies, the scope of the regional-competitiveness measures will be extended. Attention will be devoted to the per capita investment expenditures and the expenditures on research and development.

References

- Annoni P, Dijkstra L, Gargano N (2017) The EU regional competitiveness index 2016, working paper, 02. <https://doi.org/10.2776/94425>
- Begg I (1999) Cities and competitiveness. *Urban Stud* 36(5–6):795–809
- Berger T (2011) An overview and analysis on indices of regional competitiveness. *Rev Econ Finance* 1:17–33
- Bronisz U (2013) Metody badania konkurencyjności regionów. Polska Akademia Nauk, Warszawa
- Budd L, Hirmish A (2004) Competitiveness conceptual framework for regional competitiveness. *Reg Stud* 38(9):1015–1028. <https://doi.org/10.1080/0034340042000292610>
- Cellini R, Soci A (2002) Pop competitiveness. *PSL Quarterly Rev* 55(220):71–101
- Gardiner B, Martin R, Tyler P (2004) Competitiveness, productivity and economic growth across the European regions. In: Regional productivity forum seminar. Regional Studies Association. <https://doi.org/10.4324/9780203607046>
- Golejewska A (2012) Human capital and regional growth perspective. *Barometr Regionalny* 11(1):17–20
- Huggins R, Izushi H, Thompson P (2013) Regional competitiveness: theories and methodologies for empirical analysis. *J Centrum Cathedra Bus Econ Res J* 6(2):155–172. <https://doi.org/10.7835/jcc-berj-2013-0086>
- Kitson M, Martin R, Tyler P (2004) Regional competitiveness: an elusive yet key concept? *Reg Stud* 38(9):991–999. <https://doi.org/10.1080/0034340042000320816>
- Klasik A, Kuźnik F (2001) Konkurencyjny rozwój regionów w Europie. In: Szymala Z (ed) *Konkurencyjność miast i regionów*. Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków, p 29
- Kompa K (2009) Budowa mierników agregatowych do oceny poziomu rozwoju społeczno-gospodarczego. *Zeszyty Naukowe SGGW w Warszawie* *Ekonomika i Organizacja Gospodarki Żywnościowej* nr 74:5–26
- Kondratiuk-Nierodzińska M (2013) Regionalne systemy innowacji, a konkurencyjność województw w Polsce. Wydawnictwo Uniwersytetu w Białymstoku, Białystok
- Krugman P (2003) Growth on the periphery: second wind for industrial regions? The Allander series. Fraser Allander Institute, Glasgow
- Łązniewska E (2013) *Konkurencyjność regionalna w czasie i przestrzeni*. Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu, Poznań
- Łązniewska E, Chmielewski R, Nowak P (2012) Definicje, modele i studia nad regionalną konkurencyjnością. In: Łązniewska E, Gorynia M (eds) *Konkurencyjność regionalna. Koncepcje-strategie-przykłady*. PWN, Warszawa, pp 24–62
- Lengyel I (2004) The pyramid model: Enhancing regional competitiveness in Hungary. *Acta Oeconomica* 54(3):323–342

- Malecki E (2000) Knowledge and regional competitiveness. *Erdkunde* 54(4):334–351. <https://doi.org/10.3112/erdkunde.2000.04.04>
- Markowska M, Sokołowski A, Strahl D, Sobolewski M (2015) ‘Dynamiczna klasyfikacja regionów UE ze względu na strukturę rynku pracy– Pozycja regionów polskich’ (Dynamic classification of EU regions with respect to the labour market structure – Position of Polish regions). *Prace Komisji Geografii Przemysłu Polskiego Towarzystwa Geograficznego* (Studies of the Industrial Geography Commission of the Polish Geographical Society) 29(2):23–36
- Martin R (2005) Thinking about regional competitiveness: critical issues. http://irep.ntu.ac.uk/id/eprint/5191/202832_thinkingaboutregionalcompetitiveness2005.pdf
- Martin R, Cambridge Econometrics and Ecorys-Nei (2003) A study on the factors of regional competitiveness: report for the European Commission DG Regio. Available at: https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/3cr/competitiveness.pdf
- Murawska A (2010) Klasyfikacja województw pod względem rozwoju gospodarczego za pomocą metod taksonomicznych. *Studia i Materiały Polskiego Stowarzyszenia Zarządzania Wiedzą* 33:211–221
- Parkinson M et al (2006) State of the English cities, social research (NatCen). Office of the Deputy Prime Minister Publications, London
- Pessoa A (2013) Competitiveness, clusters and policy at the regional level: Rhetoric vs. Practice in designing policy for depressed regions. *Regional Sci Inquiry* 5(1):101–116
- Ponikowski H (2004) O miernikach konkurencyjności regionalnej. *Roczniki Nauk Społecznych* 32(3):241–247
- Porter ME (2000) Locations, clusters, and company strategy. In: Clark G, Feldman M, Gertler M (eds) *The Oxford handbook of economic geography*. Oxford University Press, pp 253–274
- Porter M (2001) Porter o konkurencji. *Polskie Wydawnictwo Ekonomiczne*, Warszawa
- Porter ME (2003) The economic performance of regions. *Reg Stud* 37(6&7):549–578. <https://doi.org/10.4324/9780203607046>
- Reinert E (1995) Competitiveness and its predecessors—a 500-year cross-national perspective. *Struct Chang Econ Dyn* 6:23–42
- Siudek T, Zawojska A (2014) Competitiveness in the economic concepts, theories and empirical research. *Acta Scientiarum Polonorum Oeconomia* 13(1):91–108
- Storper M (2008) Community and economics. In: Amin A, Roberts J (eds) *Community, economic creativity, and organization*. Oxford University Press, New York, pp 37–68
- Strahl D (2002) Klasyfikacja regionów Polski ze względu na poziom konkurencyjności na tle regionów Wielkiej Brytanii. In: Jajuga K, Walesiak M (eds) *Taksonomia. Klasyfikacja i analiza danych – teoria i zastosowania*. Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław, pp 41–51
- Strahl D (2004) Wykorzystanie wskaźnika Herfindalha-Hirschmana do oceny konkurencyjności regionów. In: Rapacz A (ed) *Konkurencyjność regionów i przedsiębiorstw*, 1043rd edn. Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław, pp 11–20
- Strahl D (2006) *Metody oceny rozwoju regionalnego*. Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław
- Surówka A (2014) Konkurencyjność województw Polski Wschodniej na tle regionów Unii Europejskiej w świetle badań własnych. *Nierówności Społeczne a Wzrost Gospodarczy* nr 39(3/2014):394–407
- Szafranek E (2010) *Determinanty konkurencyjności regionów. Ujęcie teoretyczne i empiryczne*. Studia i monografie nr 443. Wydawnictwo Uniwersytetu Opolskiego, Opole
- Tuziak A (2018) State regional policy and globalization: dimensions of competitiveness and development of regions. *Zeszyty Naukowe Politechniki Śląskiej, Organizacja i Zarządzanie* 129:605–620
- Winiarski B (1999) Konkurencyjność: kryterium wyboru czy kierunek strategii i cel pośredni polityki regionalnej? In: Klamut M (ed) *Konkurencyjność regionów*. Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław, pp 9–20

Drivers of Market Cartelisation on the Example of Bid-Rigging – Case Study



Lukasz Ziarko and Justyna Wiktorowicz

1 Introduction

A cartel is a market strategy adopted by competitors (independent companies), where cooperation replaces actual or potential rivalry (OECD 2012, p. 7). The main objective of the collusive rivals (the cartelists) is to make additional profits, which would not be possible under competitive conditions. Usually, a collusive arrangement consists of fixing prices, limiting supply on the market (setting production quotas), allocating products or customers and manipulating bids (UOKiK 2017, pp. 12–13). The rivalry is considered to be an essential factor in the efficient allocation of scarce resources (Stucke 2013, p. 165). The distortion of competition, among other things by forming cartels, leads to public harm. The higher costs of the goods and services resulting from the conspiracy are primarily borne by the purchasers (including public authorities), but ultimately by the consumers.

The competition process is essential for the public procurement system. It should be stressed that unrestricted competition, non-discrimination and transparency have been identified as fundamental principles of this system (in Poland, adequate regulations are included in (Procurement Law 2004, Article 7.1). The open tender procedure as the primary procedure for selecting the contractor (Procurement Law 2004, Article 10.1). Any deviations from these rules are generally prohibited. Possible exceptions are only possible under specific conditions, as in the case of direct award (monopolies) or in-house award (own resources). As a result, the public procurement rules allow the contracting authority to reject tenders that distort fair competition. In particular, bids submitted by participants in collusion may be rejected (Procurement Law 2004, Article 24.20).

