André Dorsman · Wim Westerman
John L. Simpson *Editors*

Energy Technology and Valuation Issues

Springer

Energy Technology and Valuation Issues

André Dorsman • Wim Westerman •
John L. Simpson
Editors

Energy Technology and Valuation Issues

Springer

Editors
André Dorsman
Department of Finance
VU University Amsterdam
Faculty of Economics and Business Administration
Amsterdam
The Netherlands

Wim Westerman
Department of Finance
University of Groningen
Faculty of Economics and Business
Groningen
The Netherlands

John L. Simpson
School of Economics and Finance
Curtin Business School
Curtin University
Perth
West Australia
Australia

ISBN 978-3-319-13745-2 ISBN 978-3-319-13746-9 (eBook)
DOI 10.1007/978-3-319-13746-9
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2015931249

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

Various parties have long been interested in the efficient use of scare resources in the generation and provision of producer and consumer goods. Over time, the list of resources has been extended by some from land, labor, and capital to include materials, energy, and talent (entrepreneurial and managerial).

Policy makers and academics are interested in the effect of resources (like energy) that are subject to large (un)expected shocks in both availabilities, technological innovation and costs whose macro-economic (e.g., on Gross National Product, foreign exchange, and inflation) and wealth generation effects differ markedly both across and within countries and industries. To illustrate, North Sea discoveries consisting of liquid oil and natural gas have greatly benefited the economies of, particularly, the UK and Norway, and contributed to the desire among a sizeable minority for independence in Scotland. Energy development in Canada has shifted the relative growth from the provinces of Ontario and Quebec to fossil-fuel-producing provinces such as Alberta, Saskatchewan, and Newfoundland (a previous "have-not" province).

Practitioners, policy makers, regulators, capital suppliers, and academics are interested in the efficient determination of prices in over-the-counter and organized markets and the information that they reveal about future expectations, and about the effectiveness of using derivative products for managing various risks. Market prices for fossil-based feedstock and energy output can change quickly due not only to changes in the fundamentals but also to investor sentiment (e.g., fear) and speculative activity. To illustrate, the spot price FOB per barrel of Cushing, OK WTI through the major portion of the Global Financial Crisis went from 138.91 USD on June 26, 2008 to 43.69 USD on December 8, 2008 to 68.14 USD on June 24, 2009. Its subsequent recovery has been hampered by continuing weak demand and a rapid growth in new production. While the sustainability of the recent increased (resumed) production in Libya is highly uncertain due to political considerations, the more certain increased US production is due primarily to the rapid increase in light, tight oil production from horizontal drilling, and multi-stage hydraulic fracturing in shale formations.

Practitioners, capital suppliers, rating agencies, and academics in corporate finance and real investments are interested in the merits and managerial aspects (e.g., organizational design and boundaries, and commitment problems) of energy development. Energy firms and projects provide a rich laboratory for a study of these issues. Many energy projects (particularly, exploration, development, production, and transportation) have long lives, may require large capital investments and considerable financings, and may be "long shots." Since some energy firms report information that allows one to calculate the proportion of a firm's total reserves that remain undeveloped, this allows for empirical tests of the effects on value and risk of assets-in-place versus growth opportunities. Depending on the nature of their activities, some energy firms can respond to market conditions by deferring investment; or shutting down, contracting, restarting, or expanding operations. Furthermore, many of these projects are undertaken by various combinations of private and/or public entities (e.g., joint-ventures) so that the parties can combine their capabilities to create synergies, reallocate decision rights, or alter the nature of their agency relationships.

The returns from energy exploration, development, and transportation projects are subject to considerable uncertainty. One such uncertainty is the nationalization or confiscation of energy feedstock or the risk thereof, where an oil-producing country gains control of private property, often in violation of existing agreed-upon legal contracts that the government of the oil-producing country has deemed ex post as being overly favorable to the private-sector party. This can be achieved country-wide or on a project-by-project basis by outright transfer of ownership to a public entity that may be part of a cartel or through limitations on production and export prices or through royalty payments that may be onerous. While many countries extract royalty payments from fossil-energy producers, outrights transfer of ownership for fossil-fuel activities to generally state-owned entities has occurred in various countries such as Argentina, Bolivia, Brazil, Burma, Egypt, Indonesia, Iran, Iraq, Peru, Saudi Arabia (including a pipeline as compensation for Iraqi debts), Soviet Union, and Venezuela; for the land for hydro-electricity generation in countries such as China; and for the hydro-electric generator itself in countries such as Austria, Bolivia, Britain, Canada (Ontario, Quebec, etc.), and France. In some cases, this was followed by total or partial privatization, and in some cases once again followed by renewed nationalization. A more mild form of such uncertainties is that energy production, transportation, and distribution are generally subject to considerable regulatory oversight and regulatory uncertainty due to their importance or their monopolistic or oligopolistic nature. In Canada, various regulatory bodies regulate international, inter- and intra-provincial aspects of oil, gas, and electric utilities by establishing revenue requirements.

Concerns with energy provision include its interrelationship with political activity and its relation with corporate social responsibility (CSR) performance. Since a country's economy, natural security, standard of living, and the quality and sustainability of its environment are highly linked to its access to energy, energy supply has served as a basis for either political co-operation or conflict between countries. The US-led Iraq War has been criticized as a "war for oil." A more recent example includes Europe's (arguably) more-muted reaction compared to Canada to the territorial expansions of Russia. Casual observation would suggest that the difference is due to Canada's nondependence and Europe's large dependence on natural gas imports from the country with the world's largest natural gas reserves. Energy's negative contribution to climate change and the uncertainty of its long-run sustainability has increased the importance of using natural gas and developing alternative energy sources, including "clean" coal, and wind and solar power.

Even more troubling from a societal perspective are catastrophic events, particularly with nuclear power generation. These include three major reactor accidents (i.e., Chernobyl, Three Mile Island, and Fukushima No. 1). At least 33 serious incidents and accidents at nuclear power stations can be identified since the first was recorded at Chalk River in Canada (source: http://www.theguardian.com/news/datablog/2011/mar/14/nuclear-power-plant-accidents-list-rank).

Like its three predecessors, this book is a must read since it addresses many of the issues identified above in a careful and rigorous fashion. Topics covered begin with innovations and shocks in energy markets in Chap. 2, continue with the impact of oil price shocks on industries differentiated by their oil sensitivities in Chap. 3, the effect of production decisions by producer cartels (OPEC) on the market values of publicly traded European firms and the Brent crude oil price in Chap. 4, the impact of CSR performance (both strengths and weaknesses) on accounting performance in Chap. 5, the relationship between renewable and non-renewable electricity consumption and economic growth for countries differentiated by their level of income in Chap. 6, a case study dealing with the possibility of implementing renewable electricity in the form of mobile biodiesel using social capital and social franchising to connect people and capital in Indonesia in Chap. 7, developments in the early stages of the liberation process of the Turkish domestic gas market in Chap. 8, the function and effectiveness of the Turkish Energy Market Regulatory Authority that determines the revenue requirements using the price cap method in Chap. 9, an examination of the impact on electricity of government (political) involvement in various countries in Chap. 10, and end with an examination of whether gas and oil futures prices are good predictors of future gas prices in Chap. 11.

17 October 2014
Montreal, QC, Canada

Lawrence Kryzanowski
Department of Finance
John Molson School of Business
Concordia University

Contents

Energy Technology, Policy and Valuation 1

André B. Dorsman, John L. Simpson, and Wim Westerman

Abstract

This chapter provides a preview to the motivation of the book which is to report new research undertaken in energy technology, policy and valuation issues and more specifically to cover this title in three parts to include innovation and shocks, environment and renewables and finally, fossil fuels regulation. The contents of the book provide readers with an international as well as several country specific perspectives which are included to complement to the global nature of the research. The editors trust that the book will be well received and enjoyed by anyone with an academic and/or a business interest in energy and value issues.

Keywords

Energy policy • Energy technology • Valuation

1.1 Introduction

This is the fourth research book published by the Centre for Energy and Value Issues (CEVI). New and exciting areas of research into the financial economics of energy are introduced. New ways of looking at problems such as electricity pricing

A.B. Dorsman
VU University Amsterdam, Amsterdam, The Netherlands
e-mail: a.b.dorsman@vu.nl

J.L. Simpson (✉)
Financial Economics Consultants, Perth, WA, Australia
e-mail: simmojl@iinet.net.au

W. Westerman
University of Groningen, Groningen, The Netherlands
e-mail: w.westerman@rug.nl

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_1

and the economic, social, regulatory and environmental costs of alternative energy sources is covered in an era where there is increasingly less reliance on coal for power generation. Oil continues to dominate global energy markets, however natural gas and unconventional gas are making strong inroads. On the domestic housing and to a lesser extent the domestic industrial front investment in the generation of solar and wind power are having a significant effect on conventional power generation. Albeit at different magnitudes and speeds, the developments take place at a global level.

Technology is an ever present but not always apparent driver in the energy world. Technology drives policies and vice versa, bringing about innovations. As is shown in a scene setting chapter, innovation is not autonomous and exogenous. There are gradual developments, but also shocks. Energy sourcing, whether innovative or not, influences the environment. Renewable energy production and consumption is in principle best. However, oil and gas are still major electricity inputs and regulation on fossil fuels remains important. This book thus stresses energy economics and finance aspects of issues on innovation and shocks, environment and renewables and fossil fuels regulation. Energy product, process and governance innovations increasingly lead to market transitions at various levels all across the globe. Moreover, energy innovations on both conventional and non-conventional fuels call for policies on various levels, from the global level down to the local level.

Whilst this book offers a global perspective, some of the chapters deal with specific countries. However, even in these instances a global perspective is offered as the models developed will have application to other countries within similar economic groupings, be they net importers or exporters of energy or be they developed or developing economies. The example of Turkey is one of the countries covered in the book. It is suggested that Turkey as an example, is most relevant as its potential as an important future transit country for oil and gas supply cannot be denied. Turkey is a strongly developing and net energy importing economy. Electricity generation through natural gas imports is very important. One of the chapters discusses the liberalization of the Turkish gas market, but stresses the need to simultaneously have some state control mechanisms in place to promote an orderly freeing up of the market. This issue is of great importance to many economies in the world as they grapple with the problems of energy market liberalization.

1.2 Innovation and Shocks

The first part of the book deals with innovation and shocks in energy markets which includes a reinforcement of the importance of energy markets and new studies into valuation and pricing. The second chapter by Bert Scholtens sets the scene for this book, initially making the point that all human activity from the provision of basic needs to social electronic media requires energy. In economics energy is also a factor of production which when combined with labor and capital plays a key role in the production and distribution of goods and services with energy costs conditioning and facilitating other economic activities. The downside of energy use is the much debated issues relating to global warming and the expending of resources that are not renewable. The second chapter asks the questions as to what the particular energy sources are that dominate the fueling of an economy and how do combinations of these resources change over time. It also asks what innovations trigger these changes and do they contribute to economic development generally. Furthermore, it argues that it looks as if energy transition might as well be an autonomous and exogenous process. This is not the case. However, it still is not clear what is cause and what is effect. Different views about how the energy transformations evolve point at different factors: entrepreneurial creativity, interplay between institutions and technology, as well as demand for energy-related services.

Chapter 3, by George Filis gets down to some solid empirical analysis and econometrics to examine the time-varying correlation between selected industrial sector indices (oil-intensive, oil-substitutes and non-oil-related) and oil price shocks. The problem is investigated by firstly looking at the indices correlations for both oil-importing and oil-exporting economies using data from 1998 until 2013 and employing a Scalar-BEKK model. In the analysis of this data the following regularities are reported: (1) the correlation between oil price shocks and index returns show some differences depending on whether a country is an oil-importer or an oil-exporter (2) the correlations are industry-specific and shock-specific and (3) the demand-side shocks mainly generate moderate positive correlations, whereas index returns have low to zero correlation with the supply-side shocks.

Prominent among the results in Chap. 3 is that oil specific demand shocks have a moderate positive correlation with all indices. The results have important implications. As to the first of the findings, it does appear to make a difference to countries in terms of stock price returns as to whether the country imports or exports energy. For example, for an industrial country, a high energy importing component could weaken the balance of payments current account in the absence of strong growth in the export sector and possibly increase debt on the capital account with the provision of reserves for energy imports. Growth is not promoted in the manufacturing sector, which of course results in lower expected rates of return in that sector of the stock market. The second of the findings are also important as additional evidence that energy affects different stock market sectors differently depending on the dependency of such sectors on imported energy and the prices associated with that energy. Again manufacturing sectors with increased energy costs will incur less profitability as reflected in sectoral returns. The third of the findings supports other evidence that energy demand-side shocks are more important than supply-side shocks in terms of the generation of greater returns across all sectoral indices. It may be that across all sectors greater prices in energy conspire to induce a greater inflation of expected rates of return.

Chapter 4 by Maarten Croese and Wim Westerman deals with a very important question as to whether or not OPEC quota decisions affect the stock prices of European oil firms. In addition the influence on the Brent crude oil price is tested.

The investigation uses an event study methodology, where 51 announcements of quota, increases, decreases and no changes in quota are considered in the period 1991–2012. The results imply that OPEC quota decisions have a direct influence on both crude oil returns and oil firms' stock returns. This influence is either positive or negative and large or small, depending on the type of decision and the size of the firms in terms of market capitalization. However, since the difference between the two small firms is also significant, it is concluded that market capitalization alone is not a determining factor.

Chapter 4 research results show a degree of support for past studies in this area and future research may well focus on whether or not the oil markets and the actual major players in these markets anticipate OPEC production allocations. Future research can also show that even if there is an increase in quotas the oil price and the share prices of the major oil companies rises because the markets perceive that the projected increase in oil supply will be insufficient to satisfy demand. The findings of this and other studies should be of great interest to investors who can position themselves in the market based on expected outcomes of OPEC production allocation meetings. Policy-makers can ask questions about cartel behaviour of OPEC and also about the possible prior knowledge by the major players in oil markets of quotas outcomes.

1.3 Environment and Renewables

In Chap. 5 by Özgür Arslan-Ayaydin and James Thewissen, the focus is on the impact of environmental strengths and concerns on the accounting performance of firms in the energy sector. It is posited that the performance of energy sector firms is affected by the imposition of costs and community attitudes relating to environmental impact. Kinder, Lydenberg and Domini research and analysis data are used to extract environment scores for a sample of both energy and non-energy firms over a period from 1995 to 2011. The important question is asked as to whether or not positive environmental activities add costs or assist in the achievement of greater future profitability. The findings are that environmental concerns are lower than environmental strengths and this difference is greater for energy sector firms than non-energy sector firms. Only the environmental concerns of the energy sector firms have a predictive value in terms of future corporate performance when studied against a group of financial earnings variables. It is an important finding for investors and policy-makers that the reduction in environmental concerns for energy firms improves corporate profitability and it also demonstrates that the data used in the study contains significant information value. It may be that future research in this area is conceivable to ascertain whether or not these results stand-up when sectoral stock market returns are examined with environmental scores data and whether or not such findings have greater or lesser significance when studied with the effect of movements in global energy prices in oil, coal and natural gas.

Chapter 6 by Erdinç Telatar analyzes the relationship between renewable and non-renewable electricity consumption and economic growth for a sample of countries categorized into four groups based upon the World Bank income classification (high, upper middle, lower middle, and low income). The principal motivation for the study is to discover whether or not the causal relationships change depending on the income level of countries. A panel causality test is utilized by disaggregating electricity consumption into renewable and non-renewable sources and by examining them with economic growth. The author feels that this may provide more information for policy makers to design green economic policies in the context of environmental and sustainable development. The findings are that a conservation hypothesis is supported for high, upper-middle and lower-middle income groups, and a neutrality hypothesis is supported for low-income countries. In addition the important finding is that the causal relationships between electricity consumption and economic growth disappears for lower-income levels. It is concluded that implementing green economic policies in the context of sustainable development is a reasonable choice for developing countries, but it requires support from the developed world. This is a most useful and valid panel data study of a large sample of countries and the policy implications are clear but challenging.

Chapter 7 by Bartjan Pennink, Niek Verkruijsse and Wim Westerman deals with a less conventional energy source. The chapter investigates the possibilities of implementing renewable energy in the form of mobile biodiesel with a study in Central Kalimantan, Indonesia. The study may have implications to other similarly placed developing economies. The main research aim is to construct a model in which a local economic development model can be infused with money flows and group entrepreneurship. Large-scale projects have taken place in Indonesia, however few were on a small-scale base and thus can be considered as bringing a technology push in a local situation. The field study results indicate a great lack of technical, managerial, and financial knowledge and skills in the remote villages, resulting in a lack of human capital. Furthermore, the occurrence of frequent electricity blackouts with long durations disturbs the local communities in their daily activities. To address these problems, this study argues for the integration of community empowerment, social capital, social franchising and especially group entrepreneurship in combination with a transparent financial system on the flow of money while introducing a new technology. Although the development of the model is based on empirical results in Indonesia and on the mobile biodiesel idea the chapter authors feel that the model could also be applied in other parts of the world as a useful renewable energy strategy.

1.4 Fossil Fuels Regulation

Chapter 8 by Cafer Eminoglu deals with regulation in the Turkish domestic gas market. Turkey is not alone when it comes to the need to ensure energy supply security. However, the Turkish domestic gas market, with its current 30 % private sector involvement, is in the early stages of liberalization process. The milestone in the deregulation process of Turkish natural gas market was the enacting of the Natural Gas Market Law (NGML) in 2001, which abolished the monopoly rights of

State owned BOTAŞ, the Turkish Petroleum Pipeline Company. Yet some targets in the areas of innovation and supply security are still not being met and new reforms have been proposed, such as the unbundling of the monopoly rights of the state owned pipeline company and the reducing of its share in the natural gas market. Opposition remains on the basis that due to the strategic economic importance of the gas market it is necessary that a significant government control involvement remains, particularly to support the fact that only 2 % of domestic natural gas demand is being met by domestic resources. Others say that this may be a strength because Turkey occupies a strategic position geographically between industrialized Western Europe and the vast oil and gas reserves of the Middle East. Therefore Turkey could become a natural bridge in terms of oil and natural gas transmission and thereby contribute strongly to supply security in Europe.

In Chap. 9 by Okan Yardimci and Mehmet Baha Karan the discussion focuses on the function and effectiveness of the Turkish Energy Market Regulatory Authority which sets the tariff that determines the revenue requirements of the Turkish natural gas distribution companies by using a popular type of an incentive regulation, price cap method. The chapter posits that incentive regulation improves efficiency and reduces costs and makes the point that Turkish companies may not be willing to increase the service quality in this kind of regulation. The efficiency and service quality of the Turkish natural gas distribution companies are analyzed using both non-parametric and parametric methods (data envelopment and stochastic frontier analysis). In this study similar distribution companies are ranked by the service quality scores that are obtained from the service quality data. The results can be used by policy makers to determine the relationship between efficiency and service quality and to decide the effectiveness of the regulation and to suggest a reward/penalty scheme for the tariff design. Other countries in similar positions to Turkey and at a similar stage of development might, it is suggested contribute also to regional and global supply security. As an editorial comment it is suggested that diversification of supply of natural gas is important. If a large part of the European regional markets are dependent, for example on Russian piped gas, this is not diversification and does not promote supply security. Consideration should be given to a component of liquid natural gas shipped from gas rich countries, such as Australia with the trade-off for the greater cost being less political risk.

In Chap. 10 by John Simpson, it is noted that electricity markets are perceived to be monopolistic or oligopolistic in nature, whether government or private sector owned. Prices, therefore, are subject to government (political) interference and/or monopoly pricing as well as economic factors, such as the supply cost of fossil fuels. This chapter examines a representative sample of larger OECD country and transitional/developing country electricity markets. The study controls for the influence on electricity prices of domestic and international economic factors (measuring the extent of electricity market deregulation and liberalization) and domestic political factors (measuring the extent of regulation). A vector error correction model is specified to investigate long-run equilibrium relationships and short-term exogeneity in monthly time series data. The findings show differing results for each country electricity market in the short-term and long-term.

By the criteria of the study in Chap. 10, there appears a greater degree of long-term efficiency and deregulation in the following markets based on the order of strength of explanatory power and cointegration evidence for Chile, the US, Canada, the Philippines, China, New Zealand, Thailand and Argentina. Where no such stability occurs in the long-term for the remainder of the sampled markets it might be suggested that government interference may yet be distorting those electricity markets. Interesting results are also obtained when short-run dynamics tests reveal that very few of the electricity markets studied are endogenous on a one month lag. Policy implications and recommendations could ensue from the explanatory power of such models, which will reflect market factors and thus show the level of market liberalization more directly with the residual of each relationship indicating idiosyncratic factors such as government interference and political stability.

The final chapter by John Simpson and Abdulfatah Alsameen investigates the future spot gas prices and the relationship with gas futures and oil futures prices. This research is undertaken not only to discover whether or not gas and oil futures prices are good predictors of the future gas price, but also to ascertain whether or not, in the two of the most important OECD economies, an indication may be provided of the extent of gas market liberalization through the breaking of the nexus in gas and oil prices. The authors of Chap. 11 find that there is some progress in US and (less) UK domestic market regulation, since global oil futures prices together with domestic gas futures prices are not very strong predictors of future domestic gas prices. However, they also conclude that there is some distance to go in market liberalization for both of these leading economies. The study furthermore opens the floor for policy researchers to study why one market may exhibit greater liberalization than the other.

As mentioned, some energy technology, policy and valuation issues are assuming greater importance as time goes on and all issues cannot be covered in this book. For example, the inexorable growth of natural gas as a cleaner alternative to oil; the substantially increased use in households of solar panels to generate electricity; the impact of wind power for both household and industrial power; the emergence of Canada and the USA as net energy exporters of unconventional oil and gas; the need in Europe to diversify sources of gas supply from high political risk producers; the continuing debate for energy trading schemes or carbon taxes or direct action or a combination of these steps to strive to reduce carbon gas emissions in an age of climate change. As mentioned it is hoped that these issues will be the focus of future CEVI research books.

Part I

Innovation and Shocks

2 Energy Innovations and the Economy: An Historical Overview

Bert Scholtens

Abstract
This chapter provides an introductory overview of the use of energy in relation to the economy over time. Energy consumption has skyrocketed with the course of time and energy is being used for increasingly more purposes. Especially societal, industrial and technological change brought about a dramatic increase in per capita energy use. Specific attention is paid to how changes in the use of energy sources and innovations come about. Here, we provide different views of energy transitions: the entrepreneurial perspective, the socio-technical perspective, and the economic-political view. In case energy efficient innovations induce an increase in energy consumption that partly offsets the energy savings, there is a so-called rebound effect. This effect occurs in both consumption and production. Furthermore, the role of energy in the current economy is discussed as there are widely different views about how important energy actually is for economic development.

Keywords
Economy • Energy transition • History • Innovation • Rebound effects

2.1 Introduction

All human activity requires energy. This relates to basic needs like food and shelter as well as to transport and modern electronic social media activities. It also holds for all economic activities. Energy is a factor of production that in combination with

B. Scholtens (✉)
Department of Economics, Econometrics and Finance, University of Groningen, Groningen, The Netherlands

School of Management, University of Saint Andrews, St Andrews, UK
e-mail: l.j.r.scholtens@rug.nl

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_2

labor and capital results in the production of goods and services and plays a key role in distribution. In general, the costs of energy make up a limited part of overall household expenditure. However, energy conditions and facilitates many other activities as they act as a catalyst.

Mankind has come a long way from the age in which human found out how to manage, to modern times where energy seems to be ubiquitous. However, there is a downside to the spread of energy use. This is the threat of climatic changes and that of exhaustion of non-renewable natural resources. Burning fossil fuels results in the emission of carbon dioxide which heats up the atmosphere.

This chapter is meant to provide an overview of the role of energy and energy innovations in society. What sources of energy fuel the economy? How did this change over time? What triggers these energy transformations? How does energy relate to economic development? These are the questions we will be addressing next.

The chapter is organized as follows. Section 2.2 takes the reader at high-speed through the energy history of mankind, from prehistoric time to the modern age. In Sect. 2.3, we discuss how energy transition and innovation might come about. Section 2.4 goes into the role of energy in the economy. Section 2.5 concludes.

2.2 Energy in History

There are several historical accounts of the changes of energy usage and innovation in the history of mankind (e.g. Smil 1994; Williams 2006). They usually start in prehistoric or medieval times, jump to the age of industrialization and end in the present. Here, we provide a brief overview.

We illustrate our overview with the help of Fig. 2.1 which is taken from the study of Cook (1971). It shows an estimation of the energy consumption on a per capita basis in various societal systems. In prehistoric times, it is estimated that human beings only had access to the food they ate with the result that the daily energy consumption was about 2,000 kcal (kilo calories) per capita (Cook 1971). This was about one million years ago. With the knowledge about how to manage fire for heating and cooking, energy consumption will have increased substantially. It is estimated that one hundred thousand years ago (‘hunting society’) daily energy consumption was about 5,000 kcal (Cook 1971). The advent of agriculture again resulted in such an increase. In those times, draft animals were used to aid in growing crops. Wind mills and sails started to get used to harvest wind energy. But these found their way in society to a larger scale only in the late middle ages. Leonardo da Vinci illustrated with his inventions that the use of wind as an energy source could play a role in people’s imagination. In the Low Countries of Europe (what is now mostly Belgium and the Netherlands), peat and wind energy were used in early industrialization. Here, energy production had an enormous impact on the landscape as the winning of peat resulted in floodings and, hence, next to claiming new land for agricultural purposes, it was pure protection that drove the investments. Here, the name of the Dutch inventor Leeghwater is to be mentioned.

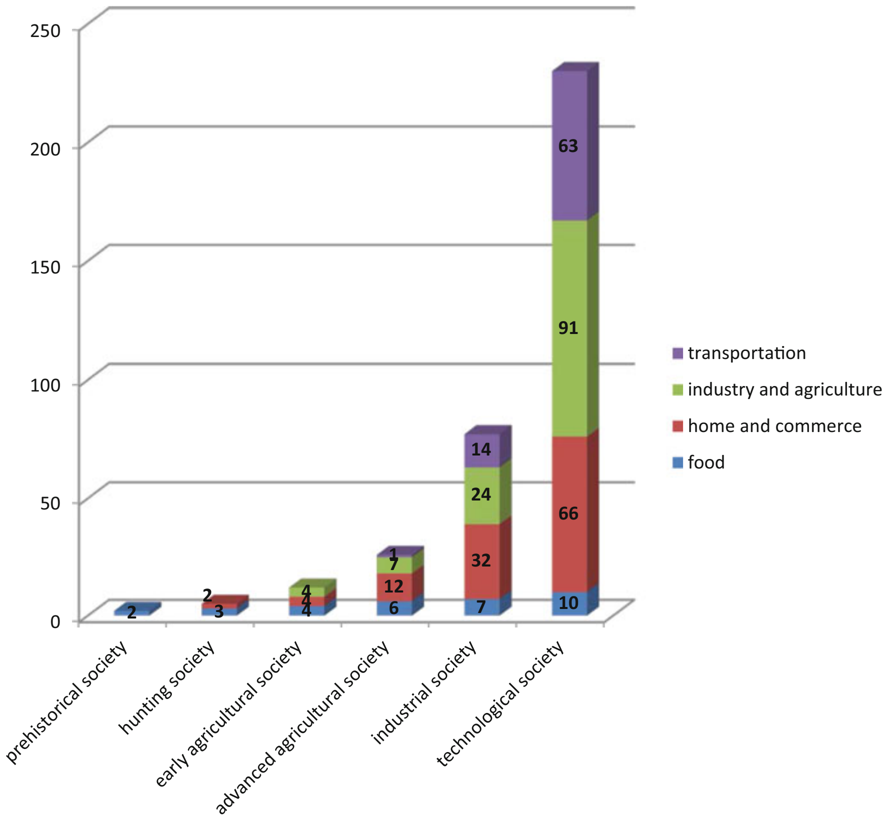

Fig. 2.1 Estimated daily per capita energy consumption along uses (in thousand kcal). *Source*: Cook (1971)

He developed mills and was an expert in water works. Several of his innovations improved the efficiency of the use of wind power. Leeghwater's inventions were applied in the Low Countries, England, Germany, and France at that time. However, for the early energy innovations, we don't know who actually invented them.

The Low Countries already had run out of wood, which was an important energy source elsewhere in Europe until the late eighteenth century. Wood was in demand for alternative uses as well, especially for (ship) building. Wind and water power were the most important energy sources and the development of camshaft and crankshaft allowed their power to be applied to various tasks (Reynolds 1983). During the late eighteenth century, the cotton mills in Britain were mainly powered by water. In Europe, coal and peat gradually grew in importance in the seventeenth and eighteenth centuries. But it took off in the nineteenth century after several eighteenth century inventions became widespread. However, hydropower still is an important source of energy in many countries, such as Brasil, Canada, Norway and Sweden. An overview of the development over time of the composition regarding

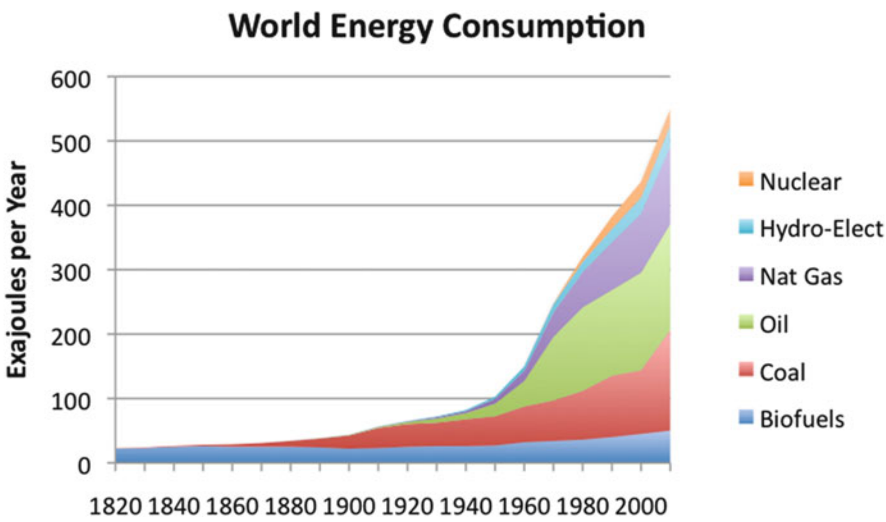

Fig. 2.2 World Energy Consumption (1820–2010; in Exajoules). *Source*: http://ourfiniteworld.com/2012/03/12/world-energy-consumption-since-1820-in-charts/

the energy sources of world energy consumption since the early nineteenth century is depicted in Fig. 2.2.

In Britain, there was synergy when steam power was introduced to source coal mine pumps. These were the first applications of steam power by Savery, Newcomen and Watt, who consecutively worked on improving the mechanical use of steam power in Britain around the turn of the seventeenth and eighteenth centuries (i.e. Savery and Newcomen) and in the second half of the eighteenth century (Watt). A huge advantage of steam power over wind and water was that it was much more flexible from a geographic perspective and that it was not subject to climate conditions. But it took until late in the nineteenth century before steam overtook wind and water as the dominant source. Several efficiency improvements did occur regarding steam engines that made them more competitive vis-à-vis wind and water power.

The work of Edison and Tesla broke ground for the development of electricity in the United States. Once again, this was a huge advantage from a geographic perspective as it loosened the tie between the actual power source and the demand. Centralized production of electrical power became economically practical with the development of alternating current power transmission. This relied on power transformers to transmit power at high voltages over long distances with relatively low efficiency losses. The first power plants were run on water power and coal. But all types of energy sources may be used to produce electricity.

The early twentieth century saw the development of nuclear fission. The work of Marie Curie in Paris about radiation lay at its basis. Here, it was especially Roosevelt's "Manhattan Project" in the US to prepare an atomic bomb that gave a boost to uranium based nuclear chain reactions. Mainly aimed at arriving at a weapon of mass destruction, it had as a side effect that nuclear fission was developed from an extremely radioactive fuel. Later on, it turned out that especially the problems of managing radioactivity risk resulted in huge costs, which increased after system breakdowns of nuclear plants in Three Miles Island (US, 1979), Chernobyl (Russia, 1986) and Fukushima (Japan, 2011).

Given the increased environmental and social problems of the use of fossil fuels, such as pollution due to oil spills, climate change and political tensions, renewable and more sustainable energy sources saw a revival at the end of the twentieth century. Especially wind, sun and biomass received a lot of attention and the cost of producing energy with these sources fell dramatically in a short period of time. However, in total, they make up still only a small part of total energy supply.

In all, the history of energy shows that societal, industrial and technological change brought about a dramatic increase in per capita energy use. Figure 2.1 suggests that with the course of time more and more energy was consumed for a particular use and that energy became to be consumed for new uses as well. As a result, the relative composition of the different functions also underwent dramatic change. Food made up 100 % of energy consumption in prehistoric times, but only 9 % in industrial society and even 4 % in current society. Transportation made up 4 % of energy consumption in advanced agricultural society, but this share rose to 18 % in industrial society and to 27 % in technological society. With every new stage in history, the demand for energy rose 2.5–3-fold. It has to be kept in mind that the more recent stages are very much closer in time than the early ones. Currently, the energy sources are quite mixed. The US Energy Information Administration estimates that total energy demand in 2013 was 547 quadrillion British thermal units (Btu). Figure 2.3 depicts the distribution along the main energy sources, showing that liquids are the major source, but that coal is very close.

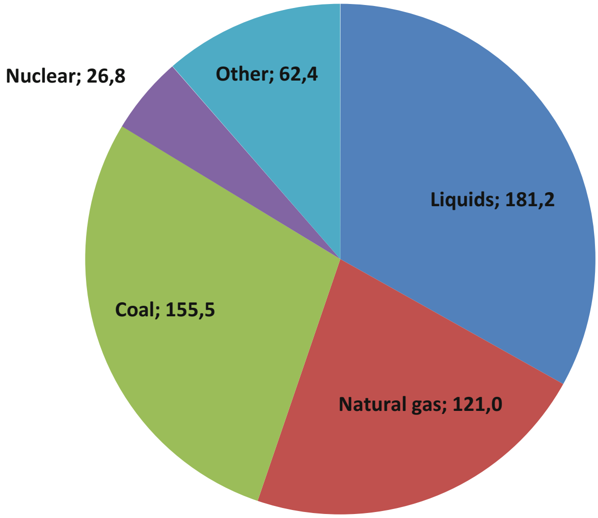

Fig. 2.3 World Primary Energy Consumption (2013; 546.8 Quadrillion Btu). *Source*: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=IEO2013&subject=0-IEO2013&table=2-IEO2013&region=0-0&cases=Reference-d041117

Fossil sources combined make up more than 80 % of total energy consumption. Renewables are in the category ‘Other’, providing about 11 % of the total demand.

After this rather factual overview, we now move on to an economic perspective; it is interesting to see how these changes came about and what drove the innovations. This is the subject of the next section.

2.3 Drivers of Energy Transition

The historical account in the previous section links up with the societal context only at a somewhat superficial level and suggests that energy transition might as well be an autonomous and exogenous process. But this is not the case. In this section, we relate the changes in the main energy sources to changes in society. Section 2.3.1 is a brief narrative, Sect. 2.3.2 is the more theoretical perspective about how energy transition comes about. In Sect. 2.4, we will specifically address the role of energy in the economy.

2.3.1 Energy in Transition

From the previous section, it may have become clear that the early industrial revolution was to a great extent powered by water and wind. Fossil-fuels only played a minor role. However, innovations came about in especially the cotton industry which lead to structural changes in the complete value chain of this industry. Please note that the steam engine already was invented but that it was not widely used. In this respect, though, Britain was a frontrunner. But all over Europe, it took until the 1850s until coal started to surpass wind and water. In the nineteenth century, there was no firm energy policy in place. Furthermore, there was very little growth in energy infrastructure. Which was quite unlike industry which witnessed major structural changes. In the second half of the nineteenth century, energy infrastructure really took off with the advent of oil and electricity. The twentieth century saw both broadening and deepening. Especially in the late twentieth century, a large number of energy sources had become available which all struggled for hegemony. This section reflects on the transition of wind and water to coal, on that towards the use of electricity, and on the rise of the mass production and the use of cars.

The two leading countries at the end of the eighteenth century, Britain and France, did show quite a different pattern as to energy transition (Moe 2010). Britain protected its new industry against resistance, which sometimes took the form of physical violence against machinery. In France, in contrast, there was little willpower to go against vested interest of guilds, bureaucratic interests, clergy, craftsmen and merchants. Although there was no well-established energy policy yet, the two countries had an active transport policy, which did have huge ramifications for the energy transition. In Britain, there was a very active transport policy. There were lobbies for the development of canals and railroads. However, the government decided in support of railroads. This gave a further boost to the development of the steam engine. Especially because there were many positive linkages between rail, coal and steam power. In France, however, the government did not pick a favorite but decided that canals would parallel railroads and that both should lead to Paris (Moe 2010). Furthermore, Britain was endowed with both iron and coal in close proximity and it was poor on wood. Hence, charcoal was scarce and the ironmasters faced a bottleneck. Coal was a way to get around this bottleneck. In France, timber was abundant and iron scarce. It had to import most of its coal, but it had import tariffs on coal.

Thus, Britain protected its new industries and the machinery and power technologies whereas France did not. Consequently, Britain's industrial landscape changed enormously in the first half of the nineteenth century, whereas France's did so only to a far lesser extent. The transformation of Britain's energy infrastructure was swift, comprehensive and crucial to structural change. But that in France did not undergo change to any great extent.

A second transition is that towards the use of electricity. This occurred at the end of the nineteenth century. This period saw economic growth driven by industries which were considerably more knowledge-based than in the past. They also depended on a very different infrastructure. In this period, innovation and growth were fueled by electricity. And major innovations did occur in the electricity industry and the chemical industry.

Electricity is a very different source of power compared to water, wind, coal, etc. This is because it is produced using primary sources of energy. The advent of electricity revolutionized the economy, but it did certainly not replace coal. It had a major impact on the economic geography as electricity freed the factory with its machines and tools from the bondage of the place. Electricity made power ubiquitous. However, it relied on the development of a power grid and power production. Here, there was a clear role for government intervention as power production was organized on a local basis and public power companies took off all over Europe. They very much relied on burning coal to produce the electric power. This clearly was very much a structural energy change, which gave rise to widespread structural industrial change.

The development of electricity was knowledge-based and hence required a lot of skilled labor. Here, we can find clear differences between Britain and Germany. It was surprising that the British state was unwilling to provide its masses with higher education as it kept relying on its public school system. This can be related to the ideology of the Conservatives who did not see the use of sponsoring education for the masses. This contrasts with Germany. Here, school participation was highly stimulated. As a result, Germany produced about ten times as many engineering students as Britain around 1910 (Moe 2010). It developed a highly integrated power network, combining central and distributed generation. Germany became the leader in electrical equipment and appliances. It exported almost three times more than the US and UK. The German state had an obvious hand pursuing structural change through human capital, infrastructure and institution building. World War I saw an end to all this.

A third transition is related to transport and mass production. In the mid-twentieth century, the 'holy alliance' of coal and rail was replaced by one of oil and cars. By the way, this was a close escape as Ford and Edison in 1914 planned the production of half a million electric cars but a massive fire blazed through Edison's uninsured factory which changed history (Black 2006). The car industry became an outlet for petroleum. Oil had been produced in the US for commercial purposes since the 1850s, with the 'Drake well'—the first US commercial oil well, Pennsylvania, 1859—attracting the first great wave of investment in oil drilling, refining, and marketing (Owen 1975). It was the oil baron that really caught the nation's imagination for a prolonged period of time.

It is interesting to find that the US government basically was laissez-faire but it strongly supported road building. It also gave the car industry more subsidies in the 1920s than railroads in the entire history (Heilbroner and Singer 1994). In contrast, Britain relied on coal and went after oil in the Middle East. But even in the 1950s, the British economy was to a degree of more than 90 % fueled by domestically mined coal (Maugeri 2006). In the US, oil was a strategic energy resource. The country was self-sufficient until the 1940s. But domestic production could not keep up with demand and the country had to import increasing amounts of oil. As a result, US international policy became more and more driven by its energy interests.

The current situation is trickier, now we are at the brink of a new energy transition. It had been envisioned that nuclear power would surpass oil as the future's energy. But Three Miles Island, Chernobyl and Fukushima resulted in enormous 'fallout' (Csereklyei 2014). Nowadays, energy sources are very diverse, although mainly still fossil-based (see Fig. 2.3). Development of renewable energy resources is being thwarted especially in fossil-based countries with heavy vested interests from energy and power companies, such as in the UK and the Netherlands. In other countries, like Spain, China and Germany, costly subsidy schemes are being used which resulted in a fast built-up of renewable energy capacity to produce electricity. Another trend is that towards distributed generation. In relation to societal change, we see that structural growth came from ICT, not from ICT producing services, but from ICT using services. This can have a huge impact on energy demand as well. However, at the same time, we witness economic change in highly populated countries like China and India, which results in an enormous additional energy demand. Climate change induced by human behavior is now widely recognized as a major hurdle for the advance of fossil fuels, although new technologies as fracking reduce its relative costs. The result may be that a lot of energy assets might become 'stranded' in case societies want to manage climate risks (Dominguez-Faus et al. 2014).

2.3.2 Perspectives on Energy Transition

There are different views about how major innovations in energy and energy transitions come about. Here, we provide a bird's eye's view of the ideas of Schumpeter, the socio-technical perspective, and the economic-political view.

The first is a traditional pure economic view, the second focuses on the interaction between societal and technological development, the third concentrates on the interaction between market forces and politics.

Schumpeter (1883–1950) was an economist and political scientist. The entrepreneur is key to his view on growth and transition (Schumpeter 1934). The entrepreneur disturbs the equilibrium by coming up with innovations and implementing them. It especially is the impact of innovations on relative prices on the existing markets that is the prime cause of economic development. Schumpeter took an economic perspective regarding innovation, not an engineering perspective. Innovation proceeds in cyclic fashion along several time scales. In fashioning his theory connecting innovations, cycles, and development, Schumpeter popularized the notion of creative destruction: new ways of producing and organizing drive out the existing ones. He saw this innovation as the critical dimension of economic change. Furthermore, Schumpeter argued that economic change revolves around innovation, entrepreneurial activities and market power. He sought to prove that innovation-originated market power could provide better results than the invisible hand. Schumpeter also hinted at the dark side of entrepreneurs. Technological innovation creates temporary monopolies, allowing abnormal profits. These profits may be competed away by rivals and imitators. Temporary monopolies provide the incentive necessary for firms to develop new products and processes. However, they also bear the risk of the advent of powerful lobbies that protect vested interests and hamper innovation and change and results in institutional rigidity. Schumpeter argues that the state should promote technologies and industries. But only while they are young and vulnerable. If protection becomes permanent, vested interests become too powerful and block progress.

This Schumpeterian view of change has been criticized on the basis of its somewhat mechanical view about how innovations come about. Socio-technical analysis tries to overcome this. Chappin and Ligtvoet (2014) provide a bibliometric analysis of the socio-technical research about energy transition and transformation. They searched about 1,000 documents and found that the keywords in this literature are sustainable development, sustainability, innovation, governance, change management, technology and social and technological change. One venue in this literature is Strategic Niche Management (see Verbong and Geels 2007). This approach looks into social networks which relates to different stakeholders, to technological changes, and to regimes, i.e. the existing energy system consisting of institutions and the dominant market players.

The route for influencing the energy system according to this approach is by protecting and managing niches or protected spaces. In these protected spaces technical development is supported by for example subsidies or tax incentives and regulations. This makes that the innovations are set apart, until the products can compete on their own. Verbong and Geels (2007) argue that a multi-level perspective on transition is required. This calls for radical innovations in niches that are the seed for system changes. They point out that this in itself is not sufficient but that the innovations must be situated in a broader regime analysis that takes deep structural trends into account. Chappin and Ligtvoet (2014) assert that 'that the notion of transition is strongly linked to the Dutch sustainable policy context' (p. 720), and that it has a strong normative inclination. Transformation literature on the other hand places developments in a broader societal change process and uses a less normative approach. Most of the literature appears to have an instrumental view on energy transitions, in the sense that these are processes that can be managed and that there are 'transition paths' that are already in place and that should be followed. Furthermore, the demand or market perspective is completely ignored in this literature.

A third perspective is one that focuses on the interplay between markets and policies. An example is O'Connor (2010). He regards energy transition as the set of changes to the patterns of energy use in a society. These changes can take place in the resources, the carriers, the services and the converters and the hallmark of the energy transition is its significant impact on society, the quality of life, and the economy. The changes are highly connected. For example, the invention of a new energy converter may open up opportunities for the expanded use of energy resources, as the internal combustion engine did for petroleum. Improvements in battery technology, an energy carrier, impact on energy resources (more use of solar power), converters (electric car usage), and services (cell phones). O'Connor (2010) argues that it especially is energy demand that is an essential precondition for energy transition. Most of the transitions in energy services involve changes in converters; the resources used do not necessarily change.

O'Connor (2010) mentions that most innovations will not be successful. Different energy options compete and this is resolved by various factors. First is supply constraints, which occur when a resource cannot be expanded in line with demand. Second is cost advantages, where costs not only relate to actual fuel costs, but also to labor costs, converter costs, and other economic impacts. Related are performance advantages. This concerns issues like speed, acceleration, safety, cleanliness and environmental benefits. Furthermore, O'Connor points out that policy decisions are important in energy consumption. For example, tariffs, subsidies, codes, regulations, infrastructure development. New technologies usually try to compete on cost or performance. In the absence of pricing external effects, cleaner energy options emerge through performance advantages or policy decisions.

Hence, there are clearly different views about how transitions come about. Schumpeter puts the entrepreneur central to societal change. The socio-technical perspective puts innovations on more or less successful transition paths. The economic view regards energy transition as a set of competing changes in energy use, where vested interests and political power have an impact.

2.4 Energy and the Economy

The role of energy in the economy seems limited if we relate it to the amount of labor involved in this industry in relation to total employment or from the perspective of its economic value added in relation to total GDP. On both accounts, the former usually is less than 1 % and the second less than 3 %. For most households in high-income countries, the energy bill makes up less than 5 % of overall expenditure. However, in several developing countries, some families spend several hours per day to collect fuel (wood, animal dung) for heating and cooking.

In the classical economic growth theory, usually only two factors of production are being investigated, capital and labor. GDP (Gross Domestic Product) is defined as the total sum of payments to capital (i.e. interest, dividend, rents, royalties, etc.) and payments to labor (wages, salaries). As a stylized fact, these cost shares remain virtually constant over time (e.g. in the US 30 % for capital and 70 % for labor). The combination of the cost-share theorem and the stylized fact of virtually constant factor shares also justifies the use of the standard Cobb–Douglas production function, which is used throughout economics (Ayres et al. 2013a, b). The economic income allocation (cost-share) theorem suggests that the output elasticity of each production factor must be proportional to its costs share. Because primary energy accounts for a very small fraction of total factor costs, it seems that energy cannot be an important source of productivity.

At the same time, we witness that changes in energy prices can have a major impact on economic development. This is well established. For example, Jones and Kaul (1996) test whether the reaction of international stock markets to oil shocks can be justified by current and future changes in expected returns. They find a significant relationship between oil prices and stock market returns. However, Huang et al. (1996) argue that despite the frequently cited importance of oil for the economy, there is little evidence of a relationship with the prices of stocks other than oil companies. Sadorsky (1999) analyses the characteristics of oil prices and oil price volatility and concludes that both play an important role in determining real stock returns. He also observes that the impact of oil price fluctuations changes over time. Basher and Sadorsky (2006) find strong evidence that oil price risk affects stock price returns in emerging markets too. Boyer and Filion (2007) show that this is the case for gas prices as well. Scholtens and Wang (2008) and Scholtens and Yurtsever (2012) are able to detect industry specific effects of oil price changes in the US and Europe respectively. This literature is reminiscent of the findings of Hamilton (1983) that oil price increases usually precede economic recession. Since then, his findings have been corroborated time and again. They suggest that relative scarcity—as reflected in the prices—might play a role in value and growth.

Stern (2011) argues that energy is a relatively limited but essential input to production and that the availability of energy may constrain or promote economic growth. The relationship between energy and GDP can be affected by the substitution between energy and other inputs, by technological change, by shifts in the composition of the factor input (energy intensity, labor intensity, capital intensity), as well as by shifts in the composition of output. To some extent the three production factors are complementary, albeit at different intensities. And to some extent they are substitutes, also at different intensities (Stern 2011). Technological change can improve energy efficiency, but it usually diffuses slowly and the diffusion tends to follow a logistic curve. Lasserre and Smulders (2013) provide an excellent overview of the interaction between renewable and non-renewable resources.

In case energy efficient innovations induce an increase in energy consumption that (partly) offsets the energy savings, there is a so-called rebound effect (Berkhout et al. 2000; Saunders 2011). These effects can occur both in production and consumption. Stern (2011, p. 14) differentiates between five types of rebound effects in the case of consumption:

1. A substitution effect toward greater consumption of the now cheaper energy service and therefore of energy.
2. A direct income effect, which can be positive or negative depending on whether the energy good is a normal or inferior good.
3. Income effects on the consumption of other energy services by the consumer.
4. Increased real income resulting in increased demand for all goods in the economy and, therefore, for the energy required to produce them.
5. Economy-wide changes that result in a further increased long-run demand response for energy.

For production, the case is very similar, except that the income effect is replaced by an output effect (Stern 2011). Consumers are constrained by their income, but producers' costs aren't. As such, output effects can be very large. Empirical studies after the rebound effect usually find these effects are typically in the range of 10–30 % for consumption and generally are at the lower end of this range for industry (Sorrell 2011).

Figure 2.4 shows the development of energy intensity from BP's Energy Outlook. It shows that energy use per unit of GDP is falling all over the world, and BP expects it will keep on doing so for the next 20 years. Hence, this suggests a

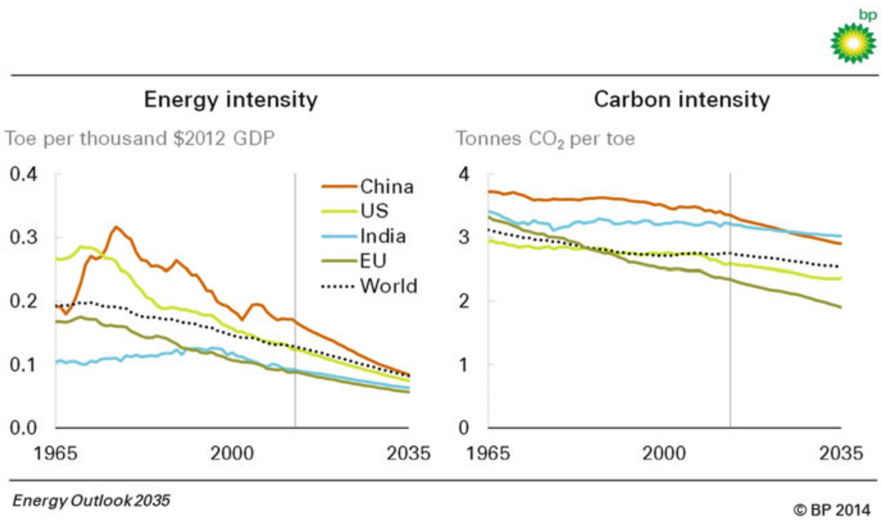

Fig. 2.4 Energy intensity and carbon intensity follow different patterns

decoupling of economic growth and energy growth. This is not very well reflected in the right hand side of Fig. 2.4 which shows carbon intensity. Furthermore, one has to keep in mind that although there may be decoupling, world energy consumption is still on the rise (see Fig. 2.2).

There are several studies that go into the empirical assessment of the causal relationship between energy and economic growth. A recent overview is provided by Ozturk (2010) (see also Menegaki and Ozturk 2013). The early studies rely on Granger causation testing, whereas more recent papers use cointegration analysis. Ozturk (2010) concludes that there is no consensus in the literature. This is the case for both the existence and for the direction of causality between energy or electricity consumption and economic growth. Some studies find that causality runs from economic growth to energy consumption, some find it is the other way round, some find bi-directional causality and some studies find no causality between the variables. Gross (2012) shows that this can differ along various industries. Ozturk (2010) argues that the different findings arise from the use of different datasets, country characteristics, variables used, and different econometric methodologies employed. For most country-specific studies, however, it appears that the causality runs from electricity consumption to economic growth. This suggests that electricity is a limiting factor to economic growth and supply shocks will negatively impact on growth. In general, energy demand growth has closely followed growth in per capita income in low and middle-income countries, whereas high income economies can sustain GDP growth with little if any increase in energy consumption.

Conclusion

This chapter gave an introductory overview of energy innovation in history. We took an economic perspective. With the course of time, different sources of energy are being used. During most of mankind's history, this was biomass, sun and wind. With the spread of industrialization in the nineteenth century, fossil fuels like coal, oil, and gas came to be used on an enormous scale and the use of energy rose in an exponential manner. This has enormous consequences for the environment. The continuation of the use of fossils will lead to heating up the planet, making living conditions very hard. We showed that changes in the use of energy sources accompany economic and societal changes. However, it still is not clear what is cause and what is effect. We discussed different views about how the energy transformations evolve, all pointing at different factors: entrepreneurial creativity, interplay between institutions and technology, demand for energy-related services.