Ł. Ziarko (✉) · J. Wiktorowicz
Department of Economic and Social Statistics, University of Lodz, Łódź, Poland
e-mail: lukasz.ziarko@uni.lodz.pl; justyna.wiktorowicz@uni.lodz.pl

What types of actions can be described as distorting competition is determined by competition law? In particular, it is determined by the provisions of the Competition and Consumer Protection Act. Interpretation of these provisions is shaped by the decision-making practice of the competition authority and by the judicial rulings. Competition law provides that an agreement will be considered anticompetitive if it contains reciprocal agreements on the terms of offers, prices in particular (Competition Protection Act 2007, Article 6.1.7). However, not all forms of agreements between contractors can be classified as anticompetitive. The first example of such a case is a consortium. The consortium is a legitimate type of cooperation between independent companies in public tenders (PPL 2004, Article 23.1). If a contractor is not able to submit a tender corresponding to the contract notice on its own, a joint tender may be drawn up by two or more contractors (The President of the OCCP 2012). Also, any agreement (including a cartel) may be exempted from the general prohibition of restrictive agreements. If it meets the four cumulative conditions set out in Article 8.1 of the Act on Competition and Consumer Protection,¹ is considered as not infringing the competition rules.² In both cases, the burden of proof lies with the undertakings that cooperate. In this paper, such a perspective is omitted – we are focusing on the contractors' cooperation other than described in Article 23.1 of the Polish Public Procurement Law.

The aim of this paper is identifying possible reasons for the bid-rigging functioning and its “stability”.

In this context, the following research questions were posed:

- What are the characteristics features of a collusive behaviour?
- How can collusion between bidders be identified?

2 When the Cartels Appear

Cartel theory identifies four main parameters that determine the conditions for stable collusion: the structure of the market, its transparency, the degree of competition between its potential participants and the nature of trade (Cabral 2000). Collusion is possible only in markets that are subject to competition between at least two rivals. Therefore, the problem of conspiracy does not exist in monopolised markets. Microeconomics provides evidence that the closer the market structure is to an ideal competitive model, the less impact on price and output has a single supplier (e.g. (Mankiw 2008), p. 66). Therefore, in a competitive environment, any efforts to raise prices or restrict sales by one or a few market players will be counterproductive.

¹These are: economic efficiency of the cooperation, no risk of eliminating competition from a substantial part of the market, consumer participation in the benefits of the agreement and no unnecessary restrictions.

²Such an agreement must contribute to improving the production or distribution of goods, not afford the possibility of eliminating competition, allow all parties to the agreement and buyers to share the benefits, and not impose undue restrictions on the parties to the agreement.

Thus, from a market point of view, a collusive strategy can only be implemented in nonmonopolistic markets with a limited number of competitors.

A cartel operates for profit. The total profit of collusion will be comparable to the gain of a hypothetical monopolist operating under the same demand conditions (Perloff 2012, p. 439). Therefore, the cartel's profit will be the highest in the case of two colluding companies. Any increase in the number of entities will proportionally reduce their earnings. It will also reduce their willingness to enter into such an agreement. A smaller number of participants in the deal also helps to define common objectives for such a project. Moreover, the cartel must capture a substantial part of the supply. Actual or potential competition minimises the ability of the cartel to operate effectively and achieve its objectives (Morozov and Podkolzina 2013, p. 21). Thus it is reasonable to assume that the higher the market concentration, the easier it is to establish and implement a collusive strategy.

An essential element for the success of a cartel strategy is the loyalty of the cartelists to the agreed arrangements. Nevertheless, a cartel member shows a natural tendency to deviate from the accepted rules (Wachs and Kertész 2019, p. 1). Given that all participants know the common strategy (at least each participant's prices and sales volume), each member may try to take over the market, for example by setting his price below the agreed level. As soon as the profit obtained from the deviation exceeds the expected profit from the conspiracy, the cartel becomes unstable. Then none of the participants will be motivated to act as agreed. The effectiveness of a disciplinary tool requires inevitable penalties and severe sanctions, making deviating from a common strategy less attractive (Harrington 2006).

Another issue is the similarity between the participants. This issue applies to production capacity, the size of the service and distribution networks or sources of supply. Such similarity makes it more likely that the cartel rules will be acceptable to all participants (Gupta 2001). Moreover, incurring similar costs may be necessary for the disciplinary system. If cartel members bear relatively equal costs, the effectiveness of the deterrence mechanism increases. However, if the costs of these undertakings vary, the operator with lower one will be less vulnerable to the risks arising from such a threat. It will, therefore, be more prone to deviate from the agreed arrangement.

Next critical factor is the scope of potential cooperation (Cabral 2000, p. 130). As the number of areas where competition between cartelists takes place increases, the opportunities to adopt a common strategy are more attractive. Increasing the number of cooperation nodes also reduces the tendency to deviate from the arrangements. The value of the potential losses incurred as a result of a disciplinary mechanism for many markets reduces the attractiveness of individual short-term profits. The loyalty of the parties is further enhanced by differences in market power in different areas. The need to balance forces will increase the stability of the cartel by the need to maintain a range of business connections. Establishing cooperation in additional areas will, therefore, strengthen the stability of the joint arrangements.

The willingness to cooperate in the form of a cartel may also result from specific market conditions, especially concerning prices. If the traditional business model or regulatory requirements increase market transparency, supervision of the implementation of joint arrangements will be considerably simplified. This conditions

may include obligations to publish price lists, transaction prices, tariff commitments or financial reporting obligations. Furthermore, purchaser rights may be subject to specific legal protection. For example, the case in public procurement, where the possibility to change conditions during the contract period is limited. Such a rule increases the risk of disclosure of possible deviations from the joint agreement and strengthens its stability.

The transparency of the market, its structure and the characteristics of competitors create favourable conditions for a conspiracy. However, these cannot be considered as direct evidence of a cartel.

3 Methods of Disclosing the Collusion

The knowledge of the features distinguishing anticompetitive collusion from the other types of companies' cooperation is crucial to identify the cartels. Based on these features, the measures of disclosing the collusion were established. The primary classification of methods for identifying anticompetitive cooperation is presented in the OECD report of 2014. Two groups of test methods were distinguished: structural and behavioural (Huber and Imhof 2018; OECD 2014). Structural methods are designed to estimate the likelihood of a collusive outcome based on structural market characteristics. They include analysis of market concentration, asymmetry of market structure, scale and importance of entry and exit barriers, demand characteristics and supply-side factors (Abrantes-Metz and Prewitt 2015). The latter methods aim to examine the behaviour of competitors in tenders. These methods focus in particular on prices, changes in sales volumes, market shares and bidding activity.

Structural methods usually involve examining inter-market and cross-sectoral dynamics. Findings are made based on changes in structural parameters over time or between tenders. These methods can, therefore, be used as the first element of analytical models, narrowing the list of areas for in-depth analysis. Three main groups of factors that can act as markers of collusion are structural factors and supply and demand factor (OECD 2014). The following table lists selected factors and markers (Table 1).

Behavioural models are intended to assess the parameters indicating the existence of one of the three collusive models: bid withdrawal, bid rotation, courtesy offers and profit-sharing mechanisms (Bergman et al. 2019). Collusive risk factors have been divided into three groups: prices, bidding patterns and market dynamics indicators. The table below lists the factors and markers used in behavioural methods (Table 2).

These methods are further developed and supplemented by the conclusions from the analysis of actual cases conducted by competition authorities and courts. In this paper, we concentrate on the second group – the case study include the chosen behavioural methods. This study is an attempt to provide evidence to justify the extension of the latter group of methods to include bidder interdependency markers.

Table 1 Parameters for assessing the risk of collusion in public procurement – structural methods (own work based on (OECD 2014))

Factor	Marker
Market structure	N° of competitors
	Barriers to entry/exit
	Intensity of competition
	Inter-market dynamics
	Market transparency
Demand-side of the market	Product life cycle phase
	Costs structure
	Marginal costs
	Production capacity
	Total output
	Products substitution
Supply-side of the market	The structural linkage between competitors
	Supply level
	Supply dynamics
	Buyers countervailing power
	Price elasticity

Table 2 Parameters for assessing the risk of collusion in public procurement - behavioural methods

Factor	Marker
Prices	Volatility of prices
	The relative difference – The first and second offer
	The relative difference - the third and subsequent offers
	Skewness of distribution
	Relative price differential
	Conformance with Benford's law
Pattern of behaviour	Probability of winning
	Regularity in winning
	Change in the number of tenderers
	Regularity in losing
Intensity of competition	Market concertation
	Stability of the market structure

Own work based on (Comanor and Schankermann 1976; Abrantes-Metz et al. 2011; Fazekas and Tóth 2016; Imhof 2017)

4 Materials and Methods

This analysis was based on the data regarding publicly available administrative decisions of the President of the Office for Competition and Consumer Protection (pl: UOKiK) related to the identified and proved bid-riggings in Poland. In the period from January 2003 to May 2017, these decisions included 323 tenders. They concerned about 30 different categories of the subject of the contract (for example seasonal maintenance services for roads and bridges, cleaning services for institutional customers, construction and renovation of residential buildings, roads and paths, transport services, operation of the Road Information Point, the supply of rabies vaccines, forest management services or solid waste disposal services). If a particular contract was divided into lots, each lot could be considered as a separate tender (item). In the analysed period the tenders in identified bid-rigging involved 589 contractors, 191 of whom were suspected of participating in a bid-rigging. As a result of the OCCP's investigation, 137 of them were found guilty.

In this paper case study of one bid-rigging proceeded by the President of the OCCP was described. The analysed cartel operated on the market for the supply of bakery products to institutional customers, such as educational institutions, medical institutions, or military units located in the south, east, and centre of Poland (The President of the OCCP 2013; The President of the OCCP 2016; The President of the OCCP 2015). Five entrepreneurs took part in the cartel: Młyn Malinie General Partnership (further: company A), Młyn Malinie Dziewit Limited Liability Company (further: company B), Stanisława Dziewit (further: company C) - conducting sole proprietorship, FPHU Tomex Stanisław Dziewit (further: company D) and FPU Natex Sylwia Graniczka (further: company E).

The case that we analysed drew our attention with the high stability of the agreement. In particular, the fact that despite its disclosure and sanctioning 2013, the cartel operates up to 2015, covering at least 23 tenders. Compared to other cartels revealed in Poland, the period during which the conspiracy performed is distinguished by its length. The average duration of the cartels exposed between 2008 and 2019 was approximately 15 months (median of 5 months),³ and the cooperation covered an average of 5 tenders. Apart from the case in question, only five other cartels operated for about 2–2.5 years.⁴

³Calculations based on the available information in the decisions of the President of the OCCP on the date of the notice of intended contract award and the date of the contract award. Such a set of information applies to 66% of the analysed tenders.

⁴Apart from the case in question, only five other cartels operated for about 2–2.5 years.

5 Baker's Cartel – Case Study

Companies identified as cartelists had business relationships. The shareholders of company B were Stanisława Dziewit, the owner of company C (40% of shares) and Artur Dziewit (60% of shares), who were also the partners in company A. Capital and business relations between those two entrepreneurs and facts described below suggest that the last remaining businessmen played a crucial role in the functioning of the discussed collusion. An essential element is also the fact that cartelists are a part of one family - husband and wife and their children. Although each of the three decisions of the competition authority was addressed to different companies from the above list, there are clear grounds for considering that the activities of all four persons constituted a single cartel strategy – arguments of this thesis were presented in this case study.

The attention of the President of the OCCP to the activities of companies A and C was drawn back in the second quarter of 2012 (The President of the OCCP 2013). At that time, the ordering party – the Health Care Centre in Dębica - identified a suspicious manner of operation of these entrepreneurs in one of the tenders. In the tender for the delivery of bakery products, company A and company C submitted bids that were ranked first and second, respectively. It should be noted that the price in the company's C offer was 9.8% higher than the amount from company A (approx. PLN 22,0 k). After announcing the results by the Health Care Centre, company A refused to sign the contract without giving any reasons. At the same time, company C applied (twice) to the contracting authority with the request to conclude a contract. The action of the contractors drew the attention of the contracting authority, as it did not inform anyone about the company A decision before. They concluded that both contractors had to exchange information about their actions undertaken in this tender. Because of doubts as to the compliance of these contractors with the competition rules, the contracting authority annulled the procedure and notified the competition authority of suspected bidding conspiracy.

Analysis of the offers of both company C and company A revealed, among others, the similarity of signatures indicating that the same person could have prepared the proposals, similar language errors and layout of documents, the same contact telephone numbers and dates in both offers. An in-depth analysis of the relationship between the cartel participants revealed that aside from family ties, they also had strong economic relations. The owner of company C admitted that her son and husband (represented other companies in an analysed cartel) helped her in running her business (run as a sole proprietorship). Both company C and company A operated in the same locations, including an industrial mill, warehouses, a bakery plant and the utilities necessary for the production and distribution of bread such as vehicles and means of production. They also shared some employees. The President of the OCCP Protection identified fourteen such tenders.

The investigation covered only three of them. The remaining ones were not included in the inquiry, because neither company C nor company A was placed the first and second position in them. It is to be assumed that the competition authority

could not, in the case of these tenders, identify a pattern of behaviour specific to a collusive bidding arrangement.⁵ The recognised scheme of conduct of this cartel was that if company A or company C take first or second place in the ranking (their offers will be the lowest), then the winner refuses to sign the agreement. As a result, the contracting authority will have to select the contractor who took the next (second) position. Thus, the cartel will obtain an additional profit in the amount of the difference between the submitted bids. The investigation made by the President of the OCCP ended with a finding of infringement by company C and company A of competition on the market of bakery products supplies to institutional customers. It was found that the collusion covered three tenders, which took place in the second quarter of 2012. Company C was charged with the fine of PLN 1308 and company A with the penalty of PLN 88,067.

The second decision of the antitrust authority was related to actions taken by company B and company E (The President of the OCCP 2015). The investigation covered ten tenders conducted in the period from the fourth quarter of 2013 to the second quarter of 2014. The cartel activities were considered in relation to 10 proceedings. The antitrust authority also revealed about eighty tenders in which bids were submitted only by company E or only by company B. As in the previously described case, the competition was distorted on the market of supplies bakery products to institutional customers.

The strategy adopted by company B and company E was unchanged concerning the above described, i.e. including refuse to conclude a contract by not responding to the call to sign the contract or by submitting a decision to withdraw from a deal. Also, the economic relations between company E and company B were as strong as between company A, company C and company B in 2012. The majority shareholder of company B used to sign the offers put by company E. What is more, the proposals of both companies included price forms filled in the same way. On the one hand, company E used the infrastructure of the company B (production capacity, cars, telephone, fax). On the other, company E was a creditor of company B. Company E repaid the liabilities of this company that has been ruled in the enforcement proceedings. In at least one tender, the same person (an employee of company B) was submitting offers from both companies. In one of the contracts, company B transferred all its rights and obligations from the agreement to company E, even though the last one firm submitted the lowest bid but withdrew from signing the contract. When refusing to sign the contract with the ordering party, the entrepreneurs pointed out economic reasons (loss of orders in the area of the ordering party) or the absence of the owners because of medical issues or holiday leave. Such explanations are not

⁵From the objective of fighting cartels, this activity of the competition authority can be assessed negatively. By deviating from the accusation where the cartelists' strategy was ineffective, the competition authority behaves as if no distortion of competition had occurred. However, such an interpretation is inconsistent with the legal provisions (see Article 6(1) of the Law on Competition and Consumer Protection) which provide that an agreement is prohibited by object or effect. Thus, even if the agreement does not have a market effect, the mere fact that the cartel members have set a common objective is already a prohibited and sanctionable act.

credible in the case of an entity running a professional business activity, which should have clarity on how to organise work during the absence of managers or on the manner of appointing proxies. It should also be noted that the offers submitted by each of these entrepreneurs were economically rational. If one of them took the first place and the offer of another one was placed on the third or further places, he entered into the contract under the offered price. The President of the OCCP found the collusion between company E and company B to be anticompetitive and imposed penalties of PLN 21,322 and PLN 109,127 respectively on these entrepreneurs.

The third and the last decision of the President of the OCCP was related to cartel's activities in the period third quarter of 2014 – the first quarter of 2015. The investigation of the anti-monopoly authority covered two already known companies, i.e. company E and company C and company D, not yet involved in the cartel. The strategy of the cartel has changed. Since then, the cartel has started the coordination of three rather than two entities and introduced a new method of influencing the outcome of the tender. If the conditions for the order of tenders were met (the cartelists made two or three best bids), they initiated the rejection of the winning bid or two lowest bids by the contracting authority itself.

The revised strategy used the fact that the incomplete offer was rejected from the procedure. Cartelists started to submit lower-priced proposals without the required documentation (e.g. tax clearance certificates or proof of payment of other public duties), which resulted in the rejection of these bids from the procedure. In this way, members of the cartel were able to influence the final decision of the contracting authority, enhancing their chances for higher profits. Cartel strategy was successful in six out of ten tenders. In four proceedings, they failed to take the first two or three positions in the ranking. The competition authority found company E, company D and company C to be responsible for the breach of the competition law and fined them with PLN 22 807, PLN 6 574 and PLN 6 049 respectively.

Summarising the above findings, the cartel was set up by five companies owned by persons linked by family ties. Although the history of this collusive arrangement has been covered by three separate decisions of the competition authority, it can be concluded that all these entities pursued a common cartel strategy. The role of company B seems to be significant to this conspiracy. It was directly or indirectly involved in all other companies' activities. The recurring pattern of behaviour of these companies in tenders may also prove this claim.

The elements connecting the parties to the cartel were family and economic dependence, mainly on company B. In the period from the second quarter 2012 to first quarter 2015, the cartel participated in 24 tenders with a total order value of nearly PLN 2 m. In 78% of the cases, the contracts were concluded by a cartel member who was ranked as the second or third. The cartel made a PLN 135,724 unfair profit. As a result of this cooperation, the price paid by the ordering parties was 7% higher than the price, which could be obtained in a competitive environment. An average of 4 contractors took part in the tenders in question. In 67%, cartels had at least one competitor, with a maximum of 7 additional bidders. Apart from tenders in which the cartel issued two or three offers, the Dziewit's family companies took part individually in other proceedings. There were at least eighty such

cases. Such market activity is unusual for a cartel. Usually, it may indicate its ineffectiveness (cartelists deceive each other) and the weakness of the disciplinary system. The above may suggest that the stability and effectiveness of the Bakers' Cartel were caused by a high level of mutual trust or a lack of ability to make independent decisions.