References

Ayres RU, Campbell CJ, Casten TR, Horne PJ, Kümmel R, Laitner JA, Schulte UG, van den Bergh JCJM, von Weiszäcker EU (2013a) Sustainability transition and economic growth enigma: money or energy? Environ Innov Soc Transit 9:8–12

Ayres RU, van den Bergh JCJM, Lindenberger D, Warr BS (2013b) The underestimated contribution of energy to economic growth. Struct Change Econ Dyn 27:79–88
Basher SA, Sadorsky P (2006) Oil price risk and emerging stock markets. Global Finance J 17:224–251
Berkhout PHG, Muskens JC, Velthuijzen JW (2000) Defining the rebound effect. Energy Policy 28:425–432
Black E (2006) Internal combustion. St. Martin's Press, New York
Boyer MM, Filion D (2007) Common and fundamental factors in stock returns of Canadian oil and gas companies. Energy Econ 29:428–453
Chappin EJL, Ligtvoet A (2014) Transition and transformation: a bibliometric analysis of two scientific networks researching socio-technical change. Renew Sustain Energy Rev 30:715–723
Cook E (1971) The flow of energy in an industrial society. Sci Am 225:134–144
Csereklyei Z (2014) Measuring the impact of nuclear accidents on energy policy. Ecol Econ 99:121–129
Dominguez-Faus R, Griffin PA, Jaffe AM, Lont DH (2014) Science and the stock market: investors' recognition of unburnable carbon. Working paper, University of California, Davis
Gross C (2012) Explaining the (non-) causality between energy and economic growth in the U.S. – a multivariate sectoral analysis. Energy Econ 34:489–499
Hamilton JD (1983) Oil and the macroeconomy since World War II. J polit Econ 91: 228–248
Heilbroner RL, Singer A (1994) The economic transformation of America since 1865. Harcourt Brace, Fort Worth
Huang RD, Masulis RW, Stoll HR (1996) Energy shocks and financial markets. J Futur Mark 16:1–27
Jones CM, Kaul G (1996) Oil and the stock markets. J Finance 51:463–491
Lasserre P, Smulders S (2013) An ABC of nonrenewable-renewable resource interactions: antibiotics, biofuels, carbon decay, expropriation, forestry. Resour Energy Econ 35:558–571
Maugeri L (2006) The age of oil. Praeger, Westport
Menegaki AL, Ozturk I (2013) Growth and energy nexus in Europe revisited: evidence from a fixed effects political economy model. Energy Policy 61:881–887
Moe E (2010) Energy, industry and politics: energy, vested interests, and long-term economic growth and development. Energy 35:1730–1740
O'Connor PA (2010) Energy transitions. Boston University, Boston
Owen EW (1975) Trek of the oil finders. American Association of Petroleum Geologists, Tulsa
Ozturk I (2010) A literature survey on energy-growth nexus. Energy Policy 38:340–349
Reynolds TS (1983) Stronger than a hundred men: a history of the vertical water wheel. Johns Hopkins University Press, Baltimore
Sadorsky P (1999) Oil price shocks and stock market activity. Energy Econ 21:449–469
Saunders H (2011) Theoretical foundations of the rebound effect. In: Evans J, Hunt LC (eds) International handbook on the economics of energy. Edward Elgar, Cheltenham, pp 164–198
Scholtens B, Wang L (2008) Oil risk in oil stocks. Energy J 29:89–112
Scholtens B, Yurtsever C (2012) Oil price shocks and European industries. Energy Econ 34:1187–1195
Schumpeter JA (1934) The theory of economic development. Harvard University Press, Cambridge
Smil V (1994) Energy in world history. Westview Press, Boulder
Sorrell S (2011) The rebound effect: definition and estimation. In: Evans J, Hunt LC (eds) International handbook on the economics of energy. Edward Elgar, Cheltenham, pp 199–233
Stern DI (2011) The role of energy in economic growth. In: Costanza R, Limburg K, Kubiszewski I (eds) Ecological economics reviews, vol 1219, Annals of the New York academy of sciences. Blackwell, Boston, pp 26–51
Verbong G, Geels F (2007) The ongoing energy transition: lessons from a socio-technical multi-level analysis of the Dutch electricity system (1960–2004). Energy Policy 35:1025–1037
Williams JC (2006) History of energy. http://www.fi.edu/learn/case-files/energy.html

3 Energy Prices, Sectoral Indices and Regulation

David Broadstock and George Filis

Abstract

The aim of this research is to examine the time-varying correlation between selected industrial sector indices (oil-intensive, oil-substitutes and non-oil-related) and oil price shocks. We investigate this correlation for both oil-importing and oil-exporting economies. Using data from 1998 until 2013 and employing a Scalar-BEKK model, we report the following regularities: (1) the correlation between oil price shocks and index returns are showing some differences depending on whether a country is oil-importer or oil-exporter, (2) the correlations are industry-specific and shock-specific and (3) the demand-side shocks mainly generate moderate positive correlations, whereas index returns have low to zero correlation with the supply-side shocks. Prominent among our results is that oil-specific demand shocks have a moderate positive correlation with all indices. Our results have important implication for investors, as well as policy makers.

Keywords

Industrial sectors • Oil price regulation • Oil price shocks • Stock market returns

D. Broadstock
Research Institute of Economics and Management (RIEM), Southwestern University of Finance and Economics (SWUFE), 55 Guanghua Cun Jie, Chengdu, Sichuan 6100074, China

Faculty of Economics Business and Law, Surrey Energy Economics Centre (SEEC), University of Surrey, Surrey, UK
e-mail: davidbroadstock@swufe.edu.cn

G. Filis (✉)
Department of Accounting, Finance and Economics, Bournemouth University, Executive Business Centre, 89 Holdenhurst Road, Bournemouth BH8 8EB, UK
e-mail: gfilis@bournemouth.ac.uk

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_3

3.1 Introduction and Review of the Literature

3.1.1 Oil Prices and the Economy

Since the seminal work of Hamilton (1983), a considerable body of literature sets out to examine the link between oil price returns and economic activity. The majority of these studies illustrate the critical role of oil prices in influencing economic variables (see, *inter alia*, Filis and Chatziantoniou 2014; Lippi and Nobili 2012; Arouri and Nguyen 2010; Nakov and Pescatori 2010; Hamilton 1996). In particular, there are two main approaches to examining the impact of oil prices on the economy. First, there is the microeconomic approach, for exploring issues such as how oil prices affect production and prices and second, there is the macroeconomic approach, for investigating questions such as how oil prices impact on aggregate demand via inflation and monetary policy reactions (Segal 2011).

The consensus is that oil prices are shown to influence macroeconomic indicators such as industrial production (negatively) and inflation (positively). This is because the escalation of oil prices leads to higher costs of production and subsequently to higher consumer prices. The latter will inevitably result in lower consumption (negative income effect) and thus, lower expected earnings (see, indicatively, Baumeister and Peersman 2012; Rahman and Serletis 2011; Hamilton 1996, 2008; Jones et al. 2004; Abel and Bernanke 2001; Hooker 1996).

3.1.2 Oil Prices and Aggregate Stock Market Indices

Despite the fact that there is an extensive literature on the relationship between oil prices and macroeconomic indicators, the examination of the oil price effects on stock markets has attracted popularity across academic circles only over the last two decades. Some studies include Filis and Chatziantoniou (2014), Ciner (2012), Filis (2010), Driesprong et al. (2008), Nandha and Faff (2008), Park and Ratti (2008), Hammoudeh and Li (2005), Hammoudeh et al. (2004), Sadorsky (1999) and Jones and Kaul (1996), among others. The general picture is that the effects of oil price changes and stock market performance is negative. Nevertheless, there is also the proposition that oil price changes do not cause any effects on stock market returns (see Filis et al. (2011) for an in-depth review of the subject).

We should not lose sight of the fact that the impact character that oil price changes will have on a country's stock market depends on the oil characteristics of the country in question, i.e. whether it is a net oil-importer or a net oil-exporter. In broad terms, authors subscribe to the belief that rises in oil prices can be advantageous for the economies and thus, the stock markets of oil-exporting countries and disadvantageous for oil-importers (Wang et al. 2013; Mohanty et al. 2011; Bjornland 2009; Lescaroux and Mignon 2009). This implies that the negative link between oil price changes and stock markets as described earlier, does not necessarily apply for those markets which operate in oil-exporting countries. Al Janabi et al. (2010), though, paint a somewhat different picture, postulating that changes in oil price do not in fact affect stock markets of oil-exporting countries.

3.1.3 Oil Prices and Industrial Sector Indices

An interesting area of enquiry, which has not received significant attention, is the examination of the oil price impacts on stock market industrial sectors. Exploring the influences of oil price shocks at a sector level can be particularly valuable for investors and other sector participants, given that the character and/or extent of the industry-specific responses are likely to vary. It should be also noted that the indices of aggregate stock markets among different countries reveal only part of the picture as the industrial bases of these countries can exhibit substantial differences (Arouri et al. 2012). In this light, any evidence that it is based solely on aggregate indices should not be treated as definite.

Among the most common findings of present studies is that the Oil&Gas sector receives a positive influence from rises in oil, whereas other sectors receive a negative effect (Degiannakis et al. 2014; Scholtens and Yurtsever 2012; Broadstock et al. 2012; Narayan and Sharma 2011; Elyasiani et al. 2011; Arouri et al. 2011; Kilian and Park 2009; Nandha and Faff 2008; El-Sharif et al. 2005). For instance, Nandha and Faff's (2008) findings suggest that out of 35 sectors, only Mining and Oil&Gas industries positively respond to oil price changes, whereas all other industrial sectors exhibit the opposite behaviour. However, this is not always the case as such effect on Oil&Gas firms has also been found to be relatively insignificant (see, for instance, El-Sharif et al. 2005).

Thus, the examination of oil price effects on various sectors illuminates that the relationship between these variables is not always so straightforward. This is also revealed by studies such as this of Narayan and Sharma (2011), which show asymmetric stock market responses to oil price changes, depending on the sector that the listed firms belong to. Thus, firms in the Supply, Manufacturing, Food, Chemical, Medical, Computer, Transportation, Banking, Real Estate and General Services sectors respond negatively to positive oil price shocks, businesses in the Energy sector respond positively, whereas mixed results are provided for firms in the Electricity, Engineering and Financial sectors. Furthermore, there seems to be a relationship between oil price impacts and company size. More specifically, stock prices of larger companies are not favoured by increases in the oil prices, independently of their sector, while the reverse is true for smaller enterprises (Narayan and Sharma 2011).

Similarly, Kilian and Park (2009) study the industry-level stock returns in four industry sectors in the US (Petroleum and Natural Gas, Automobile and Trucks, Retails and Precious Metals) and illuminate that oil price shocks affect each sector in different ways. Another interesting approach is followed by Elyasiani et al. (2011), who study oil price shocks and industry stock returns in 13 US sectors by categorising them as oil-users, oil-substitute, oil-related and financial industries. Their findings show that oil prices positively affect the oil-related and oil-substitute industries, whereas a reverse claim can be made for the oil-users and financial industries.

Furthermore, Scholtens and Yurtsever (2012) examine the effects of oil prices shocks in 38 sectors from 15 different countries. Their findings suggest that most industries would respond negatively to positive oil price changes; nevertheless, Oil, Mining and Gas sectors would exhibit a bullish behaviour when oil prices increase. Arouri and Nguyen (2010) focus on Europe and on the relationship between oil price changes and the stock returns of 12 industrial sectors. The researchers maintain that the Financial, Oil&Gas, Industrials, Basic Materials and Personal and Household Goods sectors respond positively to oil price increases whereas the Food and Beverages, Health Care and Technology sectors respond negatively. Yet, a later study by Arouri (2011) contradicts Arouri and Nguyen's (2010) findings, providing evidence that the Financial and Consumer Goods sectors respond negatively to positive oil price changes, whereas the Industrial sector does not respond at all.

Other researchers such as Mohanty et al. (2011) consider the net oil-exporting countries and they argue that almost all industries show a positive response to positive oil price changes, demonstrating the different behaviour of oil-exporting and oil-importing countries.

Overall, the review of the literature suggests that there are sectors, such as those of Oil&Gas and Mining, that are positively affected when oil prices increase and others sectors, including Transportation, Manufacturing, Food, Chemicals, Medical, Computer, Real Estate and General Services, that experience negative implications. At the same time, there are also sectors (Electricity, Engineering and Financial sectors) which exhibit a less clear relationship. In addition, these findings are different for the stock market sectors in oil-exporting and oil-importing countries. According to Gogineni (2010), a potential interpretation of such findings might be the dependency of each sector to the supply chain and hence its level of exposure to oil markets and sensitivity to oil price changes. Despite, though, the underlying reasons for these heterogeneous responses, stock market investors are required to take into consideration these different industrial sector responses to oil price changes when making decisions on portfolio adjustments.

3.1.4 Oil Price Shocks

More recently, it is also suggested that the origin of oil price shocks is of major importance and thus it should be taken into consideration as it can have different resonances across the economy. In fact, Kilian and Murphy (2013), Alquist and Kilian (2010), Hamilton (2009a, b) and Kilian and Park (2009) opine that unless we disentangle the oil prices in terms of their origin, we cannot have the full picture on the effects of oil in the economy and the stock market. More specifically, Hamilton (2009a, b) suggest that oil price shocks should be divided into supply-side or demand-side shocks. The former have their origins in global oil production and the latter in global oil consumption changes, respectively.

Moreover, Kilian (2009) and Kilian and Park (2009) distinguish demand-side oil price shocks into two distinct subcategories, underlining that the cause of a shock in each case will further shape stock returns. These subcategories are the aggregate demand shocks and the oil-specific demand shocks (or idiosyncratic oil shocks) that stem from the uncertainty surrounding the future availability of oil (Kilian 2009). The aggregate demand oil price shocks stimulate a positive response by stock markets whereas both supply-side and oil-specific demand shocks have negative implications (Kilian and Park 2009). Recently, Kilian and Lee (2014) and Kilian and Murphy (2013) argue that part of the idiosyncratic or oil-specific demand oil price shocks could be explained by speculation in the oil market.

A vast array of studies in this area also confirms the positive effects of aggregate demand shocks and the negative effects of oil-specific demand shocks on stock market developments. In parallel, an ever-growing body of empirical evidence voices the opinion that supply-side oil price shocks, as opposed to the demand-side shocks, do no longer significantly influence financial markets or the economy (Degiannakis et al. 2013, 2014; Antonakakis and Filis 2013; Abhyankar et al. 2013; Baumeister and Peersman 2012; Lippi and Nobili 2012; Kilian and Lewis 2011; Filis et al. 2011; Kilian 2008a, b; Barsky and Kilian 2004).

3.1.5 Time-Varying Relationship and Our Contribution

In their vast majority, past studies consider both the relationship of oil prices and aggregate stock market indices and the link between oil prices and industrial sector indices within a static environment. It is thus suggested that the adoption of more dynamic approach can shed some new light into the subject. An emerging strand of the literature applies time-varying correlation models to explore oil and stock market relationship through a dynamic prism (Filis 2014; Antonakakis and Filis 2013; Chang et al. 2013; Degiannakis et al. 2013; Filis et al. 2011; Bharn and Nikolovann 2010; Choi and Hammoudeh 2010).

For example, Choi and Hammoudeh (2010) use the Dynamic Conditional Correlation (DCC) model to assess the relationship between the S&P 500 and several commodity prices, including oil, copper, gold and silver. They show that from 2003 onwards the correlation between the S&P 500 index returns and the commodities price changes are declining. Filis et al. (2011) move their analysis further by drawing a distinction between oil-importing and oil-exporting countries. They observe that there is a negative relationship between oil and stock market returns during oil-specific demand shocks, whereas the same relationship is positive during aggregate demand shocks. Broadstock et al. (2012) focus on China and assess the time-varying correlation between oil prices and energy related stocks. They report a sharp increase in this correlation during the 2008 financial crisis. Furthermore, Chang et al. (2013) demonstrate that conditional correlations between crude oil prices and stock returns are indeed time-varying for the US market.

Moreover, Antonakakis and Filis (2013) focus on the time-varying effects of oil price changes on stock market correlation and report that demand-side oil prices shocks are negatively affecting stock market correlation, whereas the supply-side oil price shocks do not tend to impact their correlation. In addition, they suggest that this effect is heterogeneous depending on whether the stock market is in an oil-importing or oil-exporting country. Finally, Degiannakis et al. (2013) assess the time-varying relationship between oil prices and industrial sector returns in the European context. Their study is based on data from ten European sectors. The time-varying correlations imply that the relationship between sector indices and oil price changes is altered over time and is industry specific. The study also reveal that the correlation is impacted by the origin of the oil price, i.e. supply-side oil price shocks generate moderate positive correlation levels, the oil-specific demand shocks result in correlation levels almost to zero and the aggregate demand shocks sizably change correlation levels either in a positive or a negative manner.

The aim of this chapter is to add to this recent and growing path of research in order to enhance the current literary work. In particular, our study aspires to bridge the gap between the two key strands of enquiry, namely the impact of oil price shocks on the stock markets and the time-varying correlation between oil prices and stock market returns. The contribution and innovation of this chapter are as follows. First, we disentangle oil prices shocks by virtue of their origin. Then we investigate the time-varying correlation between each of the three different types of oil price shocks and stock market returns. Second, we explore the aforementioned relationship for selected industrial sector indices. Third, we examine this time-varying correlation for both oil-importing and oil-exporting countries.

The rest of the chapter is organised as follows: Sect. 3.2 describes the data used in the study and Sect. 3.3 presents the methodology. The empirical findings are analysed in Sect. 3.4. Section 3.5 discusses the regulatory implications before Sect. 3.6 concludes the study.

3.2 Data Description

In this study we use monthly data starting from January 1998 until July 2013 on six industrial sectors indices for both oil-importing (France, Germany, Italy, Japan, Spain and the US) and oil-exporting countries (Canada and Norway). The choice of the time period is dictated from the availability of data and the requirement to have common starting and ending points. The choice of countries is motivated by the fact that all countries are included either in the top global oil-importers or oil-exporters. The chosen industrial sectors indices comprise of oil-intensive sectors (Materials, Oil&Gas), oil-substitute sectors (Metals&Mining, Utilities) and non-oil-related sectors (Banks, Technology). The data have been extracted from Datastream®. Due to data availability issues, our sample does not include data of the French Utility sector, the Spanish Technology sector, the Italian Metals&Mining and Technology sectors and the German Oil&Gas sector.

The data for oil include world oil production (OILPROD), oil prices (OILP) and global economic activity (GEA) index, which are used for the estimation of the three oil price shocks. The choice of Brent crude oil is predicated upon the fact that it is world's largest oil market and it can thus be considered as a global oil price benchmark (Smith 2009). The data for the Brent crude oil price and world oil production have been extracted from the Energy Information Administration. Data for the global economic activity index has been retrieved from Lutz Kilian's website (http://www-personal.umich.edu/~lkilian/). Prices are expressed in real dollar terms and are transformed into log-returns and they are stationary (except from GEA which already represents percentage changes in global economic activity).

3.3 Methodology

3.3.1 Structural VAR Model and Historical Price Decomposition

We adopt Kilian's (2009) methodology to disaggregate oil prices changes by virtue of their origin. To do so, we use a structural vector autoregressive (SVAR) model of the form:

$$\mathbf{A}_0\mathbf{y}_t = \mathbf{c}_0 + \sum_{i=1}^{p} \mathbf{A}_i\mathbf{y}_{t-i} + \boldsymbol{\varepsilon}_t \tag{3.1}$$

where, $\mathbf{y}_t$ is a $[3 \times 1]$ vector of endogenous variables which includes the world oil production, the global economic activity index and real oil price returns, on that order. $\mathbf{A}_0$ denotes the $[3 \times 3]$ contemporaneous matrix, whereas $\mathbf{A}_i$ are $[3 \times 3]$ autoregressive coefficient matrices. $\boldsymbol{\varepsilon}_\mathrm{t}$ is a $[3 \times 1]$ vector of structural disturbances, assumed to be having zero covariance. Finally, p denotes the lag order of the SVAR model. In order to estimate Eq. (3.1) we require the reduced form, which can be obtained by multiplying both sides of Eq. (3.1) with $\mathbf{A}_0^{-1}$:

$$\mathbf{y}_t = \mathbf{a}_0 + \sum_{i=1}^{p} \mathbf{B}_i\mathbf{y}_{t-i} + \mathbf{e}_t \tag{3.2}$$

where, $\mathbf{a}_0 = \mathbf{A}_0^{-1}\mathbf{c}_0$, $\mathbf{B}_i = \mathbf{A}_0^{-1}\mathbf{A}_i$, and $\mathbf{e}_t = \mathbf{A}_0^{-1}\boldsymbol{\varepsilon}_t$. In order to derive the structural disturbances ($\boldsymbol{\varepsilon}_t$) we need to impose suitable short-run restrictions on $\mathbf{A}_0^{-1}$, i.e. we need to restrict certain contemporaneous interactions between our variables. Recall that for the estimation of the oil price shocks three variables are used, namely the world oil production (OILPROD), oil prices (OILP) and global economic activity (GEA) index. Following Kilian and Park (2009), the short-run restrictions among these variables are as follows. Oil production is not responding contemporaneously to changes in oil demand or oil prices, given the time lag that is required for oil production adjustment to these changes. By contrast, changes in oil supply can trigger responses by both the global economic activity and the price of oil, within the same month. Turning to the global economic activity, we argue that this cannot be contemporaneously influenced by oil price changes, due to the time lag that is required for the global economy to react to oil price changes. However, an aggregate demand shock can exert a contemporaneous impact on oil price changes, due to the instant reaction of the oil commodities markets. Finally, changes in oil prices respond contemporaneously to both oil production changes and global economic activity, as well as, to its own innovations.

One the SVAR model is estimated, we can proceed to the historical decomposition of the oil price shocks. According to Kilian and Park (2009, p. 1272, footnote 6) the historical decomposition is performed by "*simulating the path of the real price of oil from [the estimated SVAR model] under the counterfactual assumption that a given shock is zero throughout the sample period. The difference between this counterfactual path and the actual path of the real price of oil measures the cumulative effect of the shock at each point in time*." For a detailed presentation of the decomposition, please see Filis (2014) and Burbidge and Harrison (1985). In this study we denote the supply-side shocks as *SS*, the aggregate demand shocks as *ADS* and the oil-specific demand shocks as *OSS*.

3.3.2 Scalar-BEKK Model

This section presents the method that is used for the estimation of the time-varying correlations between the oil price shocks and the stock market returns.

The literature has shown that the Dynamic Conditional Correlation (DCC) method by Engle (2002) has been extensively used to model the time-varying correlation between variables. Nevertheless, Caporin and McAleer (2008, 2012) maintain that the BEKK model of Baba, Engle, Kraft and Kroner (1991, Multivariate simultaneous generalized ARCH, Unpublished manuscript, Department of Economics, University of California, San Diego) and Engle and Kroner (1995) has several advantages over DCC, given that the latter does not strictly formulate a dynamic conditional correlation. Hence, in this paper we use a BEKK model. As in Filis (2014), our sample is in monthly frequency and we do not have an extensive number of observations. Thus, we apply a more parsimonious model, that of Scalar-BEKK, which requires fewer parameters to be estimated.

Let $\mathbf{y}_t = \begin{pmatrix} ops_t \\ smr_t^c \end{pmatrix}$ be a 2×1 vector comprising our data series, with $A(L)\mathbf{y}_t = \mathbf{e}_t$ representing their conditional mean equations. L is the lag operator and $\mathbf{e}_t$ ($\mathbf{e}_t \middle| \Omega_{t-1} \sim N(0, \mathbf{H}_t)$ and t = 1, ..., T) is the normally distributed vector of innovations based on the information set (Ω) available at time t − 1. Assuming a first order GARCH process, the Scalar-BEKK structure for the variance-covariance matrix $\mathbf{H}_t$ is defined as:

$$\mathbf{H}_t = \mathbf{C}\mathbf{C}' + \mathbf{A}\mathbf{\Sigma}_{t-1}\mathbf{A}' + \mathbf{B}\mathbf{H}_{t-1}\mathbf{B}' \tag{3.3}$$

The assumption of the scalar representation is that matrices $\mathbf{A}$ and $\mathbf{B}$ are linearly related by a scaling factor, i.e. $\mathbf{B} = \boldsymbol{\delta}\mathbf{A}$ (see, Filis 2014; Silvennoinen and Terasvirta

2009; Xekalaki and Degiannakis 2010 for further discussion of the Scalar-BEKK and other multivariate GARCH methods). Given the estimated time-varying variances–covariances in $\mathbf{H}_t$, we can estimate the time-varying correlation between industrial sectors' returns and each of the oil price shocks.

3.4 Empirical Analysis

3.4.1 Descriptive Statistics of the Series Under Investigation

The development of the series under investigation is depicted in Figures 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, and 3.9, whereas Table 3.1 presents some descriptive statistics.

Figures 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, and 3.9 reveal some interesting regularities. First of all, all series have been heavily impacted by the Great Recession of 2007–2009. This is evident by the significant drop in all industrial sector indices, as well as in the global economic activity index and oil prices. We cannot observe any significant effect of the Great Recession of 2007–2009 on the world oil production, though. Furthermore, we notice that most industrial sectors have not recovered or regained their peaks of the post-2009 period. Nevertheless, the Banking and Utilities sectors of the Canada, the Materials sector of Germany, the Banking sector of Norway and the Oil&Gas and Utilities sectors of US exhibit a bullish behaviour after 2009 and most of them have reached their pre-crisis levels.

Fig. 3.1 Oil production, global economic activity and oil prices. The sample runs from January 1998 until July 2013

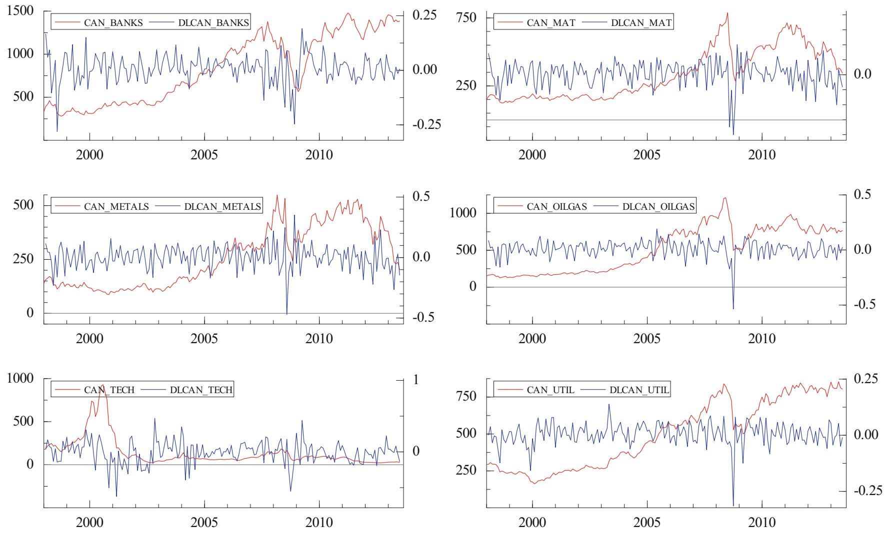

Fig. 3.2 Industrial sector indices for Canada. The sample runs from January 1998 until July 2013

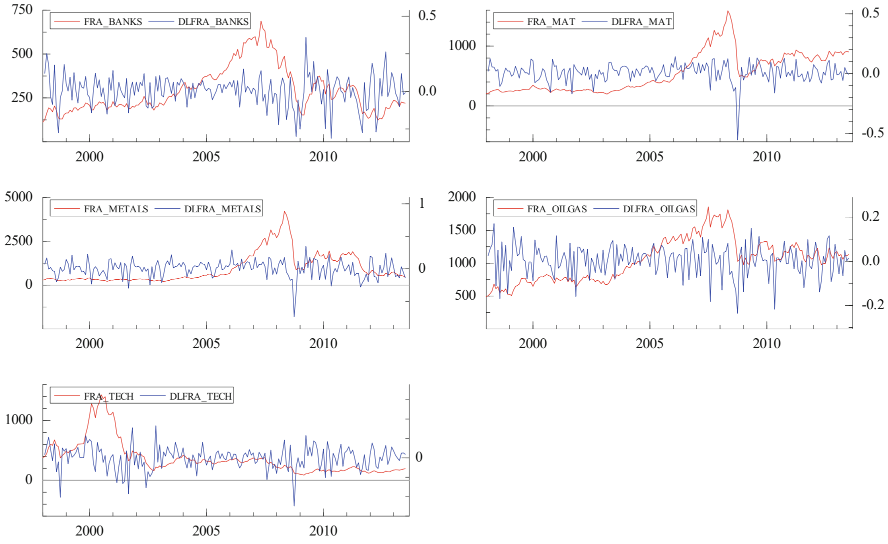

Fig. 3.3 Industrial sector indices for France. The sample runs from January 1998 until July 2013

Noticeably, some of the French, Italian and Spanish industrial sectors indices show an even further declining pattern after the 2007–2009 crisis, possibly due to the ongoing economic problems that these countries face.