The total fine imposed on participants in the conspiracy amounted to PLN 255,254, i.e. exceeded the cartel profit by approximately PLN 120 k. It cannot be ruled out that this specific project brought about a loss in general. Such a behaviour is also unusual for a cartel. In addition to the costs related to the loss of reputation due to the disclosure of illegal activities, the fines exceeding the fraudulent profit should break the cartel (Ni and Guan 2013). Hence the conclusion that the strategy adopted by the Dziewit family was stable due to their low sensitivity to changing external conditions.

6 Discussion and Conclusions

The case study discussed in this paper refers to proceedings in which bid-rigging is proved. The President of the OCCP's decisions were made based on a detailed analysis of source documents relating to particular tenders and information obtained from the parties and other participants of the proceedings. The published decisions contain a broad justification of the OCCP's position, concerning factors important for testing the applicability of bid-rigging markers. The analysis of the possibility of applying selected methods of their identification may, therefore, be conducted ex-post. However, the ex-post analysis also has its weaknesses. Considering that the information comes from the activities of the disclosed cartels, there is a risk that these were the least effective cartels - either conceptually or in terms of management. Moreover, data from public authorities may not include full information on the motives or behaviour of the parties to these agreements. Nevertheless, there is a lack of alternative data sources to check the usefulness of the selected bid-rigging markers, which is why this approach has been chosen.

In the paper, the focus is on selected behavioural markers, especially those relating to the analysis of the pattern. These are simple measures that characterise the activity of performers: the probability of winning, cyclicity of wins, reduction in the number of bidders and repeatability in the submission of bids by companies that are continually losing the race for the contract. Nevertheless, according to the practice of competition authorities, it is particularly useful to use simple methods of analysis that are based on publicly available data and methods that does not require specialist knowledge (Imhof et al. 2016, p. 3). Moreover, the data on the degree of competition in the tenders analysed by the competition authority suggests that the applicability of structural methods is limited to sectors with a strictly oligopolistic structure and stable market shares. The high volatility of the number of firms bidding in the markets with less concentrated structures makes the practical application of structural methods significantly more difficult (Imhof 2017, p. 9).

As we have presented, in the case of the bakers' cartel, the competition authority's analysis focused on an analysis of the pattern of behaviour of the companies of the Dziewit family members. Two markers of collusion were critical to the OCCP's investigations: frequency of winning and withdrawing from signing the contract with the contracting authority. They were enough to expose the collusion, but not enough to curb the bakers' cartel.

The analysis' results confirm that the existence of a strong personal or economic relationship between competitors may facilitate the formation of the cartel and strengthen its stability. The impact of other forms of dependence between entrepreneurs (transactional, strategic, organisational) on the level of risk of market cartelisation cannot be excluded either. The conditions supporting the cooperation of cartelists have been identified by the intensification of competitive links between them. The links can be understood as the number of markets under conspiracy or the scale of activities subject to joint arrangements. Similar rules were indicated as one of the main success factors of the European cement cartel - the close business connections between the managers and the companies made cooperation easy to achieve, as social events and personal ties were part of building networks (Dahlström 2019). The facts and arguments presented in this study make it possible to supplement the list of factors used in behavioural collusive identification methods. These factors should take into account the business, personal and capital links existing between competitors bidding for the same contract.

The survey also revealed a shortage of public information regarding data on bidders. The analysed decisions indicate that the system of general statistics lacks a source of information on details of tender procedures, including the names of contractors, their offers, rejected bids or companies that refused to conclude a contract with the contracting authority. Access to this information is key to the ability to contract bodies to manage the risk of fraud. Access to this information is essential for the strength of the contracting authorities in managing the risk of fraud. Activating this group of market participants in the fight against bidding cartels could significantly increase the disclosure of collusion.

References

- Abrantes-Metz RM, Prewitt E (2015) Antitrust compliance 2.0: The use of structural analysis and empirical screens to detect collusion and corruption in bidding procurement processes. *CPI Antitrust Chronicle* 2
- Abrantes-Metz RM, Villas-Boas SB, Judge G (2011) Tracking the Libor rate. *Appl Econ Lett* 18:893–899. <https://doi.org/10.1080/13504851.2010.515197>
- Bergman MA, Lundberg J, Lundberg S, Stake JY (2019) Interactions across firms and bid rigging. *Rev Ind Organ*. Springer US. <https://doi.org/10.1007/s11151-018-09676-0>
- Cabral LMB (2000) Introduction to industrial organization, 1st edn. Massachusetts Institute of Technology, Cambridge
- Comanor WS, Schankermann MA (1976) Identical bids and cartel behavior. *Bell J Econ* 7:579–584. <https://doi.org/10.1525/sp.2007.54.1.23>

- Competition Protection Act (2007) Act of 16 February 2007 on competition and consumer protection, Competition Law. 2007. Journal of Laws of 2007, N° 50, item 331, with subsequent changes
- Dahlström M (2019) The foundations of cooperation: building cartels in the Nordic cement industry and beyond, 1890–1947. *Scand Econ Hist Rev*:1–15
- Fazekas M, Tóth B (2016) Assessing the potential for detecting collusion in Swedish public procurement. Swedish Competition Authority Commissioned Research Reports 2016
- Gupta S (2001) The effect of bid rigging on prices: a study of the highway construction industry. *Rev Ind Organ* 19:453–467. <https://doi.org/10.1023/A:1012568509136>
- Harrington JE (2006) How do cartels operate? *Found. Trends Microecon* 2:1–105. <https://doi.org/10.1561/0700000002>
- Huber M, Imhof D (2018) Machine learning with screens for detecting bid-rigging Cartels. Working papers SES. University of Fribourg 494
- Imhof D (2017) Simple statistical screens to detect bid rigging. Working papers SES. University of Fribourg 484
- Imhof D, Karagök Y, Rutz S (2016) Screening for bid rigging-does it work? Working Papers SES. University of Fribourg, 468
- Mankiw GN (2008) Principles of microeconomics, 5th edn. South-Western Cengage Learning, Manson
- Morozov I, Podkolzina E (2013) No WP BRP 25/EC/2013, HSE working papers, National Research University Higher School of Economics
- Ni D, Guan X (2013) Governance of bid-rigging in the bidding. In: 19th international conference on industrial engineering and engineering management: Engineering management. Springer, Berlin/Heidelberg, pp 1213–1221. <https://doi.org/10.1007/978-3-642-38433-2-127>
- OECD (2012) Detecting bid rigging in public procurement. <http://www.oecd.org/competition/cartels/42594486.pdf>. Accessed 3 Feb 2020
- OECD (2014) Ex officio cartel investigation and the use of screens to detect cartel. <http://www.oecd.org/daf/competition/exofficio-cartel-investigation-2013.pdf>. Accessed 3 Feb 2020
- Perloff JM (2012) Microeconomics, 6th edn. Addison-Wesley, Boston
- Procurement Law (2004) Journal of Laws of 2004, N° 19, item 171 with subsequent changes
- Stucke ME (2013) Is competition always good? *J Antitrust Enforc* 1(1):162–197. <https://doi.org/10.1093/jaenfo/jns008>
- The President of the OCCP (2012) Decision N° RLU-38/2012, 31.12.2012. <https://www.uokik.gov.pl/download.php?plik=12682>. Accessed 3 Feb 2020
- The President of the OCCP (2013) Decision N° RKR-51/2013, 30.12.2015. https://decyzje.uokik.gov.pl/bp/dec_prez.nsf/0/FA06B6C2887DA214C1257EC6007BA448?editDocument&act=Decyzja. Accessed 3 Feb 2020
- The President of the OCCP (2015) Decision N° RKR-18/2015, 30.12.2015. https://decyzje.uokik.gov.pl/bp/dec_prez.nsf/1/A02A64D90760D7BBC1257F5D00586464?editDocument&act=Decyzja. Accessed 3 Feb 2020
- The President of the OCCP (2016) Decision N° RKR 10/2016, 30.11.2016. https://decyzje.uokik.gov.pl/bp/dec_prez.nsf/1/147BD237F4834FDFC12580B3004144E4?editDocument&act=Decyzja. Accessed 3 Feb 2020
- UOKiK (2017) Zmowy przetargowe. The President of the Office of Competition and Consumer Protection, Warsaw
- Wachs J, Kertész J (2019) A network approach to cartel detection in public auction markets. *Sci Rep* 9:1–10. <https://doi.org/10.1038/s41598-019-47198-1>

How Do Environmental, Social, and Governance (ESG) Factors Impact on Public Finance Performance? Risk, Efficiency, and Public Financial System Perspectives



Magdalena Ziolo, Beata Zofia Filipiak, Iwona Bąk, and Katarzyna Cheba

1 Introduction

The public sector is undoubtedly a sector predisposed to the impact of environmental, social, and governance (ESG) risk, but also a sector that can effectively manage this risk. ESG risk is a kind of risk determined by the impact of nonfinancial factors like environmental, social, and governance ones. Environmental and social changes that are taking place in the contemporary environment affect both the finances of enterprises and households and public finances. In particular, expenditure related to climate change, or expenditure related to social exclusion, or the financial consequences of an aging population are just some examples of the impact of nonfinancial factors on public finance. ESG risk affects both the expenditure and revenue side of public budgets, determining the risk of public debt related to the failure to achieve planned budget revenues or the need to incur higher than planned expenses. Public expenditure related to combating climate change is growing systematically, including fight smog, natural disasters, and the treatment of chronic diseases caused by environmental pollution. Social changes have financial consequences, social exclusion reducing tax revenues, and counteracting income inequalities implying adverse changes in terms of income and expenditure.

The crucial impact of financial factors on public finances and the growing importance of ESG risk for the efficiency of public sector operations make it necessary to take measures to mitigate ESG risk in the public sector. These activities include

M. Ziolo (✉) · B. Z. Filipiak

Faculty of Economics, Finance and Management, Szczecin, Poland

e-mail: magdalena.ziolo@usz.edu.pl; beata.filipiak@usz.edu.pl

I. Bąk · K. Cheba

Faculty of Economics, West Pomeranian University of Technology, Szczecin, Poland

e-mail: iwona.bak@zut.edu.pl; katarzyna.cheba@zut.edu.pl

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

A. Bem et al. (eds.), *Sustainable Finance in the Green Economy*, Springer

Proceedings in Business and Economics, https://doi.org/10.1007/978-3-030-81663-6_20

incorporating ESG risk into financial decisions taken in the public sector and designing an effective ESG risk management system. The inclusion of ESG risk in financial decisions requires accurate identification of risk factors and prioritization depending on the strength and direction of impacts. It is also important to recognize the relationships between ESG factors and to identify decision spheres sensitive to the impact of nonfinancial factors. Since ESG risk has an impact on the valuation of outlays and effects of activities undertaken in the public sector, it also has an impact on efficiency in the public sector. The comprehensive impact of ESG risk on public finance means that there is an urgent need to discuss how the public sector should effectively manage ESG risk to provide public services. In this regard, it is important to design a sustainable public finance system that will mitigate the impact of ESG risk on public finances.

This article attempts to identify nonfinancial factors that have the greatest impact on the public finance and public financial system, and to assess the impact of nonfinancial factors and associated risks on public finance efficiency. Considering these facts, the research questions addressed in this paper are as follows:

1. What are the crucial ESG factors impacting public finance?
2. What is the relationship between ESG factors and public finance?
3. What is the impact of ESG factors on risk and efficiency in public sector?
4. How can ESG risk in public finance be mitigated?

To this end, the paper comprises the following sections. Section 2 presents the impact of ESG factors on public finance from risk and efficiency perspective. The methodology is described in Sect. 3. Section 4 presents the results and discussion, while Sect. 5 concludes with the pertinent recommendations.

2 Impact of Nonfinancial Factors on Public Finance from Efficiency and Risk Perspective

Sustainable public finance is currently a hot topic in economic policy debate. This is because of the ongoing sovereign debt crises and the long-term public spending pressures caused by the impending demographic changes in developed countries. Theoretical criteria for sustainability are being examined. Several studies have analyzed the impact of ESG factors and nonfinancial factors and their impact on the public financial sector and decision-making in the public sector (Junaidi et al. 2012; Vasvári 2015; Schroer et al. 2018).

The concept of ESG is used in different contexts and has no single definition (Elbasha and Avetisyan 2018; Taliento et al. 2019); it is typically used to denote a set of relevant environmental, social, and governance-related elements that allow the assessment of long-term sustainability of investment or institutions (Bourghelle et al. 2009; Van Duuren et al. 2016) by integrating the traditional economic-financial parameters. In the United Nations Principles for Responsible Investment,

“Environmental, Social and Governance factors” refer to three different though related fields within “social awareness” (Taliento et al. 2019). The first factor—“the environment”—includes climate change, greenhouse gas emissions, exploitation of resources, waste, pollution, and deforestation. It is also associated with the decisions of public authorities in the field of environmental sustainability, which is associated with their responsibility and implemented tasks. In this regard, public authorities create instruments to influence the household sector, business, or institutions, which make them respect the principles of sustainability (Taliento et al. 2019; Filipiak and Wyszowska 2019).

The second topic deals with working conditions, health and safety, relationships with employees, and diversity (Schroerer et al. 2018; Taliento et al. 2019). The third factor involves corporate governance practices, including managerial compensation, the composition of the board, audit and control procedures, and behaviors in terms of compliance with the law of decision-making, transparency, and ethical principles and code of conduct (Van Duuren et al. 2016; Taliento et al. 2019).

In many cases, the direct and immediate economic benefit is missing in the public sector. An important public benefit is the concern for human life and quality of life. When we speak of efficiency, most analysts refer to economic efficiency, taken from the private sector and subjected to analysis in the public sector, in order to illustrate the so-called inefficiency of the latter (Mihaiu et al. 2010). Efficiency in the public sector must, therefore, be seen as an amount between the economic efficiency and the social environmental. From the point of view of the concern for human life and for quality of life, it becomes necessary to improve the quality of decisions, and this means that ESG factors should be included in the decisions of public authorities.

The inclusion of ESG risk in financial decisions requires accurate identification of risk factors and prioritization depending on the strength and direction of impact. It is also important to recognize the relationships among ESG factors and to identify sensitive decision spheres. Of the several available decision-making opportunities, the public authorities make use of some combination of the following criteria to reach an optimal decision that maximizes the objective function of the public system’s stability. For this purpose, the following considerations may be made by the public authority:

1. Financial criteria (Blanchard et al. 1990; Afonso 2005; Fatás and Mihov 2009; Wilson 2010; Afonso and Jalles 2014; Badinger and Reuter 2015; Woo and Kumar 2015; Bergman et al. 2016; Bostan et al. 2018)
2. Risk score (Scalet and Kelly 2010; Kapuscinska and Matejun 2014; Boniface 2016)
3. Nonfinancial criteria (Junaidi et al. 2012; Bostan et al. 2018; Taliento et al. 2019)

Public finance sustainability involves analysis and measurement of the existing relationship between public debt portfolios and financial capacity in sovereign treasury. There are different types of solvency and sustainability measurement in a public finance management system. These include budgetary insolvency, treasury illiquidity, service-level solvency, external treasury vulnerability, and public

debt-to-public finance (leverage) insolvency (Kouretas and Vlamis 2010; Alozie et al. 2017).

Risk, risk analysis, risk assessment, and risk management are all frequently used expressions in the public sector (not only in the business sector). However, the overall picture is mixed with regard to the interpretation of these concepts (Belyacz 2010; Aktas and Tiftik 2013; Vasvári 2015).

The risk concepts used in the public sector stand closest to what is known as the economic approach. They regard risk in negative terms in most cases, and applicable legal regulations require mitigating risk and taking effective measures to stabilize the financial system. During risk analysis, the probability of occurrence and potential impact of various risks are estimated, and any factors that may influence the risks are listed. There are essentially two kinds of methodology used to achieve this. Qualitative analysis, which determines risk severity levels, can be broadly used in the case of risks that cannot be quantified, but it is less exact and also includes subjective elements. The resolution of the quantitative analysis of specific quantifiable risks is much finer and has a mathematical background. Individual risks can be modelled by modifying the selected variables, which leads to more accurate risk values that are closer to reality.

It appears that increasing attention is now being paid to the link between decision-making of public authorities and qualitative factors, the so-called environmental, social, and governance (ESG) criteria. These supposedly soft factors have prompted renewed interest in the determination of the allocation of public funds and the choices of tasks carried out by public authorities (especially those that have a positive impact on environmental quality) (Scholtens 2010; Crifo et al. 2015; Van Duuren et al. 2016).

Nevertheless, if researchers observe that corruption—a key indicator of governance failings—and sovereign debt performance are clearly correlated, that social and political factors help to better assess a country's investment risk, the effect of environmental factors on sovereign bond spreads remains less noticeable. However, as noted by Decker and Woher (2012), the broader economic impacts of climate change, sustainable growth, large-scale environmental accidents, and national energy policies are decidedly macroeconomic. The most important nonfinancial factors (ESG), which are connected with research directions on factors affecting the sustainability of the public financial system, are presented in Table 1.

The results of research show a greater interest in environmental concerns, and social and governance issues in decisions made by public authorities. These supposedly soft factors have prompted renewed interest in the determination of the allocation of public funds and the choices taken by public authorities. Public authorities also operate under pressure from society, other shareholders, and financial institutions. The decisions of public authorities, taking into account the ESG outline, will have a significant impact on the types of instruments used in the framework of public policies, and as research shows, these are increasingly taking into account ESG factors. The survey provided formal proof that public authority decisions face critical and complex questions, and the way in which they manage stimuli and take decisions about financing public goods (public tasks) has a direct implication on the sustainability of the public financial system.