From Table 3.1 we observe that the most volatile industrial sector indices in almost all countries are the Banking, Metals and Technology indices. Turning our

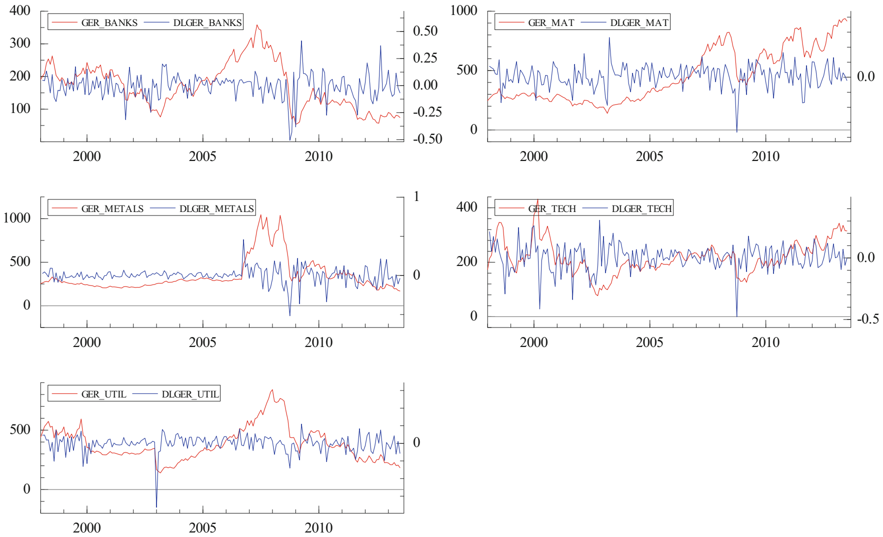

Fig. 3.4 Industrial sector indices for Germany. The sample runs from January 1998 until July 2013

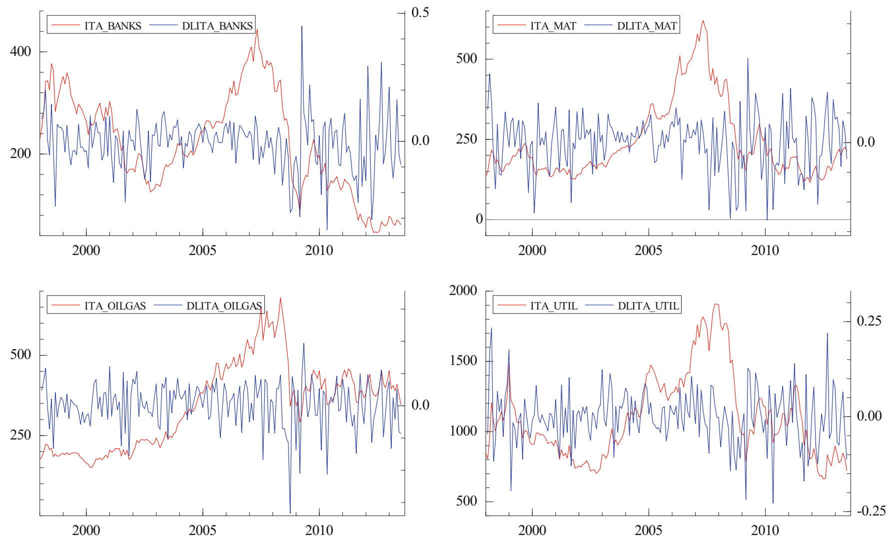

Fig. 3.5 Industrial sector indices for Italy. The sample runs from January 1998 until July 2013

attention to the oil data, we observe that the global economic activity is the most volatile variable of all, although oil price changes are also exhibiting a volatile behaviour. Finally, almost all indices are negatively skewed (except from change in oil production and global economic activity), leptokurtic (except from the global

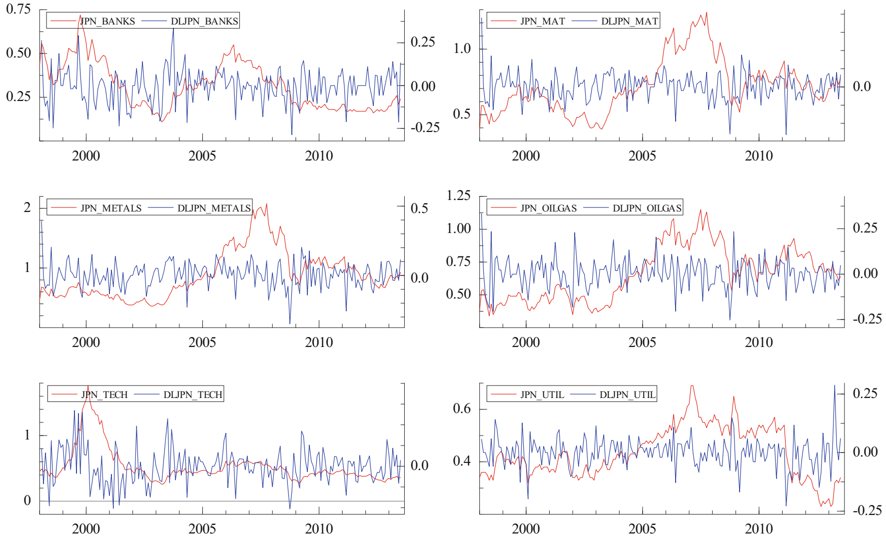

Fig. 3.6 Industrial sector indices for Japan. The sample runs from January 1998 until July 2013

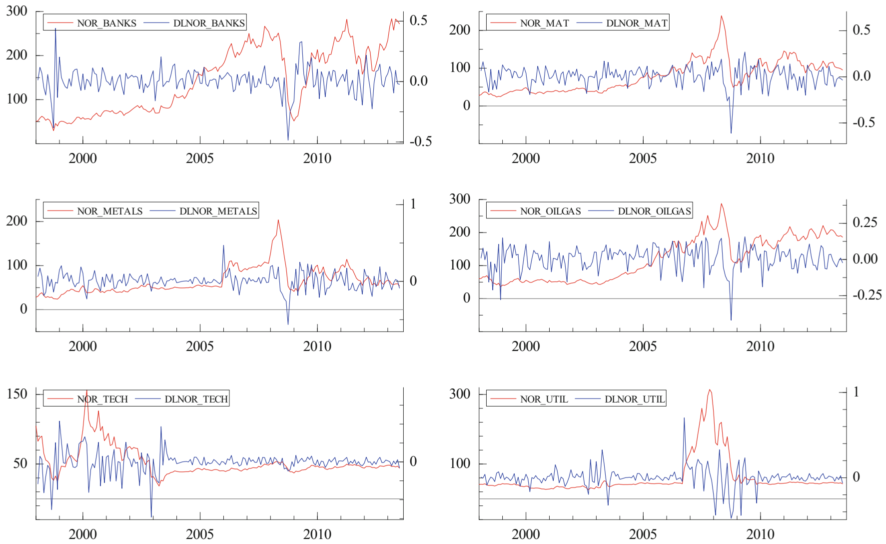

Fig. 3.7 Industrial sector indices for Norway. The sample runs from January 1998 until July 2013

economic activity which is platykurtic) and they are not normally distributed, as evident by the Jarque–Bera statistic. These statistics reveal that most observations of the variables under consideration are concentrated on higher values (negative skewness), while having some extreme low values, and clustered close to the mean value (leptokurtic).

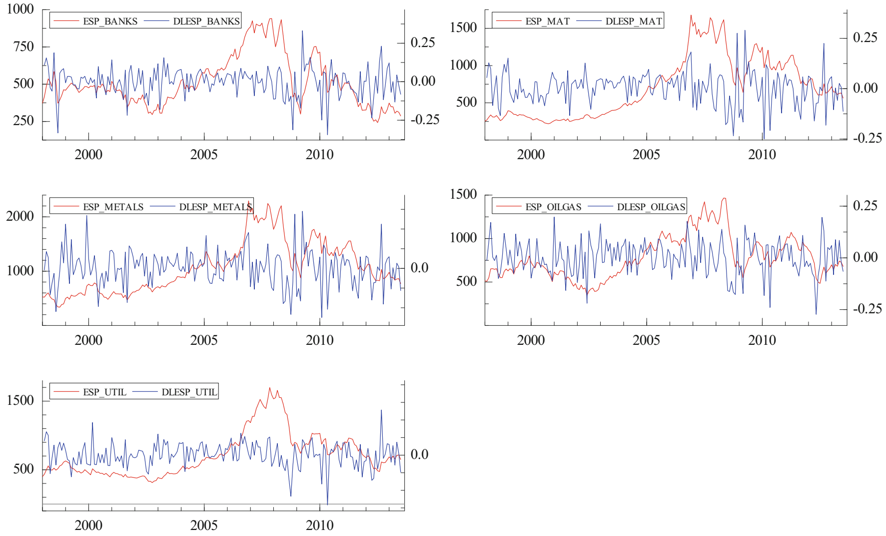

Fig. 3.8 Industrial sector indices for Spain. The sample runs from January 1998 until July 2013

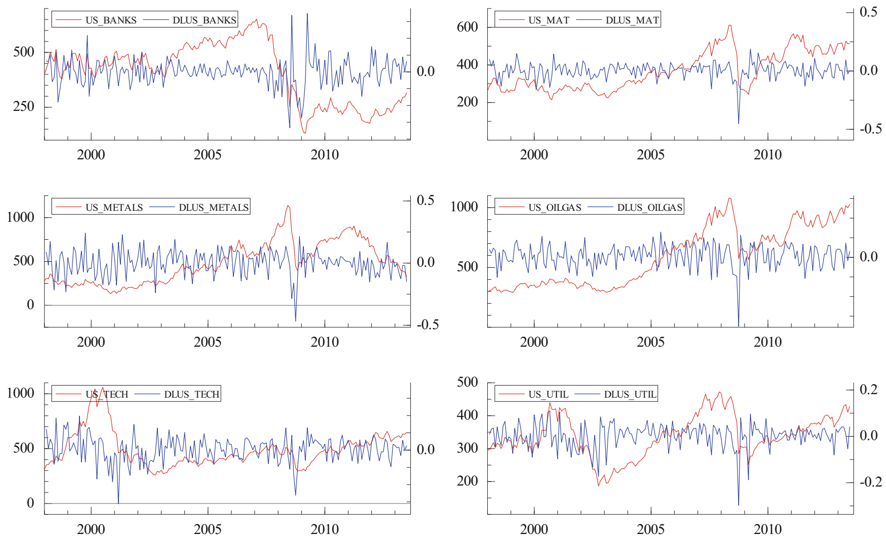

Fig. 3.9 Industrial sector indices for the US. The sample runs from January 1998 until July 2013

Figure 3.10 exhibits the decomposed oil prices shocks, as these where estimated from the SVAR model presented in Sect. 3.3.1.

It is clear from Fig. 3.10 that the largest component of the oil price changes is the oil-specific demand shock, given the magnitude of the fluctuations. Furthermore, it is evident the supply-side shocks do not contribute significantly to the oil price

Table 3.1 Descriptive statistics of the series under consideration

	Canada						France				
	BANKS	MAT	METALS	OIL&GAS	TECH	UTIL	BANKS	MAT	METALS	OIL&GAS	TECH
Mean	0.01	0	0	0.01	−0.01	0.01	0	0.01	0	0	0
Maximum	0.19	0.2	0.35	0.19	0.47	0.14	0.36	0.14	0.34	0.17	0.33
Minimum	−0.28	−0.4	−0.47	−0.54	−0.62	−0.32	−0.31	−0.55	−0.74	−0.24	−0.5
Std. Dev.	0.06	0.09	0.1	0.08	0.16	0.05	0.1	0.08	0.13	0.07	0.12
Skewness	−0.78	−1.08	−0.45	−2.14	−0.51	−1.62	−0.4	−2.32	−1.11	−0.67	−0.66
Kurtosis	5.99	6.1	5.51	16.15	4.77	11.78	4.24	16.86	7.83	3.69	4.84
Jarque–Bera	88.10***	111.16***	54.86***	1,481.47***	32.39***	679.70***	16.86***	1,655.99***	218.77***	17.55***	39.60***
	Spain					Norway					
	BANKS	MAT	METALS	OIL&GAS	UTIL	BANKS	MAT	METALS	OIL&GAS	TECH	UTIL
Mean	0	0	0	0	0	0.01	0.01	0	0.01	0	0
Maximum	0.33	0.29	0.29	0.2	0.26	0.44	0.27	0.47	0.16	0.43	0.7
Minimum	−0.34	−0.25	−0.25	−0.27	−0.28	−0.49	−0.61	−0.56	−0.42	−0.58	−0.48
Std. Dev.	0.09	0.08	0.09	0.08	0.07	0.11	0.1	0.11	0.08	0.12	0.12
Skewness	−0.59	−0.11	0.05	−0.33	−0.35	−0.42	−1.41	−0.36	−1.16	−0.9	0.09
Kurtosis	4.99	4.22	3.79	3.34	4.97	7.33	8.78	7.39	6.27	9.16	11.66
Jarque–Bera	41.44***	11.86***	4.88*	4.33	33.93***	150.95***	319.79***	153.67***	125.03***	319.14***	581.07***
	Germany					US					
	BANKS	MAT	METALS	TECH	UTIL	BANKS	MAT	METALS	OIL&GAS	TECH	UTIL
Mean	−0.01	0.01	0	0	0	0	0	0	0.01	0	0
Maximum	0.41	0.26	0.46	0.31	0.22	0.35	0.19	0.24	0.13	0.2	0.11
Minimum	−0.51	−0.37	−0.52	−0.48	−0.73	−0.33	−0.45	−0.47	−0.35	−0.31	−0.3
Std. Dev.	0.12	0.08	0.1	0.11	0.1	0.09	0.07	0.1	0.06	0.07	0.05
Skewness	−0.62	−0.73	−0.64	−0.8	−2.46	0.06	−1.63	−0.61	−1.3	−0.62	−1.42
Kurtosis	6.36	5.92	9.6	5.92	18.19	6.47	12.32	4.61	8.44	4.76	7.98
Jarque–Bera	99.27***	82.75***	350.14***	85.84***	1975.70***	93.65***	755.08***	31.66***	281.63***	36.05***	254.32***

	Japan						Italy				
	BANKS	MAT	METALS	OIL&GAS	TECH	UTIL	BANKS	MAT	OIL&GAS	UTIL	
Mean	0	0	0	0	0	0	−0.01	0	0	0	
Maximum	0.34	0.38	0.39	0.33	0.27	0.29	0.45	0.28	0.19	0.23	
Minimum	−0.29	−0.26	−0.35	−0.25	−0.21	−0.23	−0.35	−0.26	−0.33	−0.23	
Std. Dev.	0.1	0.08	0.09	0.09	0.09	0.06	0.11	0.09	0.07	0.07	
Skewness	−0.07	0.13	−0.05	0.21	0.37	−0.01	0	−0.51	−1.03	−0.04	
Kurtosis	3.66	6.1	4.72	4.25	3.73	5.57	5.57	3.66	5.39	4	
Jarque–Bera	3.5	74.94***	22.97***	13.51***	8.43**	51.03***	51.17***	11.44***	77.05***	7.82**	
	Oil										
	PROD	GEA	PRICE								
Mean	0	0.04	0.01								
Maximum	0.03	0.59	0.23								
Minimum	−0.02	−0.5	−0.42								
Std. Dev.	0.01	0.29	0.11								
Skewness	0.02	0.04	−0.8								
Kurtosis	3.86	1.85	4.03								
Jarque–Bera	5.74*	10.27***	28.12***								

The sample runs from January 1998 until July 2013

Note: *BANKS* banking sector, *MAT* basic materials sector, *METALS* metals and mining sector, *OIL&GAS* oil and gas sector, *TECH* technology sector, *UTIL* utilities sector, *PROD* changes in world oil production, *GEA* global economic activity, *PRICE* changes in oil prices

All values are in log-differences, except from GEA

*Significance level of 10 %; **Significance level of 5 %; ***Significance level of 1 %

Fig. 3.10 Historical decomposition of the oil price shocks. The sample runs from January 1998 until July 2013

changes. Finally, from the decomposed oil price shocks we observe the impact of the Great Recessions of 2007–2009 on the demand-side oil price shocks, as this is depicted by the marked decrease of aggregate demand and oil-specific demand shocks.

3.4.2 Unconditional Correlations Between Oil Price Shocks and Stock Market Indices

Before we continue to the time-varying correlations between the oil price shocks and industrial sectors returns, it would be interesting to present the unconditional correlations between these variables (see Table 3.2).

Table 3.2 suggests that the correlation between the supply-side shocks and changes in industrial sectors indices is negative but quite close to zero. Interestingly enough, the US indices are mainly positively correlated with the supply-side oil shocks (expect from the Materials and Metals&Mining sectors), which is a behaviour similar to this of the oil-exporting countries. More specifically, we also observe a positive correlation between the supply-side shocks and the industrial sectors indices returns of Canada and Norway (although this is not true for the Materials, Metals&Mining and the Utilities sectors of Canada and the Metals&Mining and Utilities sectors of Norway).

Furthermore, the evidence presented in Table 3.2 suggests that the aggregate demand shocks are positively associated with stock market indices returns,

Table 3.2 Unconditional correlations among oil price shocks and stock market indices

Oil price shock	SS	ADS	OSS	Oil price shock	SS	ADS	OSS
Canada				*Italy*			
BANKS	0.0586	0.1268	0.1981	BANKS	−0.0106	0.0435	0.1763
MAT	−0.0401	0.1962	0.2344	MAT	−0.1161	−0.0099	0.0885
METALS	−0.0758	0.1011	0.1467	OIL&GAS	−0.0768	0.0597	0.2283
OIL&GAS	0.0191	0.1243	0.3777	UTIL	−0.0323	0.0308	0.168
TECH	0.0454	0.1855	0.0793	*Japan*			
UTIL	−0.0123	0.1739	0.0505	BANKS	−0.0322	0.1241	0.1887
Spain				MAT	−0.1335	0.0795	0.1363
BANKS	−0.0535	0.02	0.1019	METALS	−0.0763	0.1183	0.1711
MAT	−0.0405	0.0069	0.0874	OIL&GAS	−0.0879	0.1154	0.2605
METALS	−0.0656	−0.0047	0.1093	TECH	0.0495	0.1316	0.2223
OIL&GAS	−0.055	0.0763	0.2414	UTIL	−0.0744	−0.0521	−0.0874
UTIL	−0.0501	0.0951	0.0787	*Norway*			
France				BANKS	0.0343	0.1429	0.1876
BANKS	−0.0459	−0.0067	0.1366	MAT	0.0042	0.1967	0.2524
MAT	−0.0547	0.1942	0.1694	METALS	−0.0297	0.0537	0.31
METALS	−0.0239	0.1207	0.1864	OIL&GAS	0.1068	0.213	0.3877
OIL&GAS	−0.0343	0.0765	0.3113	TECH	0.2109	0.0446	0.1292
TECH	0.1121	0.0389	0.0924	UTIL	−0.1167	0.2558	0.0332

(continued)

Table 3.2 (continued)

Oil price shock	SS	ADS	OSS	Oil price shock	SS	ADS	OSS
Germany				*US*			
BANKS	−0.0082	0.1451	0.0864	BANKS	0.0255	−0.0396	0.0892
MAT	−0.0583	0.0739	0.06	MAT	−0.0445	0.1426	0.2125
METALS	−0.0575	0.1351	0.1323	METALS	−0.088	0.1949	0.2494
TECH	0.0997	0.08	0.0647	OIL&GAS	0.014	0.0812	0.3374
UTIL	−0.1201	0.0751	0.097	TECH	0.0585	0.1111	0.132
				UTIL	0.0684	0.1605	0.1035

The sample period runs from January 1998 until July 2013

SS supply-side shock, *ADS* aggregate demand shock, *OSS* oil-specific demand shock, *BANKS* banking sector, *MAT* basic materials sector, *METALS* metals and Mining sector, *OIL&GAS* oil and gas sector, *TECH* technology sector, *UTIL* utilities sector regardless the characteristic of the country. The same observation can be made for the oil-specific demand shocks, which are also positively related with the changes in industrial sector indices of all countries. This latter finding is interesting, given that the literature has shown that the effects of the oil-specific demand shocks (or idiosyncratic oil price shocks) are either negatively related to stock market returns or they do not exercise a significant effect (see, *inter alia*, Degiannakis et al. 2014; Kilian and Park 2009). Finally, we notice that the correlation level differs across shocks, where the highest correlation figures are observed in the oil-specific demand shocks, followed by aggregate demand shocks and oil-supply shocks.

So far this *prima facie* evidence shows that there is some difference on the responses of the stock market industrial indices to the different oil price shocks and that there are some heterogeneous responses which are influenced by the characteristic of the country (i.e. whether this is oil-importing or oil-exporting). It is interesting to identify, though, whether these responses are time-varying and whether under a time-varying environment we can identify some additional regularities.

3.4.3 Time-Varying Conditional Correlations Between Oil Price Shocks and Stock Market Indices

Having examined the unconditional correlations, we further our analysis focusing on the time-varying relationships of oil-intensive (Materials and Oil&Gas), oil-substitute (Metals&Mining and Utilities) and non-oil-related (Banking and Technology) sectors.

3.4.3.1 Oil-Intensive Sectors

In this section we start our analysis with the oil-intensive sectors. Figures 3.11 and 3.12 present the time-varying correlations for the Materials and Oil&Gas sectors, respectively.

The different oil price shocks seem to trigger different correlations for the Materials sector. The supply-side shocks are mainly negatively correlated with the sector's returns for almost all countries. Nevertheless, a clear exception exists for Spain and Norway, where for the majority of the time period, the correlation fluctuates in positive values. Overall, though, the correlation level for all countries is close to zero.

Focusing on the aggregate demand shocks, it is clear that there is a moderate to high positive correlation with the Materials' sector returns, with a peak during the Great Recession of 2007–2009. Nevertheless, these positive correlations are interrupted in the post-2011 period, when the correlations become negative. Despite the fact that we would expect a positive correlation throughout the sample period, given the fact that aggregate demand shocks originate from the increased economic activity, we claim that the negative correlations in the post-2011 period are due to

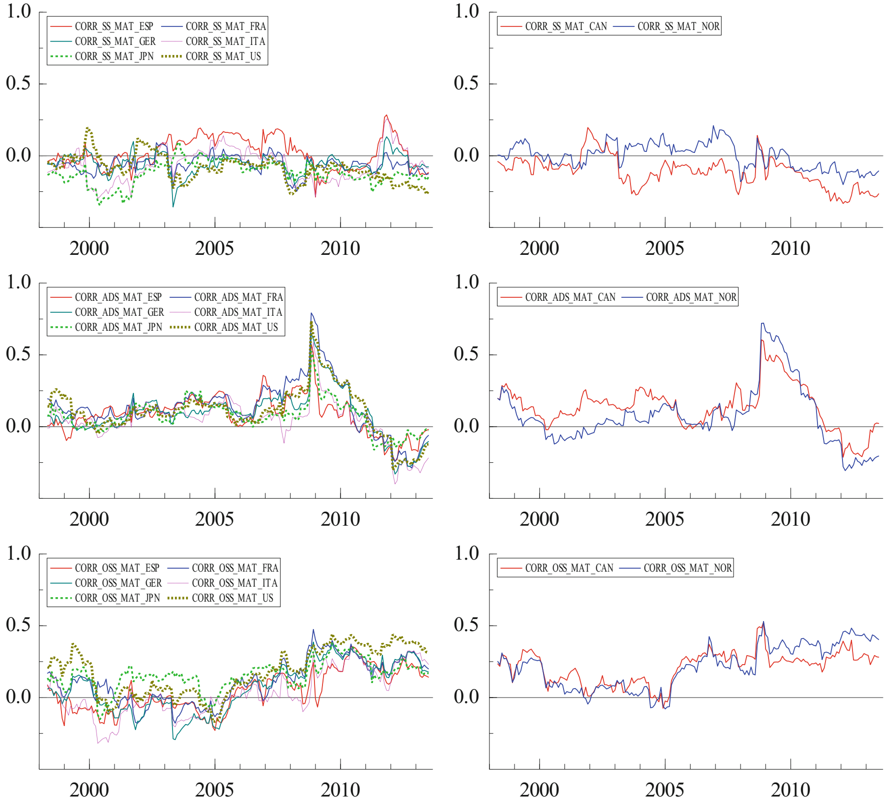

Fig. 3.11 Time-varying correlation between oil price shocks and the materials sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. *The third row* shows the correlations between stock market indices and oil-specific demand shocks

the fact that the aggregate demand shocks fluctuated very close to zero, where the indices experienced some volatile behaviour.

Regarding the oil-specific demand shocks, correlations for the oil-importing countries are fluctuating around zero in the pre-2006 period, whereas from 2006 onwards there is a clear positive correlation. By contrast, the same correlation for the oil-exporting countries is always positive. These results confirm the evidence provided by the existing literature, which maintains that positive shocks in oil prices (regardless their origin) are beneficial for the Materials' sector. For example, according to Arouri (2011), oil price increases lead to an increased demand for the products by the Materials sector and thus firms enjoy higher profitability.