Table 1 The most important nonfinancial factors (ESG) in research directions on factors affecting the sustainability of the public financial system

Environment		Social		Governance	
Emissions and climate change	Bourghelle et al. (2009);	Business behavior	Escrig-Olmedo et al. (2010); Tsheletsane and Fourie (2014); Crifo et al. (2015); Avetisyan and Hockerts (2017); Schroeer et al. (2018); Escrig-Olmedo et al. (2019)	Transparency	Bourghelle et al. (2009); Tsheletsane and Fourie (2014); Crifo et al. (2015); Boniface (2016); Avetisyan and Hockerts (2017); Schroeer et al. (2018); Bostan et al. (2018); Escrig-Olmedo et al. (2019)
Industry-specific criteria	Decker and Woher (2012);	Community relations		Risk and crisis management	
Waste use, management, and reduction	Crifo et al. (2015); Bergman et al. (2016);	Customer relationship		Board diversity, management, and structure	
Renewable energy and raw materials	Schroeer et al. (2018);	Customer and product responsibility		Audit and control system	
Raw material sourcing	Bostan et al. (2018);	Human right criteria		Governance and respect of shareholders' rights	
Protection of biodiversity	Taliento et al. (2019);	Labor management		Anti-takeover policy	
Carbon intensity		Ethics and nondiscrimination		Antitrust policy	
Emission		Privacy and data security		Compensation policy	
Eco-efficiency		Responsible investing		Codes of conduct	
Eco-design		Social reporting		Prevention of corruption and bribery	
Environmental risk management		Protection of children, product safety, quality, and impact	Vision and strategy		
Environmental reporting		Respect of trade unions			
Protection of biodiversity		Human capital development and training			

Source: own elaboration

3 Research Methodology

In this paper, to study the relationships between various nonfinancial factors influencing public finance, a two-stage procedure was used. In the first stage, the identification of criteria that are most important for the design of sustainable financial systems was carried out. In the next stage, the identification of dependencies among ESG factors influencing public finance incorporated by public institutions in the decision-making process was made. For this purpose, a fuzzy cognitive map (FCM)

was used. The collective map elaborated on the basis of the opinions of experts participated in the study was built using the software FCMapper_bugfix_27.1.2016. In the literature, a detailed description of this method and its application in various areas of the research can be found. Most popular are the applications of this method in modelling processes and diagnosing various types of phenomena, including modelling knowledge representation and management (Taber 1991; Wei et al. 2008), political and social fields (Andreou et al. 2003, 2005), engineering and technology management (Lee and Han 2000), agriculture and ecological modelling and management (Papageorgiou et al. 2009; Tan and Ozesmi 2006; Isaac et al. 2009), and prediction (Song et al. 2010; Furfaro et al. 2010), and in medical decision support and classification tasks (Papageorgiou et al. 2008; Kannappan et al. 2011). In this paper (Papageorgiou 2012), the method was utilized to identify relationships between various aspects of the sustainable financial system, but considered from the financial institutions' perspective. It should be noted that the use of the map for this purpose will allow not only for the simple identification of the most important criteria but also for the identification of the relationships between the considered criteria and their relationship with a balanced financial system during this identification. In the procedure for determining a cognitive map, five main steps can be distinguished, as follows (Axelrod 1976; Cole and Persichitte 2000; Yastrebov and Slon 2011; Burn et al. 2014; Carlucci et al. 2018):

1. Preparation of an interview questionnaire
2. Selection of experts appropriate for the research
3. Identification of conditions in order to remove ambiguities and repetitions and to standardize the terminology
4. Establishment of cause and effect relationships with an indication of its nature for each relationship
5. The presentation of the results as a cognitive matrix, including average assessments of compound intensity, having a significance higher than average and a cognitive factor map

The basis of the research carried out at work was opinions collected from six experts representing public finance management scope, with long-term (more than 20 years) experience in the public sector as financial directors and financial managers in public companies and self-governed entities.

The selection of criteria of the highest importance for the target model was based on a list of starting criteria developed on the basis of the literature review, which are taken into account by financial institutions (in particular credit rating agencies) in the context of meeting sustainable development requirements. These criteria have been assigned to three areas: environmental, social, and governance. Experts were asked to evaluate a total of 62 factors, of which 21 represented environmental scope, 25 social scope, and 16 governance scope. The factors were determined based on a review of the literature, taking into account the ESG factors included in the methodology of the sustainable rating agencies. The task of the experts participating in the study was to determine both the strength of the impact of these criteria on the planned system of sustainable finances, and to give an indication of the direction of

Table 2 The main ESG factors incorporated by public financial institutions in decision-making process selected during the study

Environment	Social	Governance
Carbon intensity emissions (C1)	Human capital development & training (C11)	Audit and control system (C18)
Climate change (C2)	Exclusion of children labor (C12)	Prevention of corruption and bribery (C19)
Energy consumption (C3)	Respect of trade unions (C13)	Respect of shareholders' rights (C20)
Environmental policy management (C4)	Responsible investing (C14)	Antitrust policy (C21)
Environmental reporting (C5)	Social reporting (C15)	Transparency (C22)
Hazardous waste (C6)	Talent attraction/retention (C16)	
Pollution management/recourses (C7)	Work-life balance (C17)	
Travel and transport impact (C8)		
Waste management reduction (C9)		
Water use and management (C10)		

Source: own elaboration based on Escrig-Olmedo et al. (2019), pp. 11–12

this impact (positive influence versus negative). Thus, the experts participating in the study were able to make their assessments in a 5-point Likert scale, where 1 was the smallest influence, but positive for the studied phenomenon, and 5 the largest impact and also positive. If a criterion was assessed as negative, then the value -1 had the least negative impact on the planned system of balanced finances, and -5 had the largest negative impact.

The result of this stage of the research was a list of the most important criteria from the point of view of the designed system of sustainable finances. Only the criteria for which the average, calculated on the basis of the absolute values of the awarded points was the highest, were selected for the next stage. The results of this stage of the study were presented to the experts for verification. Finally, a list of key criteria in each of the analyzed areas is presented in Table 2.

4 Study Results

After the identification of the main factors affecting the public finance system, each stakeholder was asked to describe the existence and type of the causal relationships among these criteria and, then, the strength of the causal relationships-influences that may exist between these criteria. This phase was implemented in 11-grade scale, numbering from -5 to $+5$, capable of describing any kind of relationship between two factors, positive and negative, where -5 means negatively very strong

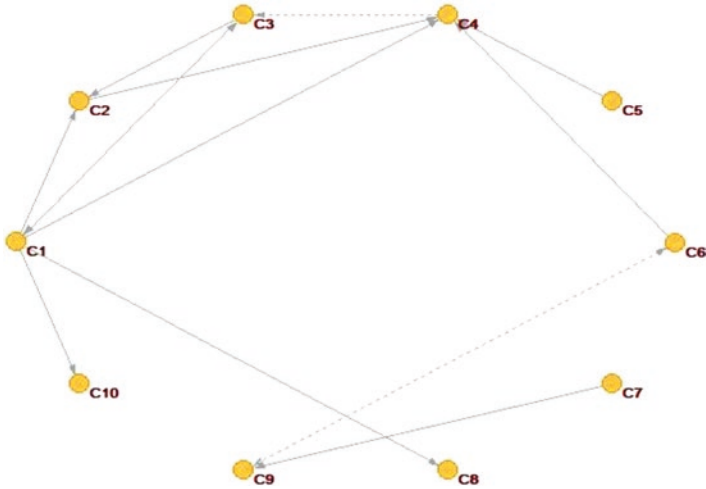


Fig. 1 The individual FCM describing environmental factors impacting on public finance

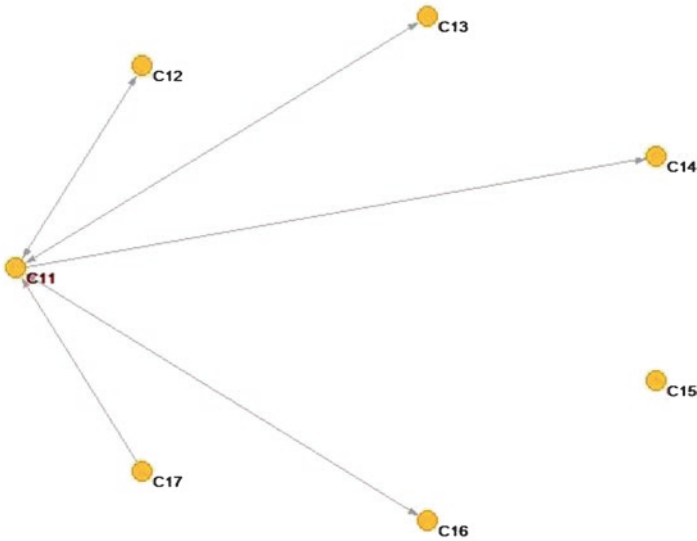


Fig. 2 The individual FCM describing social factors impacting on public finance

impact and 5 means positively very strong impact. The results of this step of the study were applied to develop a correlation matrix between the criteria. The relation identified between variables belonging to different areas presented on Figs. 1, 2, and 3 became the basis for FCM collective reconciliation, which is presented in Fig. 4. The map presents mutual relations and directions of influence between particular