Turning our attention to the Oil&Gas sector, we detect similar behaviour as in the Material sector for the cases of the supply-side shocks and aggregate demand

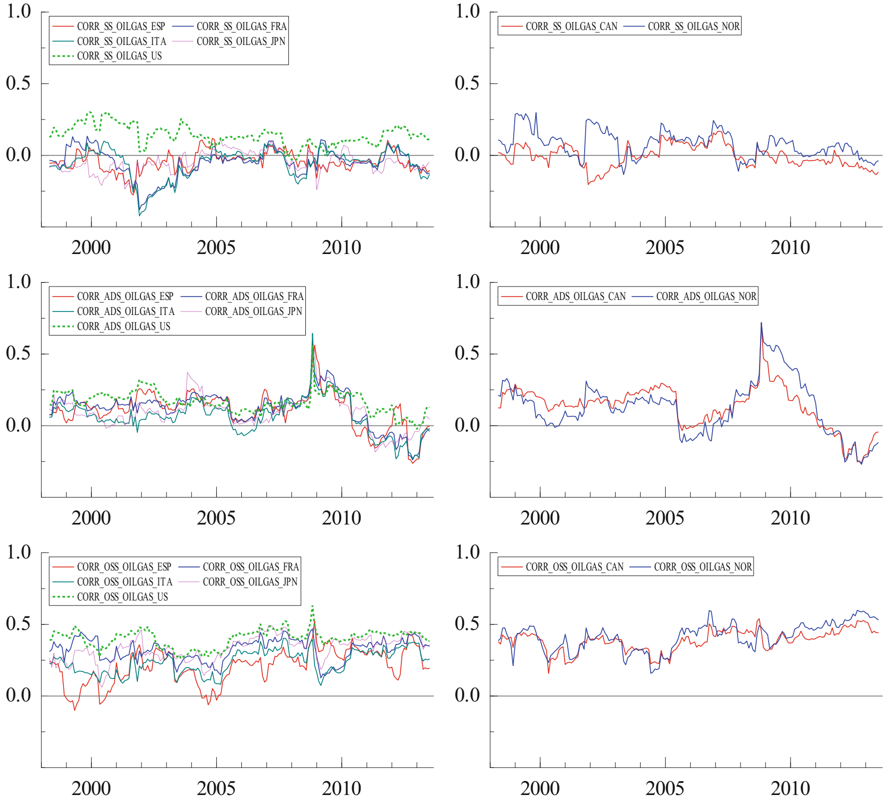

Fig. 3.12 Time-varying correlation between oil price shocks and the Oil&Gas sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. The *third row* shows the correlations between stock market indices and oil-specific demand shocks

shocks. A worth noting exception is the US Oil&Gas sector's returns which are positively correlated with the supply-side shocks, which resembles the behaviour of the same sector of the oil-exporting countries, rather than on the remaining oil-importing countries. A plausible explanation can be found in the fact that the US is a major oil-producer and thus, its Oil&Gas sector has somewhat different characteristics compared to the same sector in other oil-importing economies. Furthermore, a clear difference exists between the Materials and Oil&Gas sectors in the case of oil-specific demand shocks. In particular, the shocks trigger positive correlations for all countries, which are of significant magnitude.

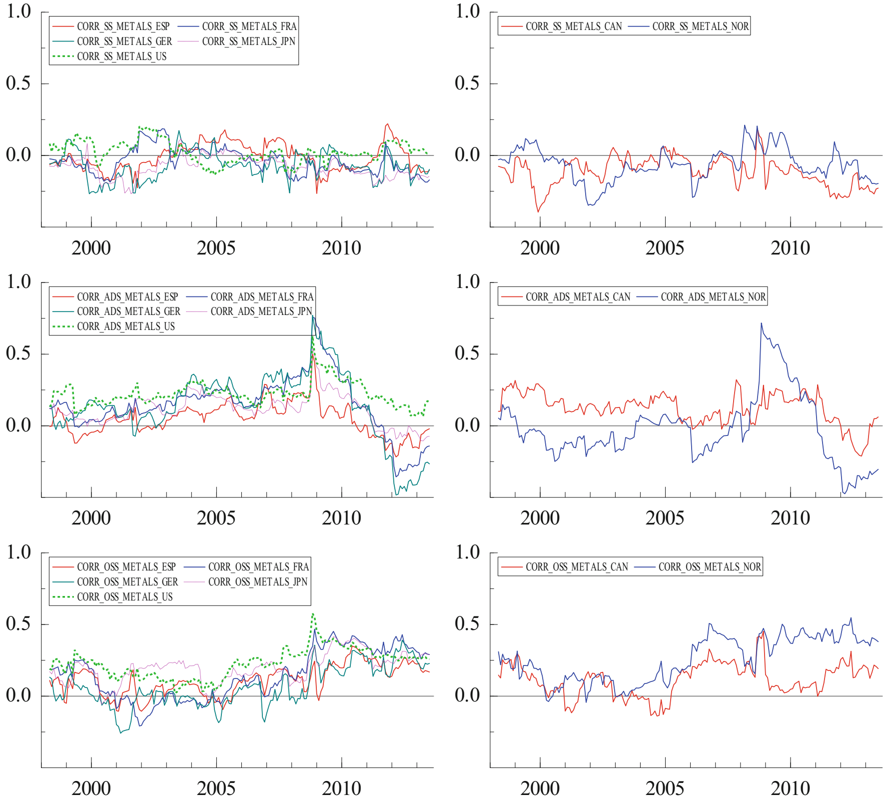

Fig. 3.13 Time-varying correlation between oil price shocks and the Metals&Mining sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. The *third row* shows the correlations between stock market indices and oil-specific demand shocks

3.4.3.2 Oil-Substitute Sectors

The time-varying correlations between oil-substitute sectors and oil price shocks are exhibited in Figs. 3.13 and 3.14.

Once again, even in the case of oil-substitute sectors, a heterogeneous behaviour is observed across sectors, countries and shocks. In particular, we observe a low to zero correlation between the Metals&Mining sector's returns and supply-side shocks, whereas the same correlation for the Utilities sector in mainly negative, with the exception of the US, where for most of the period under investigation, the correlation is positive. Notably, the correlations between these two sectors and the supply-side shocks are also negative (for most part) for the two oil-importing countries. On the whole, the low to zero correlations are expected given the fact

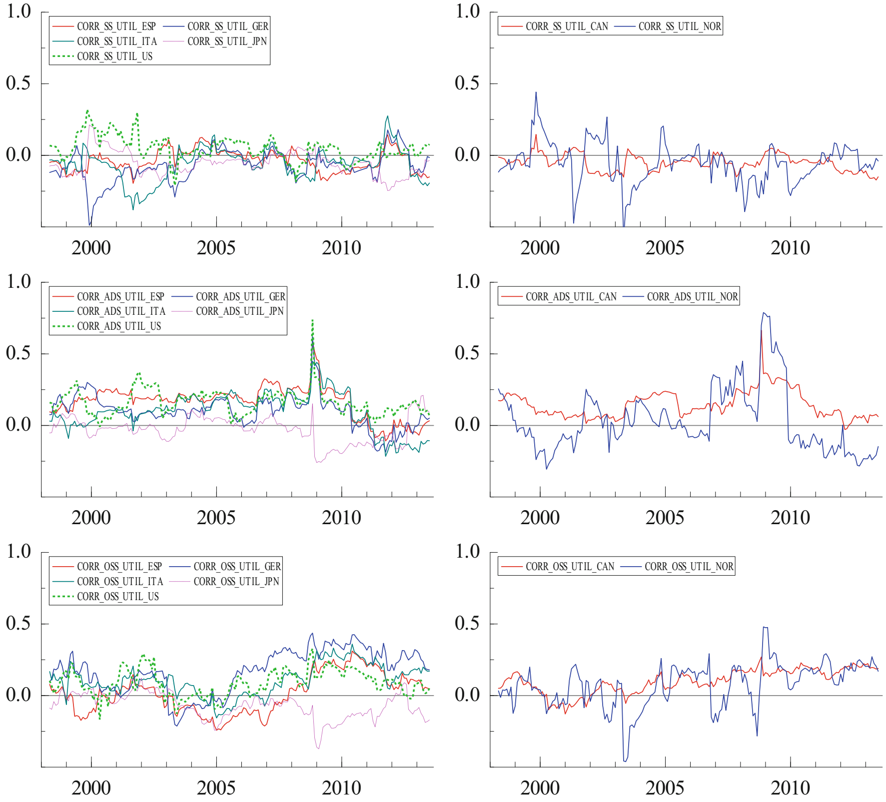

Fig. 3.14 Time-varying correlation between oil price shocks and the Utilities sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. The *third row* shows the correlations between stock market indices and oil-specific demand shocks

that supply-side shocks do not trigger any responses currently, as they are not any more surprise events.

Furthermore, the correlations between these two sectors and the aggregate demand shocks are similar with the previous observations that were made for the oil-intensive sectors; nevertheless, some noteworthy differences still exist. For example, Norway's Metals&Mining sector's returns are mainly negatively correlated with the aggregate demand shocks, apart from the period 2008–2011. Equivalently, Japan's Utilities sector's returns are negatively correlated with the aggregate demand shocks, during the Great Recession of 2008–2009, which is a distinctive behaviour compared to all other cases. The results for Norway and Japan are somewhat counter-intuitive. However, the fact that the Metals&Mining sector

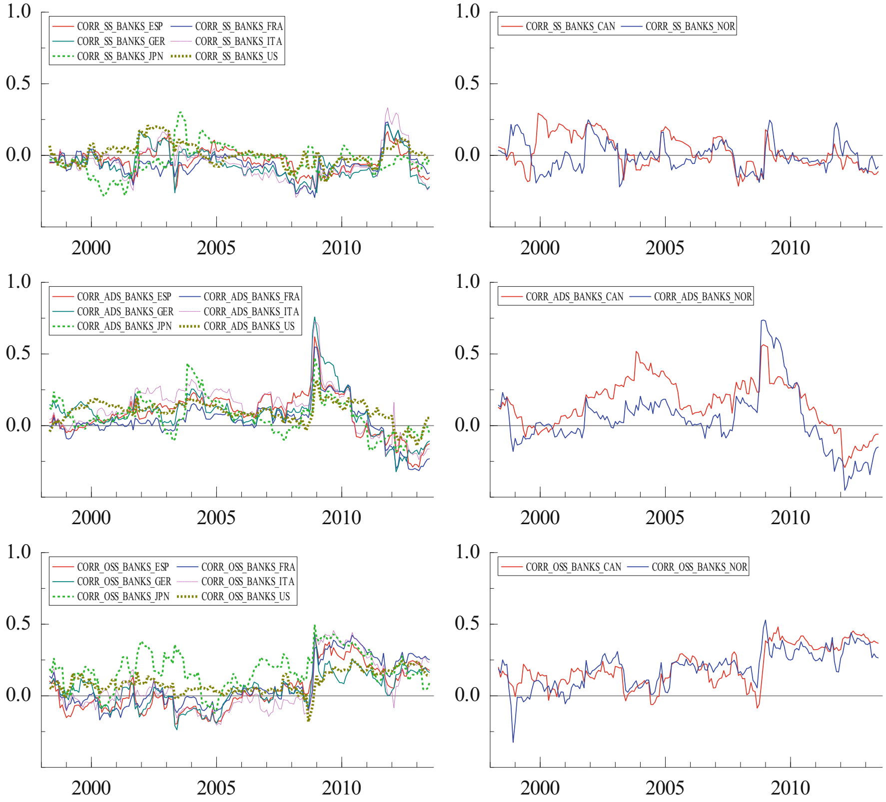

Fig. 3.15 Time-varying correlation between oil price shocks and the Banking sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. The *third row* shows the correlations between stock market indices and oil-specific demand shocks

of Norway is fairly constant in the pre-2008 period and Japan's Utilities sector is exhibiting a peak in 2009, justify these negative correlations.

3.4.3.3 Non-oil-Related Sectors

The final section of this analysis focuses on the Banking and Technology sectors (see Figs. 3.15 and 3.16, respectively), which are classified as non-oil-related sectors.

Figures 3.15 and 3.16 reveal that the supply-side shocks do not seem to be highly correlated with the sectors' returns and especially with the Banking sector. In addition, the aggregate demand shocks are mainly positively related to both sectors' returns, reaching a peak towards the end of the Great Recession of 2007–2009. Once again a change to a negative correlation in the post 2011 period is observed

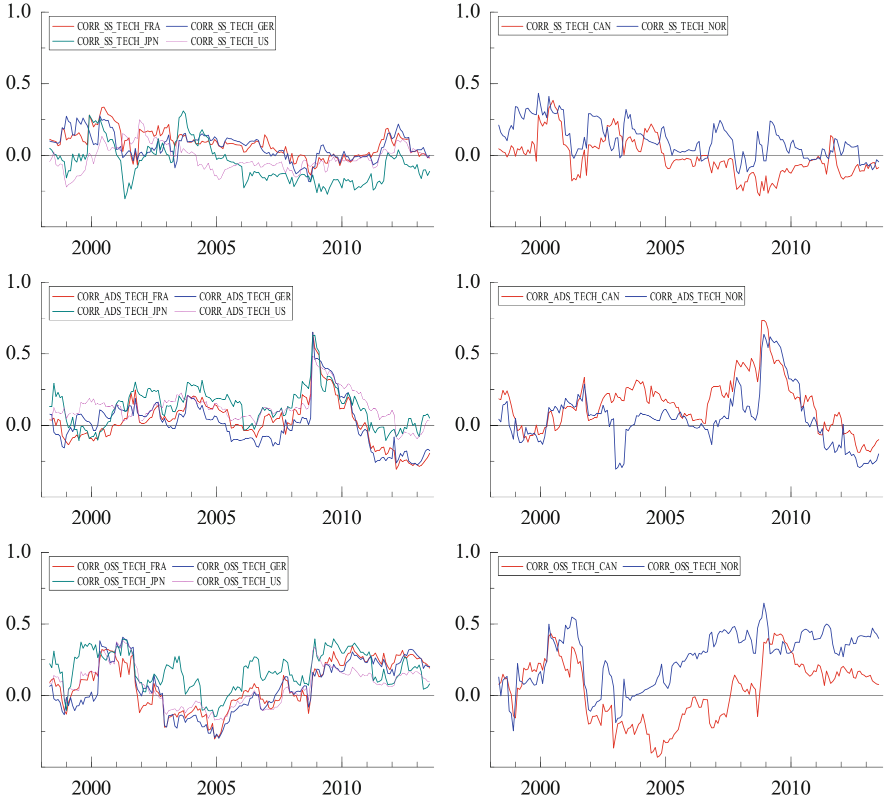

Fig. 3.16 Time-varying correlation between oil price shocks and the Technology sector. The sample runs from January 1998 until July 2013. *Note*: The group of oil-importing countries is presented in the *left column*, whereas the *right column* presents the results for the oil-exporting countries. The *first row* shows the correlations between stock market indices and supply-side shocks. The *second row* shows the correlations between stock market indices and aggregate demand shocks. The *third row* shows the correlations between stock market indices and oil-specific demand shocks

for the Banking and the Technology indices as well. The oil-specific demand shocks reveal a different correlation pattern from the Technology sector of the two oil-exporting countries. On one hand Norway's sector is exhibiting a positive correlation, whereas Canada's sector shows a moderate negative correlation during 2002–2008. The Banking sector of all countries is exhibiting a weak negative correlation with the oil-specific demand shocks, which peaks in 2009 and stabilises itself at a new higher correlation level since then. This is particularly evident for the oil-exporting countries. Notably different is the Japanese Banking sector, which is constantly positively in correlation with the oil-specific demand shocks.

3.5 Speculation and Regulation

Overall, the findings show that these relationships could be both positive and negative, depending on the type of oil price shock, the time period, the sector and the characteristic of the country. The aforementioned results also reveal that the demand-side shocks are mainly related to stock market returns, rather than the supply-side shocks. The latter finding is in line with Degiannakis et al. (2013, 2014), Abhyankar et al. (2013), Baumeister and Peersman (2012), Filis et al. (2011), Kilian and Park (2009), Hamilton (2009a, b) and Kilian (2009).

Furthermore, we observe that for the most part, and especially during the later period of the study, demand-side shocks are positively correlated with industrial sector returns, which reduce diversification opportunities. Even though this might be expected for the aggregate demand shocks, it might seem counter-intuitive for the oil-specific demand shocks. A closer look may illuminate a different picture, though.

Authors such as, Fattouh et al. (2013), Tang and Xiong (2012), Buyuksahin and Robe (2011), Buyuksahin et al. (2010) and Silvennoinen and Thorp (2010) report an increased correlation between commodities price changes (including oil) and financial markets' returns. According to Buyuksahin and Robe (2011), this can be attributed to the fact that a large number of hedge funds have entered the energy markets over the years. Hamilton and Wu (2012), Alquist and Kilian (2010), Fattouh (2010) and Buyuksahin et al. (2009), among others, also provide evidence that financial investors have increased their positions in the oil market since 2003.

This increased financialisation of the oil market results in oil price changes due to idiosyncratic movements (oil-specific demand shocks) rather than other due to changes in fundamentals (supply-side or aggregate demand shocks). The idiosyncratic character of oil price changes can be also explained by the fact that the increased participation of financial investors in the oil market has triggered increased speculative activity, driving oil prices away from its fundamentals. For example, when oil prices reached a peak in July 2008 at $145 and then crashed to about $30 at the end of the same year, it was believed that this was not attributed to fundamentals but rather to speculative activity. Even the Commodity Futures Trading Commission (CFTC) report in 2008, which originally claimed that this peak can be explained by oil market fundamentals, revised its claim in 2009, suggesting that, at least in part, the oil price peak was triggered by speculation.

Thus, we argue that given the increased idiosyncratic character of oil prices, the positive correlation that is observed between the industrial sector returns (especially after 2006) and oil-specific demand shocks is not counter-intuitive but rather expected.

Undeniably, as our results suggest that the increased speculation in the oil market has reduced the diversification opportunities between stocks and oil. In addition, speculative activity drives prices away from its fundamentals. So should speculative activity be restricted?

The belief that speculation has been held responsible for the behaviour of oil prices, over the last few years, led policy makers of the G20 countries towards shaping stricter regulation lines of the oil derivative market, as part of the tighter regulation of the financial markets (Fattouh et al. 2013). The main driver for restricting speculative activity is that the fact that this can lead to a speculative bubble. From the US side, the Obama administration passed the Dodd–Frank Act in 2010, which was aiming to provide a new financial regulation following the Great Recession of 2007–2009. Within this act, the Commodity Futures Trading Commission (CFTC) is now responsible to oversee the Over-The-Counter (OTC) derivatives market for both commodities and financial markets instruments. The European Union also introduced its new proposal for the regulation of benchmarks, which are used in setting commodities prices, among others, in an effort to review the Markets in Financial Instruments Directive (MiFID II).

Nevertheless, authors, such as Fattouh et al. (2013) opine that when regulating the oil market, in order to reduce the speculative activity, it will lead to reduced liquidity and weaker price discovery mechanisms. Stricter regulation may drive away the non bona fide investors, but at the same time it will reduce liquidity for the bona fide hedgers, causing malefactions in the oil market.

Overall, the issue at hand is rather complicated. On one hand, the increased speculation could lead to a speculative bubble in the oil market. Oil speculative bubbles are destabilizing and thus, given the increased positive correlation between the stocks and oil-specific demand shocks, the burst of this speculative bubble could have significant negative spillover effects in all stock market industrial sectors. Thus, it should be prevented. On the other hand, strict regulation to prevent this speculative activity could harm the oil market and its price discovery mechanism. Such malfunction of the price discovery mechanism in the oil market could lead to inefficient valuation of listed firms. This is justified by the fact that current stock values represent the sum of the future discounted cash flows of firms. However, oil could impact these future cash flows. Thus, if the price discovery mechanism in the oil market does not function well, then oil cannot be efficiently priced and as a consequence firms' future cash flows cannot be correctly estimated.

Hence, before the regulators make any further decisions regarding the oil market (i.e. restricting or not the speculative activity in the oil market) they should consider that regardless the direction that they might take the effects could be detrimental for the stock market sectors. Thus, this rather multifaceted problem demands careful planning.

Concluding Remarks

The aim of this study is to examine the time-varying correlation between the different oil price shocks and industrial sector stock market returns, for both oil-importing and oil-exporting countries. We use data from January 1998 until July 2013 of six industrial sectors indices for both oil-importing (France, Germany, Italy, Japan, Spain and the US) and oil-exporting countries (Canada and Norway). The industrial sectors indices include oil-intensive sectors (Materials, Oil&Gas), oil-substitutes (Metals&Mining, Utilities) and non-oil-related (Banks, Technology). This study add to the growing literature on the time-varying correlation between oil prices and stock market returns, and complement studies such as those by Filis (2014), Antonakakis and Filis (2013), Chang et al. (2013), Degiannakis et al. (2013), Filis et al. (2011), Bharn and Nikolovann (2010) and Choi and Hammoudeh (2010).

The findings suggest that the sign and magnitude of the correlation between the oil price shocks and index returns depends on the type of oil price shock, the time period, the sector and the characteristic of the country. Overall, though, we find that the supply-side shocks generate low to zero correlations, whereas the industrial sector indices are shown to be positively associated with the two demand-side shocks, for the most period. This finding is particularly interesting for the oil-specific demand shocks, as the literature has shown (although in a static environment) that oil-specific demand shocks negatively influence stock market returns.

This later result could be plausibly explained by the increased financialisation of the oil market, which resulted on one hand in lower diversification opportunities but on the other hand, possibly in increased speculative activity. Many voice the opinion that there is need to regulate the oil market in order to avoid this increased speculative activity, although others suggest that tighter regulations will result in the malfunction of the oil market. In any case, we opine that policy makers have a very difficult puzzle in their hands to solve, as on one hand they need to regulate the oil market to inhibit speculative activity but on the other hand they need to do so without harming the liquidity and the well-function of the market.

An interesting avenue for further research could be on the investigation of the ways that regulators could impose certain restrictions in the increased financialisation of the oil market, without harming its operation. Finally, future research could explore potential spillover effects between the oil price shocks and stock market returns. Spillover can provide additional information regarding the direction of the causal effects between oil price shocks and stock market returns.

References

Abel BA, Bernanke BS (2001) Macroeconomics. Addison Wesley Longman Inc., Boston

Abhyankar A, Xu B, Wang J (2013) Oil price shocks and the stock market: evidence from Japan. Energy J 34:199–222

Al Janabi MAM, Hatemi-J A, Irandoust M (2010) An empirical investigation of the informational efficiency of the GCC equity markets: evidence from bootstrap simulation. Int Rev Financial Anal 19:47–54

Alquist R, Kilian L (2010) What do we learn from the price of crude oil futures? J Appl Econ 25:539–573

Antonakakis N, Filis G (2013) Oil prices and stock market correlation: a time-varying approach. Int J Energy Stat 1:17–29

Arouri MEH (2011) Does crude oil move stock markets in Europe? A sector investigation. Econ Model 28:1716–1725

Arouri MEH, Nguyen DK (2010) Oil prices, stock markets and portfolio investment: evidence from sector analysis in Europe over the last decade. Energy Policy 38:4528–4539

Arouri MEH, Jouini J, Nguyen DK (2011) Volatility spillovers between oil prices and stock sector returns: implications for portfolio management. J Int Money Finance 30:1387–1405
Arouri MEH, Jouini J, Nguyen DK (2012) On the impacts of oil price fluctuations on European equity markets: volatility spillover and hedging effectiveness. Energy Econ 34:611–617
Barsky RB, Kilian L (2004) Oil and the macroeconomy since the 1970s. J Econ Perspect 18:115–134
Baumeister C, Peersman G (2012) Time-varying effects of oil supply shocks on the US economy. Bank of Canada Working Paper Series, WP2012-02
Bharn R, Nikolovann B (2010) Global oil prices, oil industry and equity returns: Russian experience. Scottish J Polit Econ 57:169–186
Bjornland HC (2009) Oil price shocks and stock market booms in an oil exporting country. Scottish J Polit Econ 56:232–254
Broadstock DC, Cao H, Zhang D (2012) Oil shocks and their impact on energy related stocks in China. Energy Econ 34:1888–1895
Burbidge J, Harrison A (1985) A historical decomposition of the great depression to determine the role of money. J Monet Econ 16:45–54
Buyuksahin B, Robe MA (2011) Does 'paper oil' matter? Energy markets' financialization and equity-commodity co-movements. Working paper, The American University
Buyuksahin B, Haigh MS, Harris JH, Overdahl JA, Robe MA (2009) Fundamentals, trader activity, and derivative pricing. Working paper, Commodity Futures Trading Commission
Buyuksahin B, Haigh MS, Robe MA (2010) Commodities and equities: ever a 'market of one'? J Alternat Invest 12:76–95
Caporin M, McAleer M (2008) Scalar BEKK and indirect DCC. J Forecast 27:537–549
Caporin M, McAleer M (2012) Do we really need both BEKK and DCC? A tale of two covariance models. J Econ Surv 26:736–751
Chang CL, McAleer M, Tansuchat R (2013) Conditional correlations and volatility spillovers between crude oil and stock index returns. North Am J Econ Finance 25:116–138
Choi K, Hammoudeh S (2010) Volatility behavior of oil, industrial commodity and stock markets in a regime-switching environment. Energy Policy 38:4388–4399
Ciner C (2012) Oil and stock returns: frequency domain evidence. J Int Financ Mark Inst Money 23:1–11
Degiannakis S, Filis G, Floros C (2013) Oil and stock returns: evidence from European industrial sector indices in a time-varying environment. J Int Financ Mark Inst Money 26:175–191
Degiannakis S, Filis G, Kizys R (2014) The effects of oil price shocks on stock market volatility: evidence from European data. Energy J 35:35–56
Driesprong G, Jacobsen B, Maat B (2008) Striking oil: another puzzle? J Financ Econ 89:307–327
El-Sharif I, Brown D, Burton B, Nixon B, Russell A (2005) Evidence on the nature and extent of the relationship between oil prices and equity values in the UK. Energy Econ 27:819–830
Elyasiani E, Mansur I, Odusami B (2011) Oil price shocks and industry stock returns. Energy Econ 33:966–974
Engle FR (2002) Dynamic conditional correlation: a simple class of multivariate GARCH models. J Bus Econ Stat 20:339–350
Engle RF, Kroner KF (1995) Multivariate simultaneous generalized ARCH. Econ Theory 11:122–150
Fattouh B (2010) Oil market dynamics through the lens of the 2002–2009 price cycle. OIES Working Paper 39, Oxford Institute for Energy Studies
Fattouh B, Kilian L, Mahadeva L (2013) The role of speculation in oil markets: what have we learned so far? Energy J 34:7–33
Filis G (2010) Macro economy, stock market and oil prices: do meaningful relationships exist among their cyclical fluctuations? Energy Econ 32:877–886
Filis G (2014) Time-varying co-movements between stock market returns and oil price shocks. Int J Energy Stat 2:27–42