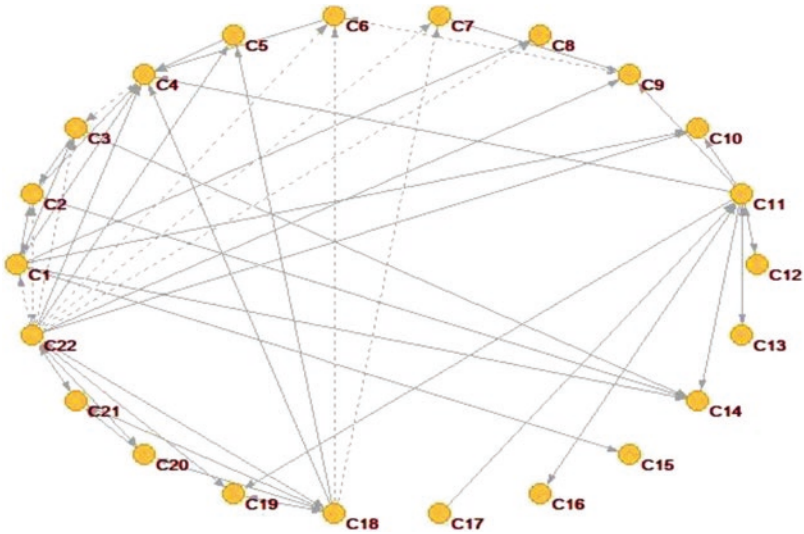


Fig. 3 The individual FCM describing governance factors impacting on public finance

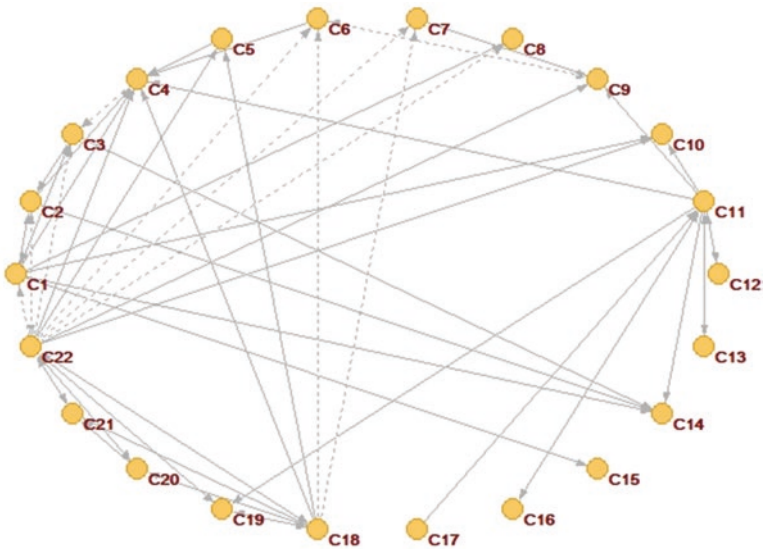


Fig. 4 The collective FCM describing ESG factors impacting on public finance

criteria (C1–C22) according to the relationships existing between 22 criteria selected for the study. The collective FCM is thus obtained (see Fig. 1 developed in Pajek software [<http://vlado.fmf.unilj.si/pub/networks/pajek/>] based on the calculation made in the software FCMapper_bugfix_27.1.2016).

As a result of the research carried out using fuzzy cognitive maps, the impact of environmental, social, and governance factors on the public finance system was confirmed. However, the analyses carried out showed a diverse impact and different patterns of the examined factors on the public finance. The strongest impact was observed in the group of environmental and governance factors, smaller in the group of social factors.

The general results of the study based on fuzzy cognitive mapping analysis are as follows:

1. In the case of the environment, it can be seen that the most important factor is the carbon intensity emissions variable, which is clearly linked to other variables from this area. This area also shows negative relationships among some variables, for example, between environmental policy management and energy consumption and waste management reduction and hazardous waste (Fig. 1).
2. In the social area (Fig. 2), relationships were found between human capital development and training and five other variables in this area. These are only positive relationships. Only one variable (15) was not connected to another, which means that in the opinion of experts, it is not related to any variables in this area.
3. Within governance, the connections are also only positive, that is, they have a positive impact on public finance (Fig. 3). Attention is drawn to two variables (18, 22), which are related to all variables in this area with very strong associations.
4. Relationships between variables belonging to different areas were also observed. A strong relationship exists between the variable carbon intensity emissions (environmental) and 2 variables from the social area (14, 15), and this is a positive relationship (solid line in Figs. 1 and 4); strong relationships also exist for variables 4–10 (environmental) with variable 14 (social) and human capital development and training (social) with the variable prevention of corruption and bribery (governance).
5. The least connections with other variables are shown by variables from the social area, for example, variable 15 is only related to variable 1 (environmental), and variables 16 and 17 only to the variable human capital development and training, that is, variables from the same sector.
6. The variable transparency from the governance sector deserves attention, as according to experts it positively impacts (and in most cases strongly impacts) all variables considered in the study.

Summing up the results of the study, it should be noted that experts have clearly highlighted the large impact of environmental variables on public finance, especially the system of public finance. Analysis of ESG factors showed that public finance is most affected by the environmental (ten risk factors), social (seven factors), and governance (five factors) factors. Such results reflect the specificity of public finance, which through so-called Musgrave public finance functions mitigate governance risk, hence there being fewest risk factors in this area. By definition, public finance must be transparent, which results from the function of public finance

and regulation. The environmental risk in public finance is a relatively new aspect. Governments will increasingly face the dilemma of how to manage this risk, even in the context of air pollution, which is a public need for quality of life and for the management of which the state is accountable to its citizens. Social risk related primarily to broadly understood inequalities is the responsibility of public finances and has an impact on them. Social risk means lower tax revenues and higher expenditures, and thus an increasing deficit and debt.

When carrying out an in-depth analysis of the research results, attention is drawn to the significant impact of greenhouse gas emissions on public finance. The public sector is aware of the costs created by the effects of greenhouse gas emissions and, therefore, through fiscal tools such as environmental taxes and eco-innovation expenses, is trying to create an environment-friendly to low-carbon solutions and technologies. The effects of environmental taxes are not explicit and are the subject of discussion in the literature, although there is yet to be a consensus regarding the effectiveness of environmental taxes on greenhouse gas emissions (Lin and Li 2011).

Studies have confirmed the relationship between environmental policy management and energy consumption, as well as waste management reduction and hazardous waste. A negative relationship indicates the effectiveness of environmental policy management in terms of the effects it brings in the area of energy consumption. The more effective the environmental policy management, the better the effects observed in energy consumption. In particular, this applies to energy consumption from renewable sources and the reduction of energy consumption from solid fuels. Similar effects are observed in waste management, the effects of which lead to a reduction of hazardous waste.

This study has shown a link between carbon emissions and responsibly investing and social reporting. This means that reporting on greenhouse gases and their impact and, thus, the disclosure of information on this topic affect the volume of these emissions, because it is very often associated with the risk of reputation of public enterprises, and thus affects their image. In turn, responsible investing relates to investments mitigating the negative impact of emissions or reducing greenhouse gas emissions, and due to the scale of the investment, very often it involves public or public-private funds. Therefore, responsible investing is an important element of the public finance system that reduces environmental risk.

Positive effects are noticeable in the area of governance. In particular, the key role is played by the transparency of activities as a variable mitigating the risk of corruption or lobby influence on financial decisions made in the public sector. The sphere of governance is related to the social sphere in terms of interaction with human capital development and training. This means that having an element of human resources policy in the public sector is a key element affecting staff awareness and limiting the risk arising from the governance factor.

The results of the study showed the dominant impact of environmental risk on public finances and the public financial system. Social risk is the second most influential, while governance risk is the least influential risk factor studied. This study showed that public policies and their management, in particular environmental policy management and waste management, prove to be an effective way to manage

environmental risk. Social reporting was another mitigating environmental risk factor. In turn, transparency was a key feature mitigating the risk of governance in public finance.

5 Conclusion and Recommendations

Many factors affect public financial decision-making. Increasingly, decision models for the public financial system from the market system are used. Governance must be analyzed in the context of public finance sustainability to achieve certain criteria such as transparency and stability.

Sustainability has been gaining momentum in recent years at the country and global level. This paper contributes to the literature by examining the impact of government ESG performance on efficiency and risk management in public finance. Pointing to the social and governance sectors, it is these factors that affect the quality of decisions, the scope of tasks carried out by public authorities, and the preservation of environmental sustainability and resources.

The survey provided evidence that the impact of environmental, social, and governance factors on the public finance system exists. However, the analysis carried out showed a diverse impact and different patterns of the examined factors. ESG factors affect the increase in the efficiency of the public financial system, as the quality and efficiency of public funds allocation improves. The limitations of the study are lack of prior research studies on the problem and lack of available data set.

The literature concerning the issue of public finance sustainability is limited and inconclusive. The link between the path to a sustainable fiscal system and some variables of ESG risk remain poorly studied. Our contribution to the research confirms that the strongest impact on public decisions comes from the groups of environmental and governance factors, with a smaller impact in the group of social factors.

In view of the above findings, we recommend the following:

- In order to increase effectiveness, it is necessary to implement transparency and to include efficiently operating audit and control systems. Transparency is an important factor in the stability of the financial system; hence, it is necessary for the sustainability of public finance system to ensure the transparency of decisions.
- The “social reporting” factor in social policies should be strengthened.
- The public sector should be aware of the costs created by the effects of greenhouse gas emissions and, therefore, using fiscal policy (environmental taxes and eco-innovation expenses), should try to create an environment-friendly to low-carbon solutions and technologies.
- In order to influence the quality of public authority decisions and the effectiveness of public allocations, efforts should be made to develop human capital and training (social aspect). This factor allows for a better understanding of public authorities’ decisions and implemented sustainability policies.

Finally, we can state that lack of efficiency in the public sector is a problem which most governments have to face. Taking into account ESG factors can have a positive impact on the efficiency of decisions and increase public finance stability, redistribution, and some public programs (tasks) which are based on performance objectives.

Acknowledgment Research results are a part of the project financed by the National Science Centre Poland, the grant OPUS13 no. 2017/25/B/HS4/02172.

References

- Afonso A (2005) Fiscal sustainability: the unpleasant European case. *Finanz Archiv* 61:19–44
- Afonso A, Jalles JT (2014) A longer-run perspective on fiscal sustainability. *Empirica* 41:821–847
- Aktas A, Tiftik ME (2013) Measuring fiscal sustainability for practical use in short-term policy making: evidence from Turkey. Leicester University. Research Paper Series.
- Alozie Ch E, Arumaologbede S, Arumaologbede J (2017) Measuring public finance sustainability and financial performance in Nigeria’s Federal Treasury. *Int J Gov Financial Manag* 17(2):1–18
- Andreou AS, Mateou NH, Zombanakis GA (2003) Evolutionary fuzzy cognitive maps: a hybrid system for crisis management and political decision-making. In: *Proceedings of the computational intelligence for modelling, control and automation*, Vienna, Austria, pp 732–743
- Andreou AS, Mateou NH, Zombanakis GA (2005) Soft computing for crisis management and political decision making: the use of genetically evolved fuzzy cognitive maps. *Soft Comput J* 9(3):194–210
- Avetisyan E, Hockerts K (2017) The consolidation of the ESG rating industry as an enactment of institutional retrogression. *Bus Strateg Environ* 26:316–330
- Axelrod R (1976) *The structure of decision: cognitive maps of political elites*. Princeton University Press, Princeton
- Badinger H, Reuter WH (2015) Measurement of fiscal rules: introducing the application of partially ordered set (POSET) theory. *J Macroecon* 43:108–123
- Belyacz I (2010) Risk or uncertainty? *Econ Rev* 17:652–665
- Bergman UM, Hutchison MM, Jensen SEH (2016) Promoting sustainable public finances in the European Union: the role of fiscal rules and government efficiency. *Eur J Polit Econ* 44:1–9
- Blanchard O, Chouraqui J-C, Hagemann RP, Sartor N (1990) The sustainability of fiscal policy: new answers to an old question. *OECD Econ Stud*:7–36
- Boniface O (2016) Financial risks management in public sector organisations. *Res J Finance Account* 7(1):94–106
- Bostan I, Toderascu C, Gavriluta AF (2018) Challenges and vulnerabilities on public finance sustainability. A Romanian case study. *J Risk Financial Manag* 11:55
- Bourghelle D, Hager J, Louche C (2009) The integration of ESG information into investment processes: toward an emerging collective belief? Working Paper; Vlerick Leuven Gent Management School: Ghent, Belgium.
- Burn I, Durif F, Ricard L (2014) E-relationship marketing: a cognitive mapping introspection in the banking sector. *Eur J Mark* 48(3/4):572–594
- Carlucci D, Ferreira F, Schiuma G, Jalali M, António N (2018) A holistic conception of sustainable banking: adding value with fuzzy cognitive mapping. *Technol Econ Dev Econ* 24(4):1303–1322
- Cole JR, Persichitte KA (2000) Fuzzy cognitive mapping: applications in education. *Int J Intell Syst* 15(1):1–25
- Crifo P, Diaye MA, Oueghlissi R (2015) Measuring the effect of government ESG performance on sovereign borrowing cost. *HAL* 2014-16:3–25

- Decker CS, Woher ME (2012) Substitutability or complementary? Re-visiting Heyes IS-LM-EE model. *Ecol Econ* 74:3–7
- Elbasha T, Avetisyan E (2018) A framework to study strategizing activities at the field level: the example of CSR rating agencies. *Eur Manag J* 36:38–46
- Escrig-Olmedo E, Muñoz-Torres MJ, Fernández-Izquierdo MA (2010) Socially responsible investing: sustainability indices, ESG rating and information provider agencies. *Int J Sustain Econ* 2:442–461
- Escrig-Olmedo E, Fernández-Izquierdo MÁ, Ferrero-Ferrero I, Rivera-Lirio JM, Muñoz-Torres MJ (2019) Rating the raters: evaluating how ESG rating agencies integrate sustainability principles. *Sustainability* 11(3):915
- Fatás A, Mihov I (2009) Why fiscal stimulus is likely to work. *Int Finance* 12:57–73
- Filipiak BZ, Wyszowska D (2019) Impact of green taxes on the public financial system – an example of European Union countries (2019). In: Ziolo M (ed) *Social, economic, and environmental impacts between sustainable financial systems and financial markets*. IGI Global, Hershey, pp 96–119
- Furfaro R, Kargel JS, Lunine JJ, Fink W, Bishop MP (2010) Identification of cryovolcanism on titan using fuzzy cognitive maps. *Planet Space Sci* 58(5):761–779
- Isaac ME, Dawoe E, Sieciechowicz K (2009) Assessing local knowledge use in agroforestry management with cognitive maps. *J Environ Manag* 43:1321–1329
- Junaidi J, Triyatni CS, Nurdiono N (2012) Financial and non financial factors on going-concern opinion. *Winners J* 13(2):135–146
- Kannappan A, Tamilarasi A, Papageorgiou EI (2011) Analyzing the performance of fuzzy cognitive maps with non-linear Hebbian learning algorithm in predicting autistic disorder. *Expert Syst Appl* 38(3):1282–1292
- Kapuscinska K, Matejun M (2014) Risk management in public sector organizations: a case study. *Int J Bus Manag Stud* 3(3):129–143
- Kouretas G, Vlamis P (2010) The Greek financial crisis: causes and implication. *Panoeconomies* 4:391–404
- Lee S, Han I (2000) Fuzzy cognitive map for the design of EDI controls. *Inf Manag* 37:37–50
- Lin B, Li X (2011) The effect of carbon tax on per capita CO₂ emissions. *Energy Policy* 39(9):5137–5146. <https://doi.org/10.1016/j.enpol.2011.05.050>
- Mihaiu DM, Opreana A, Cristescu MP (2010) Efficiency, effectiveness and performance of the public sector. *Rom J Econ Forecast* 4:132–147
- Papageorgiou EI (2012) Learning algorithms for fuzzy cognitive maps – a review study. *IEEE Trans Syst Man Cybern Part C Appl Rev* 42(2):150–163
- Papageorgiou EI, Spyridonos P, Glotsos D et al (2008) Brain tumor characterization using the soft computing technique of fuzzy cognitive maps. *Appl Soft Comput* 8:820–828
- Papageorgiou EI, Markinos A, Gemtos T (2009) Application of fuzzy cognitive maps for cotton yield management in precision farming. *Expert Syst Appl* 36(10):12399–12413
- Scalet S, Kelly TF (2010) CSR rating agencies: what is their global impact? *J Bus Ethics* 94:69–88
- Scholten B (2010) The environmental performance of Dutch Government Bond Funds. *J Bus Ethics* 92:117–130
- Schroerer LR, Forsgren KE, Chapman TA, Peterek GJ (2018) Through the ESG lens: how environmental, social, and governance factors are incorporated into U.S. public finance ratings. *S&P Glob Rat* 10:1–11
- Song H, Miao C, Roel W, Shen Z et al (2010) Implementation of fuzzy cognitive maps based on fuzzy neural network and application in prediction of time series. *IEEE Trans Fuzzy Syst* 18(2):233–250
- Taber WR (1991) Knowledge processing with fuzzy cognitive maps. *Expert Syst Appl* 2:83–87
- Taliento M, Favino C, Netti A (2019) Impact of environmental, social, and governance information on economic performance: evidence of a corporate ‘Sustainability Advantage’ from Europe. *Sustainability* 11:1738

- Tan CO, Ozesmi U (2006) A generic shallow lake ecosystem model based on collective expert knowledge. *Hydrobiologia* 563:125–142
- Tsheletsane I, Fourie D (2014) Factors hindering public financial management and accountability in South Africa. *Afr J Public Aff* 7(4):42–56
- Van Duuren E, Plantinga A, Scholtens B (2016) ESG integration and the investment management process: fundamental investing reinvented. *J Bus Ethics* 138:525–533
- Vasvári T (2015) Risk, risk perception, risk management. *Public Finance Q* 1:29–48
- Wei Z, Lu L, Yanchun Z (2008) Using fuzzy cognitive time maps for modelling and evaluating trust dynamics in the virtual enterprises. *Expert Syst Appl* 35(4):1583–1592
- Wilson C (2010) Why should sustainable finance be given priority? *Account Res J* 23:267–280
- Woo J, Kumar MS (2015) Public debt and growth. *Economica* 82:705–739
- Yastrebov A, Slon G (2011) Optimization and adaptation of dynamic models of fuzzy relational cognitive maps. In: Kuznetsov S, Slezak D, Hepting DH et al (eds) *Rough sets, fuzzy sets, data mining and granular computing - 13th international conference, RSFDGrC 2011*. Springer, Moscow, pp 95–102