Filis G, Chatziantoniou I (2014) Financial and monetary policy responses to oil price shocks: evidence from oil-importing and oil-exporting countries. Rev Quant Finance Acc 42:709–729
Filis G, Degiannakis S, Floros C (2011) Dynamic correlation between stock market and oil prices: the case of oil-importing and oil-exporting countries. Int Rev Financial Anal 20:152–164
Gogineni S (2010) Oil and the stock market: an industry level analysis. Financ Rev 45:995–1010
Hamilton JD (1983) Oil and the macroeconomy since World War II. J Polit Econ 91:228–248
Hamilton JD (1996) This is what happened to the oil price-macroeconomy relationship. J Monet Econ 38:215–220
Hamilton JD (2008) Oil and the macroeconomy. In: Durlauf S, Blume L (eds) New Palgrave dictionary of economics, 2nd edn. Palgrave McMillan Ltd., New York
Hamilton JD (2009a) Understanding crude oil prices. Energy J 30:179–206
Hamilton JD (2009b) Causes and consequences of the oil shock of 2007–08. Brookings Papers on Economic Activity Spring, pp 215–261
Hamilton JD, Wu JC (2012) Risk Premia in crude oil futures prices. Working paper, University of California at San Diego
Hammoudeh S, Li H (2005) Oil sensitivity and systematic risk in oil-sensitive stock indices. J Econ Bus 57:1–21
Hammoudeh S, Dibooglu S, Aleisa E (2004) Relationships among U.S. oil prices and oil industry equity indices. Int Rev Econ Finance 13:427–453
Hooker AM (1996) What happened to the oil price-macroeconomy relationship? J Monet Econ 38:195–213
Jones CM, Kaul G (1996) Oil and the stock markets. J Finance 51:463–491
Jones DW, Lelby PN, Paik IK (2004) Oil prices shocks and the macroeconomy: what has been learned since. Energy J 25:1–32
Kilian L (2008a) Exogenous oil supply shocks: how big are they and how much do they matter for the US economy? Rev Econ Stat 90:216–240
Kilian L (2008b) The economic effects of energy price shocks. J Econ Lit 46:871–909
Kilian L (2009) Not all oil shocks are alike: disentangling demand and supply shocks in the crude oil market. Am Econ Rev 99:1053–1069
Kilian L, Lee TK (2014) Quantifying the speculative component in the real price of oil: the role of global oil inventories. J Int Money Finance 42:71–87
Kilian L, Lewis LT (2011) Does the Fed respond to oil price shocks? Econ J 121:1047–1072
Kilian L, Murphy DP (2014) The role of inventories and speculative trading in the global market for crude oil. J Appl Econ 29(3):454–478
Kilian L, Park C (2009) The impact of oil price shocks on the US stock market. Int Econ Rev 50:1267–1287
Lescaroux F, Mignon V (2009) The symposium on ‘China’s impact on the global economy’: measuring the effects of oil prices on China’s economy: a factor-augmented vector autoregressive approach. Pac Econ Rev 14:410–425
Lippi F, Nobili A (2012) Oil and the macroeconomy: a quantitative structural analysis. J Eur Econ Assoc 10:1059–1083
Mohanty SK, Nandha M, Turkistani AQ, Alaitani MY (2011) Oil price movements and stock market returns: evidence from Gulf Cooperation Council (GCC) countries. Global Finance J 22:42–55
Nakov A, Pescatori A (2010) Oil and the great moderation. Econ J 120:131–156
Nandha M, Faff R (2008) Does oil move equity prices? A global view. Energy Econ 30:986–997
Narayan PK, Sharma SS (2011) New evidence on oil price and firm returns. J Bank Finance 35:3253–3262
Park JW, Ratti RA (2008) Oil price shocks and stock markets in the US and 13 European countries. Energy Econ 30:2587–2608
Rahman S, Serletis A (2011) The asymmetric effects of oil price shocks. Macroecon Dyn 15:437–471
Sadorsky P (1999) Oil price shocks and stock market activity. Energy Econ 21:449–469

Scholtens B, Yurtsever C (2012) Oil price shocks and European industries. Energy Econ 34:1187–1195
Segal P (2011) Oil price shocks and the macroeconomy. Oxford Rev Econ Policy 27:169–185
Silvennoinen A, Teräsvirta T (2009) Multivariate GARCH models. In: Anderson TG, David RA, Kreisand Blume L (eds) Handbook of financial time series. Springer, Berlin, Heidelberg
Silvennoinen A, Thorp S (2010) Financialization, crisis, and commodity correlation dynamics. Working paper, University of Technology, Sydney
Smith JL (2009) World oil: market or mayhem? J Econ Perspect 23:145–164
Tang K, Xiong W (2012) Index investment and financialization of commodities. Financ Anal J 68:54–74
Wang Y, Wu C, Yang L (2013) Oil price shocks and stock market activities: evidence from oil-importing and oil-exporting countries. J Comp Econ 41:1220–1239
Xekalaki E, Degiannakis S (2010) ARCH models for financial applications. Wiley, New York

OPEC's Influence on European Oil Stock Returns

4

Maarten Croese and Wim Westerman

Abstract

This study examines the influence of OPEC quota decisions (quota cut—increase or unchanged decision) on the stock price of four typical-listed-oil firms in Europe. In addition, we consider the influence on the Brent crude oil price. Using the event study methodology, 51 announcements are considered in the period 1991–2012. The results imply that OPEC quota decisions have a direct influence on both crude oil returns and oil firms' stock returns. This influence is either positive or negative and large or small, depending on the type of decision and the size of the firms in terms of market capitalization. However, since the difference between the two small firms is also significant, we conclude that market capitalization alone is not a determining factor.

Keywords

Europe • Event study • Oil firms • OPEC • Stocks

4.1 Introduction

Global oil demand is expected to grow by approximately 1 % per year and Europe, as a net importer of oil, therefore has a strategic vulnerable position (Bredin and Muckley 2011). Oil is inevitably one of the most valuable natural resources our planet has, as it is the most widely used component of primary energies in the world (Mazraati and Tayyebi Jazayeri 2004). Around 40 % of the world's oil production is supplied by the OPEC, the joint Organization of Petroleum Exporting Countries (Simpson 2008). Decisions made by OPEC, and the way they are implemented, can

M. Croese • W. Westerman (✉)
University of Groningen, Groningen, The Netherlands
e-mail: maartencroese@hotmail.com; w.westerman@rug.nl

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_4

greatly affect oil market sentiment and prices (Mazraati and Tayyebi Jazayeri 2004).

Currently, the OPEC has 12 member states. These are the five initial member states, Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela, as well as Qatar, Libya, United Arab Emirates, Algeria, Nigeria, Angola and Ecuador. The OPEC describes its central mission as '*to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry*.'[1] The organization has several meetings a year (OPEC conferences) to agree on the supply level of world oil production. These meetings generally result in an official statement (hereafter referred to as OPEC announcement) in which a declaration about the oil production level is made (either *cut*, *increase* or *maintain*). Therefore the OPEC conferences can be seen as an important source of information to the market.

Existing literature has focused upon the relation between OPEC announcements and crude oil prices, although there is ambiguity in the results. However, even though the relevance of OPEC announcements and oil prices is acknowledged by a large amount of literature, a gap exists when it comes to market reactions on OPEC announcements, with respect to oil producing firms. Partly furthering upon Simpson (2010), the main purpose of this research is to determine whether OPEC announcements are related to stock price movements of firms in the oil industry. Moreover, by selecting four typical firms (two large and two small firms) this study investigates the relation between exogenous oil supply shocks (i.e. the OPEC announcement) and stock returns of different oil firms in Europe. By distinguishing between large firms on the one hand (Shell and BP) and small firms on the other hand (Premier Oil and DNO International), we investigate if firm size plays a role in this relation.

The relation between OPEC announcements and oil stock returns cannot be seen separately from the relation between oil prices and oil stock returns. Therefore, and in line with existing literature among this topic, we first examine the relation between OPEC announcements and crude oil prices. Moreover, since a significant relation is found between OPEC announcements and oil futures prices on the one hand (Lin and Tamvakis 2010; Hyndman 2008; Guidi et al. 2006; Demirer and Kutan 2010) and oil futures prices and oil stock returns on the other hand (Huang et al. 1996; Sadorsky (1999); and others) one could expect a relation between OPEC announcements and oil stock returns. Simpson (2010) indeed finds evidence of cointegration of OPEC announcements and three individual oil firm stock returns, but he does not study signs of the relationships found.

Guidi et al. (2006) study the impact of OPEC announcements on an entire share price index. He finds a significant *negative* reaction on the UK share price index, at the day of an oil production *cut* announcement by the OPEC, but for the US, no

[1] http://www.opec.org/opec_web/en/about_us/23.htm.

significant results are found for either a production *cut* or *increase*. The reasoning behind this seems straightforward. Since even the largest oil producing firms are dependent on OPEC supplies, a production *cut* (less supply of oil) implies that oil producing firms have to pay a higher price for their oil sourced, which implies a negative influence on firm cash flow and thus stock returns. However, Huang's (1996) results (oil futures returns lead by one day on oil stock returns) show an opposite direction. Our findings are mixed, as we will show later.

As stated by Simpson (2008), the OPEC cartel has been a frequent topic of discussion. Some argue that the cartel has initiated unlawful conspiracies with large oil firms, causing extremely high gasoline prices and large differences in regional oil prices. In this paper, we assume efficient markets, where new information to the market is directly reflected in market prices of oil production firms. As stock prices reflect the discounted value of future cash flows, we investigate how news concerning the oil production levels is translated by the market into future performance of the firm.

A widely used method to measure the effect of unexpected news 'shocks' to the market is the event study methodology (Brown and Warner 1980, 1985; MacKinlay 1997). Since the OPEC conferences always conclude with an official press announcement about the oil production level, the unexpected character of the event is guaranteed. However, since the OPEC conferences may take some days, we will capture the pre-announcement days in our analysis to account for any leaking effects.

The rest of this paper is structured as follows. In Sect. 4.2, we provide an extensive overview of exiting literature concerning the relationship between oil spot- and future prices, stock returns, and OPEC announcements and we develop the hypotheses. Next, in Sect. 4.3 we discuss the data, followed by the methodology in Sect. 4.4. Subsequently, Sect. 4.5 provides an overview of the results. Finally, in Sect. 4.6 the concluding remarks and limitations of the research are discussed.

4.2 Literature Review

In the first section of this paragraph, we briefly describe the existing literature concerning the relation between OPEC announcements, oil- and stock prices. Next, a brief overview concerning the distinction between oil spot- and futures prices is given. Finally, in order to develop a better understanding of the relation between OPEC announcements and stock prices, we examine existing literature considering the relation between oil and stock prices.

4.2.1 OPEC Announcement and Oil Prices

Lin and Tamvakis (2010) investigate the influence of OPEC announcements on crude oil prices. They differ in 'heavy' and 'light' crudes (bad versus good quality) and use data of announcements between 1982 and 2008. They find that quota cuts always result in positive and statistically significant returns (price increase). For quota increases they find opposite results, however not always statistically significant. When prices are already relatively high, they find no significant results. When they look at differences in types of oil (e.g. heavy versus light crudes) they find significant results only when a decision is made to leave quotas unchanged. Thereby, the low quality heavy crudes have bigger price losses than the high quality lighter crudes.

Hyndman (2008) investigates the relation between 52 OPEC announcements and their effects on oil prices in the period 1986–2002. He also categorizes the different types of announcement (quota cut—unchanged or—increase) and finds that when OPEC reduces the quota, positive significant abnormal returns accrue to oil prices. This is not the case when the quota is increased. Then, Hyndman (2008) finds no significant results, opposed to Lin and Tamvakis (2010). Finally, he finds that when OPEC leaves the quota unchanged, a statistically significant negative reaction occurs to oil prices.

Guidi et al. (2006) investigate the influence of OPEC policy decisions on UK and US stock markets. In addition, they also look at oil spot price reactions. They only use 'increase' or 'decrease' decisions in their dataset and they differentiate between conflict- and non-conflict periods. They find that on average stock market reactions are more volatile on conflict days when OPEC announces to decrease oil production for both US and UK stock markets. They find reverse reactions for an increase in the quota. However, the magnitude of volatility during conflict days when OPEC decides to increase the quota is twice as large as during non-conflict days. During the whole period, the UK stock market was only slightly more volatile than the US stock market when OPEC increased the quota.

Demirer and Kutan (2010) investigate the efficiency of oil spot and futures prices with respect to OPEC announcements on the period 1983–2008. They only find statistically significant reactions for announcements that the oil production quota would be reduced. There is no significant reaction of oil prices when a quota is increased and when OPEC announces to maintain the status-quo. However, in the latter case there are significant negative cumulative abnormal returns, indicating price decreases in respond to the announcement. Therefore the authors conclude that the market seems to be surprised by the oil cut- and unchanged announcements.

Bina and Vo (2007) perform an event study to investigate OPEC output decisions in the period 1983–2005. In contrast to the previously described research, they only find statistically significant results when an oil increase is announced. The unchanged 'group' as well as the oil cut group show no significant results in the event window. What is remarkable is that the significant results are found in the days prior to the announcement date, indicating that the news reached the market before the official statement.

Schmidbauer and Rosch (2012) use OPEC announcements in the period 1986–2009 and investigate price reactions on West Texas Intermediate (WTI), a grade of crude oil also known as Texas light sweet. It is used as a benchmark in oil pricing and it is the underlying commodity of the New York Mercantile Exchange (NYMEX) oil futures contracts. They find that OPEC production cut announcements result in an oil price decrease opposed to a 'maintain' and increase decision that both result in a price increase.

Buyuksahin et al. (2010) differ in perspective from the previously described studies. They investigate whether OPEC price statements (rather than production level announcements) are related to crude oil prices. In that way they investigate the informational efficiency of the energy futures markets. They find no significant results in the OPEC price announcements, indicating that the pronouncements have already been incorporated in market expectations.

4.2.2 Oil Futures- and Spot Market

Oil futures contracts are traded many times more than spot oil contracts. Investors (speculators, hedgers) are the main agents that demand and supply these commodity contracts and thus together determine the price. Both futures and spot prices react to new information. In addition, there is ambiguity among research as for what prices reflect better new information to the market. Therefore we assume OPEC announcements to have a simultaneous impact on both oil spot- and future markets and we will only investigate the effect of OPEC announcements on spot prices. The following hypothesis is being tested.

H1: OPEC announcements do not have an effect on the spot price of the crude oil commodity.

4.2.3 Oil and Stock Prices

Stock prices are a reflection of discounted values of expected future cash flows. Guidi et al. (2006) name various reasons how future oil prices can affect expected cash flows and discount rates. The first is straightforward. Since oil is a real resource which is necessary for the production of many goods, expected changes in oil prices cause changes in the expected costs of a firm. In that way the expected cash flow of a firm is directly affected and thus stock prices will move in opposite directions as energy prices do. In addition, the effect will also depend on whether the firm is a net producer or consumer of oil. For the world economy as a whole, oil is an input and an increase in oil prices will therefore depress stock prices and real output (Huang et al. 1996; Hammoudeh and Li 2005).

Another way how expected oil prices can affect stock returns is via the discount rate, since the expected discount rate is composed of the expected real interest rate and the expected inflation rate. Both may vary as respond to different oil prices. Huang et al. (1996) explain this by considering the United States, a net importer of oil. Higher oil prices would negatively affect the US' balance of payments, putting a downward pressure on the dollar's foreign exchange rates and an upward pressure on the US' inflation rate. This implies that a higher expected inflation rate (as a consequence of higher oil prices) is negatively related to stock returns, as it is positively related to discount rates. However, since oil is a commodity, oil prices also track the inflation rate and so expected changes in the oil price might serve as a proxy for the expected inflation rate. So if an increase in the inflation rate causes stock prices to decline, and oil prices to rise at the same time, the negative impact of inflation on stock prices might be overstated.

The study of Huang et al. (1996) tests the link between stock prices and energy prices. They could not find a significant relation between oil futures returns and stock returns for broad market indices like the S&P 500. However they did find significant results for the correlation between the stock prices of three oil producing firms. The stock returns of Exxon, Chevron and Mobil are found to be positively correlated with current and lagged oil futures returns. However, when they test for the economic significance of this result, Huang et al. (1996) find that the bid-ask spread is too large relative to the movement of oil and stock prices so that investors are not able to profit of this small arbitrage opportunity.

Dorsman et al. (2013) study the general movements of oil-, stock- and bond returns in order to determine whether the addition of oil to a traditional portfolio of bonds and stocks can improve the risk-return trade-off. They show that sometimes stock- and oil prices show co-movements (during crises), while sometimes they move independently from each other. In general they conclude that there are no specific cyclical or counter cyclical patterns to be identified. However they do show that adding oil to a traditional portfolio improves the risk-return trade-off, i.e. oil serves as a hedge for both stocks and bonds. These findings show that oil prices and oil firms stock returns, plus their interdependent relation, are also dependent on exogenous economic circumstances.

Hammoudeh and Li (2005) examine the oil sensitivity of equity returns of two oil exporting countries, Norway and Mexico. They also test the sensitivity to oil prices to two oil sensitive industries, the US oil industry and the transportation industry. They acquire oil future prices from the NYMEX and use the AMEX Oil Stock Index (AMEXO, representing a wide group of stocks from companies involved in the oil industry) as a representation of the US oil industry. They find that oil price growth has a positive impact on oil-related stocks and that there is a negative relation between the oil price and the US transportation industry. In addition, the different impact of an oil price increase on different countries makes them conclude that investors should first invest in the US oil industry, than in Mexican stocks, before investing in Norwegian stocks to take an optimal profit of higher oil prices.

In a comparable study, Boyer and Fillion (2007) measure the stock sensitivity of Canadian oil and gas stocks to five common factors. All factors are highly significant and therefore they state that the crude oil price and natural gas price have a positive impact on oil and gas stock returns, whereas interest and exchange rates have a negative influence. This is in line with Sadorsky (2001), who shows that Canadian oil- and gas firms' stock returns are positively related to changes in oil price. In addition, Boyer and Fillion (2007) differentiate between oil producers and integrated firms, the latter being firms that have upstream (exploration, development, production) and downstream (distribution, marketing, refinery) activities. They find only two factors to be significant (market return, natural gas price return) in relation to integrated firms' stock returns. Also, they find the impact of oil and natural gas prices to be larger in producing firms than in integrated firms. They explain this by stating that integrated firms have less risk exposure because of vertical integration.

Nandha and Faff (2008) investigate 35 industry indices and find that oil price increases have a negative impact on equity returns, except for the oil, mining and gas industry. They confirm the view that the increases in earnings from OPEC- and other oil exporting countries due to a higher oil price is more than outweighed by the negative impact this has on economic activity in importing countries.

Simpson (2010) studies the effects of 13 OPEC production allocation meetings between early 1998 and late 2006, using both a 30 day and a 60 day event window. He examines three firms whose share returns dominate the AMEXO index. Royal Dutch Shell possesses the strongest relationship with the oil market, with Mobil being the next and BP showing the weakest relationship. Other than Simpson, we investigate the signs of the relationships. Having a European focus, we leave out Mobil from our sample, replacing it by two small firms.

Now, in order to investigate whether there is a direct link between OPEC announcements and oil stock prices, the following hypothesis is being tested.

H2: OPEC announcements have no effect on stock prices of oil firms.

The next hypothesis is a follow-up of the previous one and presumes that OPEC announcements do have an effect on the stock prices of oil producing firms (i.e. a rejection of *H1*). With this hypothesis, in line with the findings of existing literature considering OPEC announcements and oil prices, we will test for asymmetry in the effects of different OPEC announcements on stock prices. Therefore, the following hypothesis is being tested.

H3: There is no asymmetry in the effect of different announcements on stock prices of oil firms.

Finally, as far as we know, no research has ever differentiated between different oil firms and their stocks' reactions on OPEC announcement. By investigating two very large and two relatively small firms (in terms of market capitalization), we want to investigate whether the market responds differently to OPEC announcements, with respect to differences in these firms' size characteristics. Therefore we develop the following hypothesis.

H4: There is no asymmetry in the effect of different announcements on stock prices of different oil firms, based on the firms' market capitalization.

4.3 Data

Daily price data of Brent crude oil, traded on the electronic ICE platform, is analyzed for the period 1992–2012. Brent is high quality sweet light crude oil, ideally to process gasoline, kerosene and high-quality diesel. It is sourced from the North Sea in Northwestern Europe and its demand is high in that area. Therefore, we use Brent futures as a benchmark for the oil price reactions on OPEC announcements.

Table 4.1 The four oil companies of this study

Company	Country	Market Cap. (EUR bn)	Primary business	Main upstream activity
Royal Dutch Shell	NL	163.52	Upstream and downstream	North- and South America
BP	GB	105.07	Upstream and downstream	Angola, North Sea, Gulf of Mexico, Azerbaijan
Premier Oil	GB	0.11	Upstream	North Sea, South East Asia, the Middle East, Africa, Pakistan, Falkland Islands
DNO International	NOR	1.31	Upstream	Middle East

Furthermore, daily stock prices of the two largest- (Royal Dutch Shell and BP) and two of the smallest listed European oil firms (Premier Oil and DNO International) are retrieved. The firms represent of both small and large European firms. The choice for Royal Dutch Shell and BP in that light is straightforward. Premier Oil and DNO International are small firms with similar activities. More information on the four oil firms is provided in Table 4.1.

The entire sample is tested for market reactions on OPEC announcements. By comparing large and small firms, we investigate if the market differentiates into firm size. We compare the different announcements (quota cut, increase, unchanged) to test for stock price reaction asymmetry. The stock prices of each firm around the announcement days in the period 1992–2012 were requested. These days were found on the OPEC website[2] and in an article by the OPEC secretariat (2003). In total 51 OPEC announcements are considered: 16 quota 'cut', 12 quota 'increase' and 23 'unchanged' announcements (see Table 4.2). The daily stock price- and Brent futures data is retrieved from Thomson DataStream.

Figure 4.1 shows the monthly changes of the Brent crude oil price in the period 1992–2012.

The price of oil has changed radically over time. In the first 10 years of the sample period, oil prices fluctuate around 20–30 dollars per barrel.[3] From that point on, prices more than quadrupled with an absolute peak in 2007. Thereafter prices fell sharply in 2008 to 40 dollars a barrel, while climbing back to the 100 dollar level in the years following. While world real GDP increased by 9.4 % between 2003 and 2005, the next 2 years even had a 10.1 % cumulative growth. Chinese oil consumption alone in that period increased by 870,000 barrels per day. Consistent with the laws of supply and demand, the economic downturn halfway 2008 caused the oil price to decrease dramatically. US petroleum consumption fell by 8.8 % in

[2] http://www.opec.org/opec_web/en/press_room/28.htm.

[3] One barrel of oil contains around 158 L of oil.

Table 4.2 List of OPEC announcements

Announcement date	Decision	Announcement date	Decision	Announcement date	Decision
14-June-2012	0	1-June-2006	0	23-March-1999	–
14-December-2011	0	8-March-2006	0	24-June-1998	–
11-December-2010	0	31-January-2006	0	30-March-1998	–
14-October-2010	0	15-June-2005	+	1-December-1997	+
17-March-2010	0	16-March-2005	+	26-June-1997	0
22-December-2009	0	10-December-2004	–	28-November-1996	0
10-September-2009	0	03-June-2004	+	7-June-1996	+
28-May-2009	0	10-February-2004	–	22-November-1995	0
17-December-2008	–	24-April-2003	–	22-November-1994	0
24-October-2008	–	12-January-2003	+	26-March-1994	0
10-September-2008	0	12-December-2002	–	29-September-1993	+
5-March-2008	0	17-March-2001	–	10-June-1993	0
01-February-2008	0	17-January-2001	–	16-February-1993	0
5-December-2007	0	30-October-2000	+	27-November-1992	–
11-September-2007	+	11-September-2000	+	17-September-1992	+
14-December-2006	–	21-June-2000	+	22-May-1992	0
20-October-2006	–	29-March-1999	–	15-February-1992	–

Note: Dataset comprises of normal (bi-annual) OPEC meetings, and the extraordinary OPEC meetings. The latter are not planned in advance but are organized due to -changing-economic circumstances

that period.[4] The relative repair of the crisis in the years thereafter caused the crude oil price to climb again from 2009 onwards.

Figure 4.2 shows the time series of the four stock prices researched in this study. Because of large differences in prices, the stock of BP is used as a base and the other stocks are rescaled to get a better oversight of how the different stocks moved over time.

[4] http://www.econbrowser.com/archives/2009/04/causes_of_the_o.html.

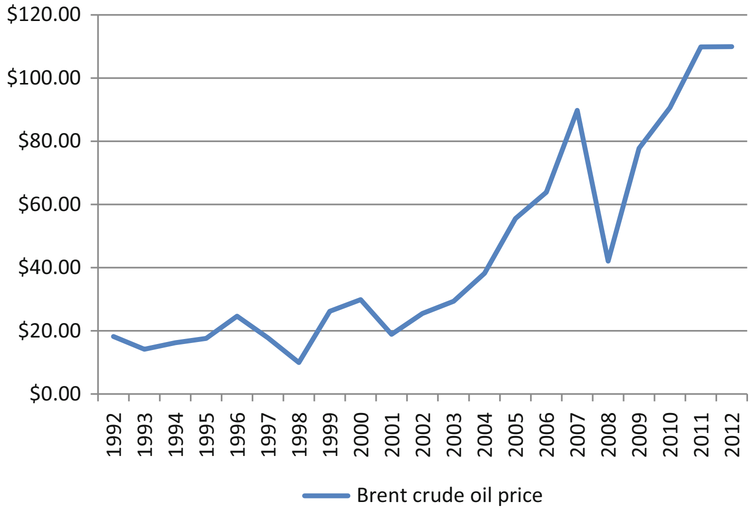

Fig. 4.1 Brent crude oil price per barrel (1992–2012)

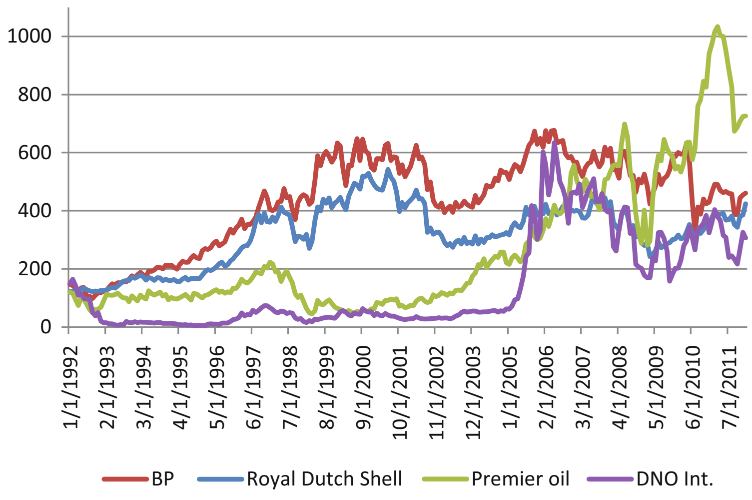

Fig. 4.2 Time series of the stock prices of the four firms (1992–2012). *Note*: The *vertical axis* only reflects BP stock price. Royal Dutch Shell, Premier Oil and DNO International stocks are rescaled with factor 15, 2 and 40 respectively to better show their relative movement over time

In period 1992–1998, the small stocks (Premier Oil, DNO International) show a clear relation with the crude oil price. The time series of the large firms in this period suggest that these firms are less dependent on the oil price in their stock performance. On the other hand, Royal Dutch Shell and BP tend to move in similar directions over time. Furthermore the economic crisis in 2008 is reflected in all stock movements, however in the recovery period, when oil prices increase again,

Table 4.3 Descriptive statistics in the estimation window (−65:−10) for the four stocks returns and Brent crude oil prices

Statistic	Total (of four firms)	Shell	BP	Premier Oil	DNO Int.	Brent oil
Mean	0.0000	−0.0002	−0.0001	0.0001	0.0002	0.0002
Median	0.0000	−0.0004	−0.0004	0.0003	−0.0001	0.0006
Std. deviation	0.0023	0.0021	0.0025	0.0039	0.0059	0.0030
Minimum	−0.0058	−0.0044	−0.0064	−0.0073	−0.0130	−0.0081
Maximum	0.0045	0.0051	0.0063	0.0097	0.0133	0.0073
Skewness	−0.1915	0.4699	0.0683	0.0937	−0.0484	−0.4925
Kurtosis	0.1402	−0.0266	0.7880	−0.5431	−0.2561	0.7583
Jarque–Bera	70.7654	21.3416	10.4371	26.7516	22.5498	12.7404

All the OPEC announcements are considered (N = 51)
Since the Jarque–Bera statistic is larger than 5.99, a normal distribution cannot be assumed. Therefore, the non-parametric Wilcoxon signed rank test is conducted in addition to the students' t-test. More information on these tests follows in the methodology section

only BP shows a remarkable drop in share price. This obviously holds relation with the BP oil disaster in the Gulf of Mexico on April 20th, 2010. Credit rating office Fitch immediately downgraded BP from a healthy AA status to BBB, almost the junk status.[5] The jump in Premier Oil shares in 2010 is a result of the discovery of new oil fields in the North Sea in June of that year.[6] The irregularity of the BP oil disaster and the discovery of a new oil field for Premier Oil could bias the dataset, however no OPEC announcements are held during or around these two events.

The descriptive statistics for the firms' stock prices and the Brent crude oil daily prices are presented below. First, we show the descriptive statistics containing the whole dataset of events (Table 4.3) without distinguishing for the different announcements. Following, Tables 4.4, 4.5, and 4.6 present the descriptive statistics for the quota cut—increase or unchanged quota respectively.

4.4 Methodology

As in previous research, in this paper we use the event study methodology (Brown and Warner 1980, 1985) to measure the impact of OPEC announcements on stock returns and crude oil prices. The event study methodology is particular useful to test the impact of events that are not anticipated by the market, such as OPEC press announcements about the oil production. When these have no impact on stock- or oil prices, the average abnormal returns (AAR's) are insignificant. In this study, we

[5] http://www.bloomberg.com/news/2010-06-15/bp-s-credit-rating-cut-by-fitch-to-bbb-two-levels-above-junk-from-aa.html.

[6] http://www.guardian.co.uk/business/marketforceslive/2010/jun/28/premieroil.

Table 4.4 Descriptive statistics in the estimation window (−65:−10) for the four stocks returns and Brent crude oil prices, for the quota cut announcement (N = 16)

Statistic	Total (of four firms)	Shell	BP	Premier Oil	DNO Int.	Brent oil
Mean	−0.0016	−0.0004	−0.0005	0.0002	−0.0006	0.0004
Median	−0.0036	−0.0009	−0.0014	−0.0007	−0.0021	0.0005
Std. deviation	0.0210	0.0045	0.0045	0.0085	0.0126	0.0070
Minimum	−0.0461	−0.0099	−0.0086	−0.0240	−0.0386	−0.0232
Maximum	0.0471	0.0102	0.0101	0.0199	0.0267	0.0132
Skewness	0.3628	0.3403	0.5090	0.1736	−0.2788	0.9038
Kurtosis	−0.2273	−0.4103	−0.3068	0.9215	0.7224	1.7051
Jarque–Bera	7.2948	8.0621	7.9806	2.9605	3.6656	3.2961

Table 4.5 Descriptive statistics in the estimation window (−65:−10) for the four stocks returns and Brent crude oil prices, for the increased quota announcement (N = 12)

Statistic	Total (of four firms)	Shell	BP	Premier Oil	DNO Int.	Brent oil
Mean	−0.0004	0.0001	0.0002	−0.0006	−0.0001	0.0003
Median	−0.0008	−0.0004	−0.0004	−0.0015	0.0007	0.0001
Std. deviation	0.0162	0.0039	0.0043	0.0060	0.0111	0.0066
Minimum	−0.0347	−0.0080	−0.0153	−0.0149	−0.0413	−0.0166
Maximum	0.0370	0.0076	0.0086	0.0166	0.0215	0.0196
Skewness	−0.0924	0.1246	−0.6088	0.5537	−0.8137	0.1325
Kurtosis	−0.3226	−0.7928	2.1022	0.6275	2.6026	1.6691
Jarque–Bera	5.5370	7.2238	1.1444	3.4276	1.4030	0.9207

Table 4.6 Descriptive statistics in the estimation window (−65:−10) for the four stocks returns and Brent crude oil prices, for the unchanged quota announcement (N = 23)

Statistic	Total (of four firms)	Shell	BP	Premier Oil	DNO Int.	Brent oil
Mean	0.0010	−0.0002	−0.0001	0.0005	0.0008	0.0000
Median	0.0013	−0.0002	−0.0001	0.0004	0.0008	−0.0004
Std. deviation	0.0146	0.0027	0.0031	0.0048	0.0085	0.0029
Minimum	−0.0322	−0.0076	−0.0074	−0.0081	−0.0178	−0.0065
Maximum	0.0471	0.0063	0.0064	0.0118	0.0289	0.0056
Skewness	0.1791	−0.1212	−0.2348	0.2873	0.4368	0.1147
Kurtosis	1.4517	0.4416	−0.2588	−0.7299	1.2506	−0.8312
Jarque–Bera	2.4205	6.3288	10.3884	13.6485	3.6644	7.3655

use a window of 21 days (−10:10): 10 days prior to the OPEC press announcement and 10 days after the event day (t = 0). Lin and Tamvakis (2010) use a similar event window. The duration of some of the events is longer than one day, and therefore there is a bigger chance of leaking effects, prior to the official OPEC press announcement. Any possible leaking effects would be reflected by significant AAR's in the days (−10:0). The argument for the long post-event window (0:10) is given by Lin and Tamvakis (2010): it takes longer for the market to absorb information, and this new information is therefore not priced directly into stock prices. They also argue that with a too long event window, other information than the OPEC announcements could have an effect. However, Wirl and Kujundzic (2004) showed that from a variety of event windows, the most appropriate is an event window with 10 days before and after the event.

There is no exact procedure about the best estimation period (Bina and Vo 2007). Since oil prices fluctuate heavily, it cannot be too long though, otherwise it does not reflect the current trend of oil returns before the meetings, leading to incorrect estimation. On the other hand, when the period is too short, there are simply not enough observations for an adequate estimation of the model. Therefore, Bina and Vo (2007) use an estimation period of 30 days. Lin and Tamvakis (2010) apply an event window of 40 days. However, in the event study methodology, as first described by Brown and Warner (1980), the longer the estimation period, the better the estimation of the model. Demirer and Kutan (2010) use an estimation period of 60 days. All in all, we have used a 55 days estimation period (−65:−10).

Brown and Warner (1980, 1985) describe several ways to compute the average abnormal returns in the event window, of which the mean adjusted return, is the most basic one. It yields similar results as the more complex methods to calculate average abnormal returns. Therefore, in line with Bina and Vo (2007) and Lin and Tamvakis (2010), we use the mean adjusted return method as well. Also, we show market adjusted return results (Brown and Warner 1980, 1985), in which the mean adjusted returns are corrected for the movement of the market. In addition, we use the MSCI world index as a proxy for market return.

4.5 Results

This section presents the results for the mean- and (partly) market adjusted method. In addition, the Wilcoxon singed rank values are shown, since not all sub-datasets are normally distributed. However, in line with current research, the mean-adjusted method is accepted as a solid measure for calculating abnormal returns. Therefore we will limit our analysis primarily to the mean-adjusted method. Also when the data is not normally distributed, we assume normality because according to the Central Limit Theorem, the sample of independent random variables will be approximately normally distributed.

The Wilcoxon test values are in all cases less significant than the mean adjusted method values. A possible explanation is that the estimation period is not long enough. To give an appropriate estimation of the normal returns, MacKinlay (1997) suggests an estimation period of 200 days. However, all the events (OPEC announcements) would then overlap in this study, which would bias the data. Therefore, we use a shorter estimation period.

In addition, Lin and Tamvakis (2010) and Guidi et al. (2006) distinguish in their data the general level of oil prices and conflict- and non-conflict periods respectively. They find significant and different results for the different sub data, which indicates that market conditions and political influences have a significant impact on the dataset. To take these issues into account, however, goes beyond the scope of this research.

Table 4.7 shows the CAR Student's t-values of the Brent crude oil returns around the OPEC announcements (−10:10). Furthermore, Fig. 4.3 shows the CAR values in the event window graphically for the mean-adjusted method.

For the quota cut announcement, the CAR values are insignificantly positive in general, with exceptions at day −10, day −7, day −5, day 1 and day 10. There is one significant positive return at a 10 % level, namely on day 7. Guidi et al. (2006), Demirer and Kutan (2010) and Lin and Tamvakis (2010) find positive significant

Table 4.7 Student's t- and Wilcoxon signed rank test values of the CARs of the Brent crude oil returns around the OPEC announcements

	Quota cut		Quota increase		Quota unchanged	
	Mean adjusted	Wilcoxon value	Mean adjusted	Wilcoxon value	Mean adjusted	Wilcoxon value
CAR-10	−0.923	1.473*	0.437	0.419	−0.146	0.242
CAR-9	0.055	2.094**	0.387	0.489	−0.680	0.802
CAR-8	−0.0301	−0.025	1.858*	0.908	0.212	0.055
CAR-7	−0.638	0.439	1.935*	0.279	−0.584	0.093
CAR-6	−1.069	−0.025	2.609**	0.489	−1.138	0.354
CAR-5	−0.031	1.318	5.307***	0.559	−1.201	0.727
CAR-4	0.4281	0.129	3.360***	1.327	−0.885	0.466
CAR-3	0.819	0.542	3.267***	0.069	−1.119	−0.018
CAR-2	1.292	0.646	2.707**	0.139	−1.440	0.317
CAR-1	1.125	0.284	2.619**	0.628	−1.432	0.391
CAR0	0.385	1.215	2.959**	0.628	−1.497	0.802
CAR1	−0.608	1.990**	0.777	0.000	−1.018	0.690
CAR2	0.596	2.042**	2.161*	1.397	−1.850*	0.914
CAR3	1.435	0.904	0.404	1.048	−2.400**	1.325
CAR4	1.269	0.129	3.756***	1.747*	−2.849***	1.138
CAR5	1.364	0.336	1.000	1.677*	−3.914***	0.018
CAR6	1.548	0.439	3.659***	1.188	−2.624**	1.399
CAR7	2.074*	1.111	1.752	1.467	−3.143***	0.765
CAR8	1.145	1.680*	0.754	0.349	−1.119	0.205
CAR9	1.208	0.542	−3.444***	0.628	−1.278	0.727
CAR10	−1.596	1.163	−4.763***	0.908	−1.495	0.279

*Significant at 10 % level; **significant at 5 % level; ***significant at 1 % level

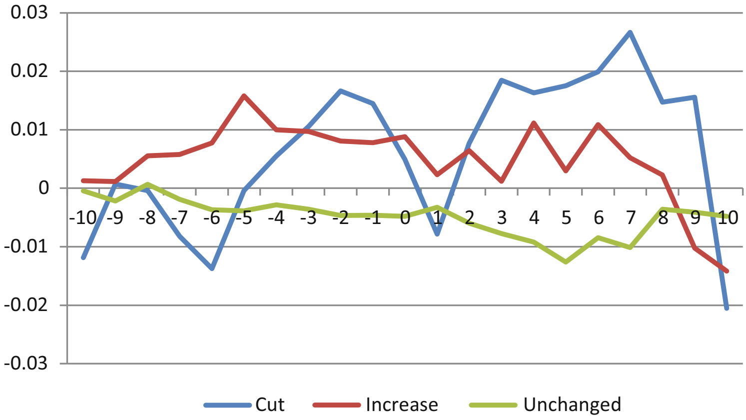

Fig. 4.3 Graphical representation of the Brent crude oil CARs in the event window, mean adjusted method

returns in most cases for a quota cut announcement. However, Lin and Tamvakis (2010) provide an explanation for negative returns after quota cuts as the OPEC not being credible enough to enforce the announced cuts on its members, with the market perceiving the cuts as not being far-reaching enough.

For the quota announcement being unchanged, the CAR is negative, significant at a 10 % level on day 2. In the next 5 days, the CAR's are negative, significant at a 5 % level. According to Hyndman (2008), when times are bad, the OPEC sometimes reduces the aggregate quota and sometimes it does not. The market therefore holds intermediate beliefs during bad times. When no change is announced, a negative reaction will occur.

For the quota increase, we find significant positive returns, at 5 and 1 % levels, in the 9 days up until the event itself. This indicates that the market has already adjusted prices before the official announcements. There is a positive significant effect, at a 10 % level, on day 2. There are also positive effects at day 4 and day 6, at a 1 % level. However, we find also negative effects, at day 9 and 10, which are significant at a 1 % level.

Although the results found are not all that significant, there are negative significant post event returns in case of a quota unchanged decision. Also, before and after the event there are positive results with the quota increased decision. Thus we reject the first hypothesis that OPEC announcements have no influence on the spot price of the crude oil commodity.

Now we focus on the influence of OPEC announcements on oil companies' stock prices. Again, we discuss primarily the mean-adjusted method results. Table 4.8 shows the Student's t- and Wilcoxon signed rank test values of the cumulative abnormal returns for the four oil companies taken together, so without distinguishing for small or large companies. The CAR's of all companies taken together are shown graphically in Fig. 4.4.

Table 4.8 Student's t- and Wilcoxon signed rank test values in the event window for the different OPEC announcements (N = 51) and all companies taken together (N = 4)

	Quota cut			Quota increase			Quota unchanged		
	Mean-adjusted	Market adjusted	Wilcoxon value	Mean-adjusted	Market adjusted	Wilcoxon value	Mean-adjusted	Market adjusted	Wilcoxon value
CAR-10	−0.969	−0.881	0.982	−0.443	−0.430	1.544	−0.805	−0.824	2.171**
CAR-9	−0.253	0.650	0.784	0.229	0.652	0.395	−2.702**	−1.942*	2.266**
CAR-8	0.080	0.954	0.346	−0.831	−0.377	0.149	−2.261**	−1.490	1.827**
CAR-7	−0.385	0.530	0.537	−0.488	−0.043	0.138	−2.570**	−1.807*	1.902*
CAR-6	−0.735	0.212	0.859	−0.056	0.376	0.631	−1.825*	−1.045	1.245*
CAR-5	0.096	0.968	0.092	−0.601	−0.153	0.497	−1.350	−0.558	0.758
CAR-4	1.030	1.817*	1.208	−0.331	0.109	0.056	0.054	0.879	0.002
CAR-3	1.138	1.915*	0.928	0.032	0.461	0.149	−1.039	−0.240	−0.002
CAR-2	0.739	1.552	0.626	0.388	0.806	0.621	−2.313**	−1.544	1.130
CAR-1	1.357	2.114**	1.195	0.829	1.233	0.600	−2.660**	−1.899*	0.572
CAR0	0.476	1.313	0.346	0.997	1.397	0.467	−1.875*	−1.095	0.346
CAR1	−0.180	0.717	0.229	1.224	1.617	0.713	−1.245	−0.451	0.042
CAR2	0.222	1.083	0.140	1.473	1.859*	0.569	−0.642	0.167	0.291
CAR3	0.465	1.303	0.168	2.113*	2.480**	0.744	−1.648	−0.864	0.825
CAR4	1.007	1.796*	−0.003	1.618	1.999*	0.364	−2.409**	−1.642	1.011
CAR5	0.944	1.739	0.229	1.610	1.991*	0.538	−1.713	−0.929	0.730
CAR6	1.738	2.461**	0.168	2.314**	2.675**	1.123	−3.036***	−2.284**	1.502
CAR7	2.157**	2.841**	0.243	2.275**	2.637**	1.174	−0.289	0.528	0.461
CAR8	2.449**	3.107***	0.455	1.653	2.033*	0.969	−1.020	−0.221	0.885
CAR9	1.878*	2.588**	0.250	1.229	1.622	0.631	−1.377	−0.586	0.746
CAR10	2.348**	3.015***	0.661	0.825	1.230	0.190	−4.157***	−3.431***	1.415

*Significant at 10 % level; **significant at 5 % level; ***significant at 1 % level

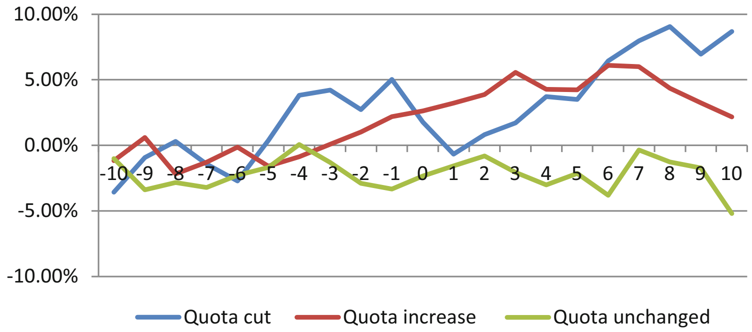

Fig. 4.4 Graphical representation of the whole dataset of the oil companies' CARs in the event window, mean-adjusted method

4.5.1 Quota Cut Announcement

Table 4.8 shows some highly significant values for both the mean- and market adjusted method quota cut announcements. Especially at the end of the event window, starting on day 7 CAR (−10:7), positive significant abnormal returns accrue for the mean adjusted method. In addition, for the market-adjusted method there are positive significant CARs on day −4 (CAR −10:−4), day −3 (CAR −10:−3) and day −1 (CAR −10:−1) prior to the event, which could indicate possible leaking effects. The results are quite in line with the findings of Hyndman (2008), who describes that: '*positive abnormal returns accrue*, *peaking approximately 3 days before the announcement and then make a significant fall*, *only to recover again at the end of the event window*'. On contrary, Hyndman (2008) finds the same positive significant returns for the crude oil price, which we don't find.

Figure 4.5 shows the CARs of the four different oil companies. The different Student-t and Wilcoxon signed rank values of the different CARs around the event window are not shown, but available with the authors upon request. Again, we will focus our analysis on the mean-adjusted method. However, the market-adjusted values are also reported when relevant.

The Shell and BP values show a very similar pattern. In line with the general findings described above of a quota cut for all companies taken together, positive significant values occur. In the prior event window, this occurs on day −4 (CAR −10:−4) and day −1 (CAR −10:−1) for Shell and on day −4 CAR (−10:−4) and day −3 CAR (−10:−3) for BP. In addition, for both Shell and BP the more significant values (on the 5- and 1 % level) occur for the first time on day 3 CAR (−10:3). Then, from day 5 (CAR −10:−5) and day 6 (CAR −10:6) on for Shell and BP respectively, positive significant returns occur until the end of the event window.

When looking at the CARs of Premier Oil, we find other values than what one would expect. The values are negative during the whole event window and significant values occur, starting from day −9 (CAR −10:−9) until day 5 (CAR −10:5) of

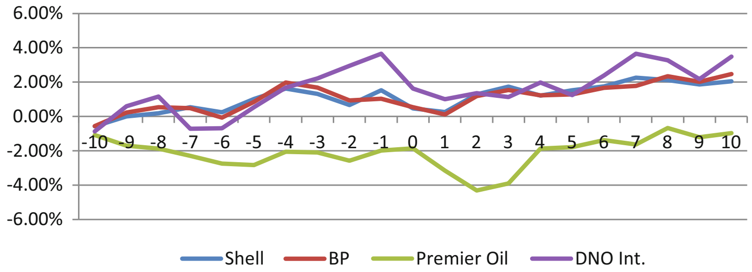

Fig. 4.5 Graphical representation of the oil companies' CARs in the event window, for the quota cut (mean-adjusted method)

the event window. In addition, on day 7 (CAR −10:7), a negative significant value occurs, albeit on a 10 % level. The CARs reach the lowest values on day 1 (CAR −10:1), 2 (CAR −10:2) and 3 (CAR −10:3) of the event window (all highly significant). However, also in the prior event window on days −6 (CAR −10:−6) and −5 (CAR −10:−5), negative highly significant values occur. Figure 4.5 shows that in general, the patterns of the four companies are not completely random. A certain pattern with increasing CARs on day 1 for Shell, BP and DNO International and day 2 for Premier Oil seems to occur. However, the negative values during the whole event window for Premier Oil give the impression that investors of this firm have different interests concerning a quota cut announcement than for the other three firms. Since Premier Oil is the smallest of the four firms, assuming higher oil costs because of the quota cut announcement might indicate higher relative costs for this firm. As DNO International also has only upstream activities, the size of the firm (market capitalization) seems to be a determining factor here.

For DNO International, positive significant values occur on day −2 (CAR −10:−2) and day −1 (CAR −10:−1) of the prior event window. This again might indicate leaking effects of a quota cut, or the market already anticipating on a quota cut, based on the state of the economy (Hyndman 2008). For DNO International, positive significant values occur on day 7 (CAR −10:7), day 8 (CAR −10:8) and day 10 (CAR −10:10) of the post event window.

4.5.2 Quota Increase Announcement

Turn to Table 4.8 again for the values of the aggregate CARs of the four companies in case of a quota increase announcement. Again, the different Student-t and Wilcoxon signed rank values of the different CARs around the event window are available upon request. For the mean adjusted method, significant returns occur on day 3 (CAR −10:3), and on day 6 (CAR −10:6) and 7 (CAR −10:7). Although we find some positive significant returns, the impact is less than for the quota cut announcement. Guidi et al. (2006) argue that quota increase announcements don't affect oil prices and therefore don't affect oil companies' stocks. In addition, Hyndman (2008) argues the same because OPEC always increases the quota in good economic times. Therefore, the market fully anticipates this. We do find significant values for the Brent crude oil commodity for a quota increase announcement, but only on a 10 % level for the market adjusted method (Table 4.7). Therefore, one would expect only light significant values for the oil firms' stock returns in case of a quota increase, as is the case.

The rationale behind positive significant values to occur could be that OPEC had not increased the quota during economic good times. Then, the market would never be able to fully anticipate the decision of OPEC anymore. As an increase would be required by the market, positive abnormal returns would occur if that decision has been made. It is not certain whether OPEC has made such a decision, as one can never know if the market and OPEC always have a similar view on when economic times are good or bad.

Figure 4.6 shows the CARs of the four oil companies separately in case of a quota increase announcement. The paths of Shell and BP show a similar track, just as was the case for the quota cut announcement. On contrary, the two small firms Premier Oil and DNO International show opposite CARS during the event window. Considering the prior event window for Shell, on day −6 (CAR −10:−6) and day −3 (CAR −10:−3), significant returns occur at a 10 % level. For BP, no significant returns occur in the prior event window. In the post event window, significant CARs on the first 3 days occur for Shell; on day 1 (CAR −10:1) at a 5 % level, day 2 (CAR −10:2) at a 1 % level and on day 3 at a 10 % level for the mean adjusted method. For BP, only on day 2 (CAR −10:2) and day 3 (CAR −10:3) positive significant values occur at a 5 % level.

For Premier Oil positive significant values are found for the first time on day −3 (CAR −10:−3), at a 10 % level. Then, from the day of the event (CAR −10:0) until the last day of the event window, significant positive returns occur. They start at a 10 % level on day 0 (CAR −10:0) and 1 (CAR −10:1), than at a 5 % level on day 2 (CAR −10:2), to return to a 10 % significant level on day 9 (CAR −10:9) and 10 (CAR −10:10). For DNO International, there are even less expected results. As can be seen in Fig. 4.5, opposed to the other three firms, DNO International has negative returns almost during the whole event window. These are significant at a

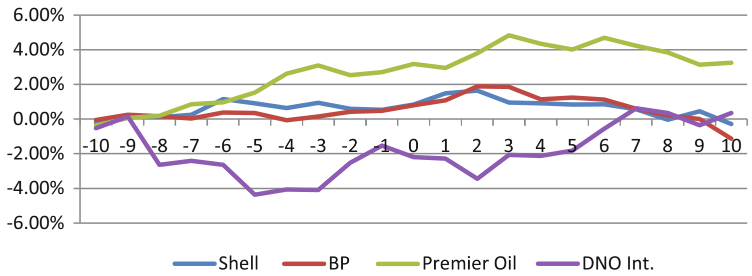

Fig. 4.6 Graphical representation of the oil companies' CARs in the event window, for the quota increase (mean-adjusted method)

5 % level on days −5 (CAR −10:−5) until −3 (CAR −10:−3), and 2 days after the event (−10:2). As was the case for Premier Oil for the quota cut, now the market seems to have different interests and beliefs for DNO International when a quota increase occurs than for the other three firms.

4.5.3 Quota Unchanged Announcement

For the unchanged quota announcement for the whole dataset of firms, Table 4.7 shows significant negative returns, starting at a 5 % level on day −9 (CAR −10:−9) until day −7 (CAR −10:−7). Then, on day −6 (CAR −10:−6) the significance weakens to a 10 % level, where after no significant returns occur anymore until 2 days prior to the event (CAR −10:−2). They remain significant until the day of the announcement, first at a 5 % level, and on the event day itself on a 10 % level. Next, in the post-event window, significant negative returns occur on day 4 (CAR −10:4) at a 5 % level, day 6 (CAR −10:6) at a 1 % level, and on day 10 (CAR −10:10) at a 1 % level. Lin and Tamvakis (2010) find mixed results for the unchanged quota announcement. Although their results are not all significant, they are all negative, as is the case in this study. In addition, Hyndman (2008) finds similar results with strong negative abnormal returns.

When we look at Fig. 4.7, the CARS in the event window of the four companies show a visible difference between CARS of the large (Shell, BP) and small (Premier Oil, DNO International) firms. Shell and BP seem to follow a very similar track, with both negative and positive returns in the prior event window (non-significant). At the end of the event window, positive significant returns occur for Shell at a 5 % level on days 7 (CAR −10:7), 9 (CAR −10:9) and 10 (CAR −10:10) and on a 10 % level on day 8 (CAR −10:8). For BP, on day 2 (CAR −10:2), day 3 (CAR −10:3) and day 7 (CAR −10:7) positive significant returns occur at both the 5- and 10 % level. This is contrary to what one would expect. Hyndman (2008) finds cumulative abnormal returns to around −3.5 %

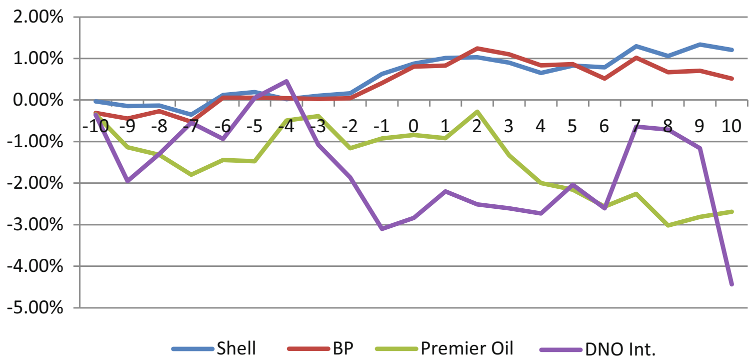

Fig. 4.7 Graphical representation of the oil companies' CARs in the event window, for the unchanged quota announcement (mean-adjusted method)

where Lin and Tamvakis (2010) even find cumulative abnormal returns that in some cases reach values around −10 %. However the results are based on crude oil returns rather than oil firms' stock prices.

Premier Oil has significant negative returns in the prior event window in days −7 (CAR −10:−7) at a 5 % level and on day −5 (CAR −10:−5) at a 10 % level. Then the CARS are declining from day 2 (CAR −10:2) on, becoming significant on day 4 (CAR −10:4) until the end of the event window. One day prior to the event, DNO International shows negative cumulative returns, significant at a 5 % level. Then, the values stay significant until day 4 (CAR −10:4). In addition, day 6 (CAR −10:6) and day 10 (CAR −10:10) show significant negative returns at the 5- and 1 % level respectively. Figure 4.6 shows the drop in the end of the event period.

We have to reject the second and third hypothesis that OPEC announcements have no effect on the stock prices of oil producing firms, and that there is no asymmetry in the effect of different announcement outcomes on the stock price of oil firms respectively. In addition, we also reject the fourth hypothesis that there is no difference in oil firms' stock reactions on OPEC announcements based on market capitalization. Moreover, as Shell and BP show very similar market reactions, it seems that the market does not incorporate any more firm specific factors with respect to these firms and the different OPEC announcements. However, the returns of Premier Oil and DNO International move in separate ways. While not having the exact same market capitalization, compared to Shell and BP they are both small. This implies that there are more firm specific issues to be taken into account.

4.6 Discussion/Conclusion/Recommendations

Table 4.9 presents an overview of the results on the hypotheses tested in this study. They relate to the relation between OPEC announcements and the crude oil price on the one hand, and between OPEC announcements and oil firms' stock prices on the other hand. By investigating exogenous oil supply 'shocks' (i.e. OPEC announcements) for two sub datasets (large- and small firms) in Europe, we show that indeed there is a significant difference between these two datasets. The large firms' returns, Shell and BP, show a similar track for all the quota announcements. On contrary, the small firms' returns, Premier Oil and DNO International, move apparently random in the event window. A variety of possible explanations for positive or negative abnormal returns have been given. However, since there is a significant difference between the two small firms as well, it seems that there are more firm specific characteristics that play a role in the relation between OPEC announcements and stock returns for small firms.

For the influence of OPEC announcements on Brent crude oil returns, the results for the unchanged quota announcements are in line with the current body of research. Negative returns can be explained as follows. During good times, OPEC always increases the quota and the market fully anticipates this, not leading to any significant returns. However, during bad times, OPEC sometimes increases the

Table 4.9 Overview of the results on the four hypotheses tested in this study

Hypotheses	Quota decision	Rejected yes/no	Highest significance level	Sign positive/ negative	In line with literature yes/no
OPEC announcements do not have an effect on the spot price of the crude oil commodity	*Cut*	YES	10 %	Positive	YES
	Increase	YES	1 %	Positive	YES
	Unchanged	YES	1 %	Negative	YES
OPEC announcements have no effect on the stock prices of oil producing firms	*Cut*	YES	5 %	Positive	YES
	Increase	YES	5 %	Positive	NO
	Unchanged	YES	1 %	Negative	YES
There is no asymmetry in the effect of different announcements on the stock price of oil firms	*Cut*	YES	–	–	–
	Increase	YES	–	–	–
	Unchanged	YES	–	–	–
There is no asymmetry in the effect of different announcements on the stock price of different oil firms, based on the firms' market capitalization	*Cut*	YES	–	–	–
	Increase	YES	–	–	–
	Unchanged	YES	–	–	–

Note: For the third and fourth hypothesis, all the different quota announcements yield different results for the four firms

quota and sometimes holds the status quo. A status quo decision during bad times is seen by the market as a failure to agree on a cut in production. Therefore the market adjusts prices downward. In addition to this, quite some significant returns are found in case the OPEC increases its quota. We show that the signs of the cumulative abnormal returns are positive from the start of the event window until almost its end. This is also in line with current research. It indicates that the market has already adjusted prices before the official announcements. For the quota cut announcements, the generally positive returns are once more in line with the literature. Negative returns after quota cuts may indicate that the market perceives the OPEC decision as not being far-reaching enough.

For the influence of OPEC announcements on oil firms' stock prices in general, we find positive significant returns for a quota cut, positive significant returns for a quota increase and negative significant returns for an unchanged quota decision. Positive abnormal returns for oil firms are logical when the oil price is dependent on OPEC announcements, since oil serves as an input for the economy as a whole and increasing oil prices will have an opposite influence on firms' stock prices. However, we find that OPEC reduction announcements lead to both positive abnormal oil- and stock price returns. A logical explanation is that oil-producing firms are little consumers and more producers of oil, and a general increase in the level of crude oil prices would let oil producing firms benefit from higher selling prices.

Firms from oil industries obviously only use oil as an input. In addition, since the oil industry is better off with a cut in bad times, the (stock) market may positively react on a quota cut, leading to positive stock returns.

For the quota increase announcement, we find some significant returns, albeit less than for the quota cut announcement. A reasonable explanation for positive abnormal returns to occur is that OPEC, in the eyes of the market, has recently, maybe just once, not increased the quota when economic times were good. Then, the increase announcement is unexpected for the market. In addition, information asymmetry between OPEC and the market might force OPEC to not increase the quota, even though times are good and the market expects an increase. For the unchanged quota, negative significant returns occur with the same reasoning as for the crude oil commodity stated above.

Existing literature has focused primarily on the relation between OPEC announcements and crude oil returns. However a gap exists when it comes to OPEC announcements and oil stock returns. This paper presents new evidence to fill this gap; however the results imply that more work needs to be done. Firm specific characteristics, like size in this study, seem to play a role when oil stocks react to oil supply shocks. There are many other factors that influence the oil firms' stock prices, irrespective of OPEC decisions. Excluding all possible variables requires a thorough analysis of each firm, which goes beyond the scope of this research. Therefore, the results of this study should be interpreted with this knowledge.

References

Bina C, Vo M (2007) OPEC in the epoch of globalization: an event study of global oil prices. Global Econ J 7(1):1–49

Boyer MM, Fillion D (2007) Common and fundamental factors in stock returns of Canadian oil and gas companies. Energy Econ 29(3):428–453

Bredin D, Muckley C (2011) The price forming process in energy markets. In: Dorsman A, Westerman W, Karan MB, Arslan O (eds) Financial aspects in energy. Springer, Heidelberg, pp 85–107

Brown SJ, Warner JB (1980) Measuring security price performance. J Financial Econ 8 (3):205–258

Brown SJ, Warner JB (1985) Using daily stock returns, the case of event studies. J Financial Econ 14(1):3–31

Buyuksahin B, Brunetti C, Robe MA, Soneson KR (2010) Do OPEC members know something the market doesn't? 'Fair price' pronouncements and the market price of crude oil. Working paper. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1652834

Demirer R, Kutan AM (2010) The behavior of crude oil spot and futures prices around OPEC and SPR announcements: an event study perspective. Energy Econ 32(6):1467–1476

Dorsman A, Koch A, Jager M, Thibeault A (2013) Adding oil to a portfolio of bonds and stocks. In: Dorsman A, Simpson JL, Westerman W (eds) Energy economics and financial markets. Springer, Heidelberg, pp 197–214

Guidi MGD, Russell A, Target H (2006) The effect of OPEC policy decisions on oil and stock prices. OPEC Rev 30(1):1–18

Hammoudeh S, Li H (2005) Oil sensitivity and systematic risk in oil- sensitive stock indices. J Econ Bus 57(1):1–21
Huang RD, Masulis RW, Stoll HR (1996) Energy shocks and financial markets. J Futur Mark 16 (1):1–27
Hyndman K (2008) Disagreement in bargaining: an empirical analysis of OPEC. Int J Ind Organ 26(3):811–828
Lin SX, Tamvakis M (2010) OPEC announcements and their effects on crude oil prices. Energy Policy 38(2):1010–1016
MacKinlay AC (1997) Event studies in economics and finance. J Econ Lit 35(1):13–39
Mazraati M, Tayyebi Jazayeri SM (2004) Oil price movements and production agreements. OPEC Rev 28(3):207–226
Nandha M, Faff R (2008) Does oil move equity prices? A global view. Energy Econ 30 (3):987–997
Sadorsky P (1999) Oil price shocks and stock market activity. Energy Econ 21(5):449–469
Sadorsky P (2001) Risk factors in stock returns of Canadian oil and gas companies. Energy Econ 23(1):17–28
Schmidbauer H, Rosch A (2012) OPEC news announcements: effects on oil price expectation and volatility. Energy Econ 34(5):1656–1663
Simpson JL (2008) The effect of OPEC production allocations on oil prices. In: Twenty first Australian finance and banking conference 2008 paper. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1231602
Simpson JL (2010) Do the major oil companies anticipate OPEC production allocations? An examination of oil and financial market data for arbitrage investment opportunities. J Wealth Manage 12(4):101–118
Wirl F, Kujundzic A (2004) The impact of OPEC conference outcomes on world oil prices 1984–2001. Energy J 25(1):45–62

Part II

Environment and Renewables

The Impact of Environmental Strengths and Concerns on the Accounting Performance of Firms in the Energy Sector

5

Özgür Arslan-Ayaydin and James Thewissen

Abstract

Energy sector firms are highly affected by the imposition of costs and community attitudes related to their environmental impact. In this chapter, we study the impact of environmental strengths and concerns of firms in the energy sector on their firm performance. We aim to uncover whether positive environmental activities add extra costs or help firms in the energy industry achieve a higher future profitability and compare this impact with firms that do not belong to that industry. Based on the environmental scores compiled by Kinder, Lyndenberg and Domini Research and Analytics, Inc., we show that the environmental concerns of US firms in the energy industry are significantly lower than their environmental strengths and this difference is much larger for energy firms than for firms that do not belong to the energy industry. In addition, we find that only the environmental concerns of energy sector firms have predictive value in terms of future corporate performance that is incremental to a group of earnings-predicting variables. Our results for the energy sector indicate that reducing environmental concerns pays off by improving corporate profitability.

This research was carried out thanks to financial support in the form of a grant from the Intercollegiate Center for Management Science and the Flemish IWT. We would like to thank the Editor, André Dorsman, and two anonymous reviewers for their constructive comments, which helped us improve the manuscript.

Ö. Arslan-Ayaydin
Department of Finance, University of Illinois at Chicago, 601 S. Morgan St., Chicago, IL 60607, USA
e-mail: Orslan@uic.edu

J. Thewissen (✉)
Department of Finance, Katholieke Universiteit Leuven, 33 Korte Nieuwstraat, 2000 Antwerp, Belgium
e-mail: James.Thewissen@kuleuven.be

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_5

Keywords
Accounting performance • Energy sector • Environmental performance

5.1 Introduction

For the past four decades no definitive consensus has been reached on the relationship between financial performance of firms and their corporate social responsibility (CSR) (McWilliams et al. 2006; Orlitzky et al. 2003). Corporate environmental initiatives are considered as an important component of the CSR construct and inherently demand significant portions of a company's financial resources. The lack of consensus in the literature can be attributed to the fact that the revenue-enhancing impact of environmental initiatives may differ across industries and, in particular, for the energy industry. This chapter aims at providing additional evidence on the unsolved puzzle between environmental and financial performance by analyzing a single industry context. Specifically, by focusing on the energy firms, our chapter tackles two main issues: (1) What are the current trends in environmental strengths and concerns in the energy industry and how do these trends compare to firms in the non-energy industry? (2) Does environmental consciousness foster value creation by enabling energy firms to achieve higher accounting performance?

There exists an increasing pressure on the environmental performance of energy firms. Because the worldwide demand for energy is forecasted to grow by 40 % over the next 15 years, energy firms need to adapt their production process and those that are unprepared to address environmental challenges are expected to be disadvantaged in the long run. In addition, energy firms' nature of operations requires them to engage in activities with a high environmental exposure given that they are subject to very specific economic and political risks that do not exist in other industries. For instance, in 2010, the disaster of the British Petroleum PLC is considered as one of the worst oil spill in the history and further emphasized the environmental impact of the energy industry with scandalous headlines. Tait (2010) argues that following this accident the concerns of investors grew even more on the environmental risks associated with the energy firms. As of 2013, the United States Environmental Protection Agency (EPA 2013) indicates that costs of pollution controlling activities are the highest in energy firms.

In this chapter, we first look at the dynamics of environmental strengths and concerns over time and observe considerable differences for energy and non-energy firms. We find that the environmental concerns of both energy and non-energy firms significantly decreased between 1995 and 2011. On the other hand, the environmental strengths of both categories of firms substantially fluctuated between 1995 and 2011. We also show that the difference between environmental strengths and concerns of energy firms is much larger than that of the firms that do not belong to the energy sector.

It is therefore natural to ask whether this variability in environmental strengths and concerns is explanatory of a firm's future performance. Given the gap between energy and non-energy firms, how does this impact differ between energy and non-energy firms? Our results show that energy firms obtain a higher accounting performance when they not only focus on shareholder value maximization by engaging solely in profit oriented business principles, but also through catering to their stakeholders by increasing their environmental performance. In this chapter, we measure corporate performance by the return on assets, which is based on the firm's contemporaneous income. Return on assets is one of the broadest measures of a firm's operating performance and gives an idea of how effectively companies utilize their assets to generate profit. In sum, our study contributes to the growing body of literature by providing new evidence on the relationship between environmental performance and corporate financial performance, with a particular focus on firms in the energy industry.

Our results support the "it pays to be green" literature, as we find that environmental concerns have predictive value of a firm's future performance that is incremental to a group of financial earnings predicting variables. However, this result does not apply for environmental strengths and only holds for firms in the energy sector. We thus conclude that the economic impact of environmental performance is more positive for issues reducing negative externalities than for issues generating positive externalities, explaining the decreasing trend in environmental concerns. This means that, *ceteris paribus*, a firm in the energy industry is able to improve its economic performance more if it manages to decrease its environmental concerns rather than increase its strengths.

Our chapter is structured as follows. Section 5.2 presents the theoretical background, Sect. 5.3 introduces the data, sample selection and variables. Section 5.4 explains the evolution of environmental strengths and concerns of energy firms versus those that do not belong to the energy sector. Section 5.5 investigates whether environmental performance of energy firms influences their future accounting performance and this relationship is compared with non-energy firms. Finally, Sect. 5.6 concludes the chapter.

5.2 Theoretical Background

Environmental efficiency is defined as the attempts to protect the interests of environmental stakeholders by creating higher value with less environmental impact such as pollution (Renneboog et al. 2008). Environmental protection has become a major concern for the key stakeholders of the firms; namely, investors, customers and governments (Brinkmann et al. 2008).

The critiques of corporate attempts for environmental efficiency defend that it is a vague construct requiring firms to give up their shareholder's wealth by raising operating costs. Investments in environmental efficiency are viewed as dragging down the financial performance given that resources are committed to a seemingly non-productive use (Cohen et al. 1997). Specifically, environmental expenditures, whether minor as end-of-pipeline treatment or major as pollution prevention, are treated as liabilities at the expense of shareholders' value (Filbeck and Gorman 2004; Palmer et al. 1995). Cordeiro and Sarkis (1997) show a negative association between environmental proactivism and short-term market performance. Chen and Metcalf (1980) find that environmental performance is not related to financial performance even when differences in firm size were also taken into account. Mahapatra (1984) compares pollution control expenditures across six different industries to the average market returns in those industries and concludes that pollution control expenditures are "a drain on resources which could have been invested profitably, and do not reward the companies for socially responsible behavior." Brammer et al. (2006) examine the relation between corporate environmental performance and stock return in the UK between 2002 and 2005. They find that their measure of environmental performance is negatively correlated with returns. Finally, Freedman and Jaggi (1998) concur that there is not a significant relationship between environmental pollution disclosure and several accounting based performance indicators. In addition, in case of a misalignment of incentives between owners and controllers, investment decisions on enhancing environmental efficiency will be taken by entrenched managers (Jensen 1986) and hence end up having a negative impact on financial performance.

However, the defendants of corporate environmental efforts posit that environmentally responsible behavior enhances the corporate value. A strand of research concur that environmental efficiency is highly taken into account by investors seeking extra-financial returns (Derwall et al. 2005; Guenster et al. 2010; Statman and Glushkov 2009). Recently, Iatridis (2013) also finds that quality of environmental disclosure and the adoption of environmentally friendly policies are positively associated with investor perceptions. Better environmental performance may also lead to higher revenues given that consumers may be willing to pay a premium for environmentally friendly products (Grimmer and Bingham 2013; Klassen and McLaughlin 1996; Konar and Cohen 2001). Environmentally responsible behavior is likely to improve overall reputation among customers and increase investors' trust (McGuire et al. 1988). It is also discussed that better environmental performance reduces labor costs (Earnhart and Lizal 2007; Porter and van der Linde 1995), through lowering discharges into the internal environment, improving quality of the working conditions, decreasing labor's compensation claims and litigation costs due to health reasons. Furthermore, environmental efficiency may depress costs thanks to lower third party lawsuits, regulatory scrutiny and regulatory sanctions. In congruent with these findings, return on assets has been extensively utilized for measuring accounting performances of environmentally conscious corporations to verify the impact of environmental efficiency on earnings. Russo and Fouts (1997) and King and Lenox (2002) show that a firm's return on assets increases as a firm's environmental performance improves. Hart and Ahuja (1996) find that emission reduction and pollution prevention initiatives have positive impacts on a firm's return on assets.

The lack of consensus in the literature can be attributed to the fact that revenue-enhancing impact of environmental initiatives may differ across industries. For instance, in some industries there is a higher potential for a firm that achieves a good environmental performance to gain an advantage over its competitors. Smolarski and Vega (2013) show that, over the last decade, stakeholders' awareness and activism on environmental activities of energy firms have considerably grown. In addition, they find that because energy firms' nature of operations requires high environmental exposure, these firms are subject to specific economic and political risks that do not exist in other industries. To face these risks, energy firms have been investing substantial resources in low-emission and renewable energy sources, anticipating regulation and developing green capabilities through new products or markets, and strategic behavior vis-à-vis competitors (Kolk and Levy 2001; Reinhardt 1999). Energy firms' specific environmental risks, regulation, operating costs and natural exposition to environmental issues places the energy sector at the center of the puzzle between environmental and financial performance.

In this chapter, we contribute to the literature by focusing our discussion on energy firms. We study the impact of their level of environmental strengths and concerns on their future accounting performance and compare this impact with non-energy firms. We expect firm's environmental efforts to translate into higher accounting performance as their environmental attempts lead revenues (costs) to rise (fall) so that profits unambiguously increase. Given their potential exposure to environmental risks, we also expect this positive relationship to be stronger for energy firms than for non-energy firms.

For both energy and non-energy firms, consumers and political authorities expect a firm's environmental strengths not to fall below some minimum threshold at the expense of being boycotted. However, because the energy sector is highly regulated and scrutinized, the mere fact of environmental compliance hardly allows an energy firm to distinguish itself from its competitors since most intra-industry peers are affected by compliance and activism in a similar way. In this vein, real benefits to such corporations are likely to come from more proactive forms of environmental performance that reduce environmental concerns. This means that, *ceteris paribus*, a firm is likely to improve its economic performance more if it manages to decrease its environmental concerns rather than increasing its strengths.

5.3 Data, Sample Selection and Variables

To test our hypotheses, we define a linear least-squares model in which we regress the firm's future performance on the firm's environmental strengths and concerns. We measure future firm performance as the firm's return on assets. We also control for variables that have been shown in prior literature to explain a firm's future performance (see, e.g., Fama and French 2006). In Sect. 5.3.1, we first define our measures of environmental strengths and concerns, Sect. 5.3.2 describes our set of control earnings-predicting variables. We finally define in Sect. 5.3.3 how we select firms that belong to the energy and non-energy sectors.

5.3.1 Environmental Strengths and Concerns

To measure a firm's environmental performance, we use the Kinder, Lyndenberg and Domini Research and Analytics, Inc. (KLD) database between 1995 and 2011. KLD is a Boston-based investment research firm specializing in following firms' CSR activities. The main benefit of the KLD data is that it is an independent investment research center that specializes in firm ratings of environmental, social and governance performance to use in investment decisions. KLD uses a firm's both internal (e.g. annual reports) and external (e.g., articles in the business press) sources to conduct year-by-year assessments of the social performance. Since the assessment is based on objective information (Waddock and Graves 1997), KLD safeguards against inflated assessments about a firm's social performance (Liston-Heyes and Ceton 2008; Waddock and Graves 1997). For instance, in the case of regulatory problems, the criteria are rated as dollars paid for fines (Waddock and Graves 1997). Given that the criteria are applied similarly for each firm in each year, the dataset gives consistent ratings (Harrison and Freeman 1999; Waddock and Graves 1997) over time and across industries. Because KLD provides an objective, quantifiable and enhanced corporate social performance measure and is an independent rating system (Hillman and Keim 2001), it has been used in a growing body of research on corporate social performance issues (see e.g. Hillman and Keim 2001; Johnson and Greening 1999; Waddock and Graves 1997).

The rating agency assesses listed US-based corporations. Only larger US firms will thus be included in the sample of this study. The KLD agency initially started in 1990 by examining the social performances of all companies in the S&P 500 Index and Domini 400 Social SM Index, totaling 650 firms. Over time, KLD's coverage has substantially increased. Since 2001, KLD has expanded its coverage universe to incorporate the largest 1,000 US companies in terms of market value, an expansion that advanced further in 2003 with the inclusion of the 3,000 largest US firms.

Each category is rated following a binary scheme. If the assessment indicated that a company fulfills certain criteria for a category (strengths or concerns), it takes the value of 1 whereas 0 denotes neutrality. For example, a company that develops clean energy systems to limit their impact on climate change has a 'one' in the category *Clean Energy*. If it had to pay fines for environmental issues, this will be shown in the category *Regulatory Problems* as a 'one'. A firm earns a 0 for that category if it pays no fines at all. If a firm shows the same strength or concern every year, they are also rated each year in the same way. KLD further aggregates data for environmental performance, where all items for strengths and of concerns are equally-weighted. A weighted measure of environmental performance that would regroup each category as a function of their importance with respect to environmental matters would be more appropriate. However such a weighting scheme would require detailed understanding and entail theoretical background of these measures (Hillman and Keim 2001), which is out of the scope of this paper. In addition, as argued by Oehme and Kemp (2013), some studies aggregate the data by measuring the spread between the number of concerns and strengths to have a

Table 5.1 KLD rating categories

Strengths	Concerns
Beneficial products and services	Climate change
Clean energy	Land use and biodiversity
	Negative impact of products and services
Management system	Non-carbon emissions
Other strengths	Other concerns
Pollution prevention	Regulatory problems
Recycling	Substantial emissions

This table lists the KLD rating categories

Table 5.2 KLD score distribution

	Total strengths				Total concerns				
Sample	≥3	2	1	0	≥3	2	1	0	Total
Total firms	353	473	1,755	15,356	538	748	1,480	15,171	17,937
% Energy	2.486	6.038	24.962	66.514	13.546	14.663	29.274	42.516	89.864
% Non-energy	1.735	2.067	7.445	88.753	1.639	2.664	5.7389	89.958	10.136

This table lists the KLD rating categories and reports the distribution of the KLD score. Total firms refer to the number of firms in the sample with a KLD strength (concern) of ≥3, 2, 1 or 0. % Energy reports the number of energy firms in the sample with a KLD strength (concern) of ≥3, 2, 1 or 0. % Non-energy reports the number of non-energy firms in the sample with a KLD strength (concern) of ≥3, 2, 1 or 0

single estimate for each firm (see e.g. Hillman and Keim 2001; Waddock and Graves 1997). This is a problematic method since we show in the results section that both are significantly and positively correlated. Consolidating the two values would give similar results for companies that are rather neutral and companies that have high ratings in both strengths and concerns. This would not only decrease the variation of the data (Sharfman and Fernando 2008), but would also reduce the amount of information provided by KLD scores. In this study, strengths and concerns are not combined. We distinguish between environmental strengths and concerns and investigate their informational value to predict future firm performance. The list of KLD strengths and concerns are reported in Tables 5.1 and 5.2.

The number of strengths and concerns in each category has evolved over time as KLD refined the database. For example, in 2007, there are six possible strengths in the environment category and seven possible concerns for SAFECO Corporation. In 1995, there were only five possible environmental strengths as well as seven concerns. As a result, it is not possible to directly compare strengths or concerns within a category across years. However, such a comparison is essential for our work because we are interested in both the time-series and the cross-sectional dimensions of CSR activities. We therefore scale the strengths and concerns for each firm year to obtain two indices that range from 0 to 1. To achieve this, we follow Servaes and Tamayo (2013) and we divide the sum of environmental strengths (concerns) for each firm year by the number of strengths (concerns) in each category year, formally defined as;

$$wStrength_{j,t} = \frac{\sum_{s=1}^{S} Strength_{j,t,s}}{S_{j,t}} \tag{5.1}$$

and

$$wConcern_{j,t} = \frac{\sum_{c=1}^{C} Concern_{j,t,c}}{C_{j,t}} \tag{5.2}$$

$Strength_{j,t}$ ($Concern_{j,t}$) is the KLD strength (concern) for firm j in year t and $wStrength_{j,t}$ ($wConcern_{j,t}$) is the weighted environmental strength (concern) of firm j in year t. The total number of strengths (concerns) for firm j in year t is denoted as $S_{j,t}$ ($C_{j,t}$).

5.3.2 Accounting and Financial Market Variables

Accounting data employed to compute performance are obtained from the Compustat database, which contains financial and accounting data for all listed US firms. We proxy future firm performance by using return on assets ($ROA_{j,t+1}$). To avoid any look ahead bias, we start measuring $ROA_{j,t+1}$ on the quarter following the quarter on which the KLD data was made public knowledge. Although the data collection process and appraisal of firm social performance is an ongoing, continuous process, KLD actually assembles the data at the end of each calendar year, and compiles the data into the spreadsheets at the beginning of the next year (Oikonomou et al. 2012). Therefore, we start measuring firm performance on the second quarter of each year $t+1$, based on the KLD score from year t. Specifically, firm future performance $ROA_{j,t+1}$ is measured as the sum of quarterly earnings before extraordinary items $Y_{j,q+i,t+1}$ (Compustat data item #18) over the four quarters starting at the end of the first quarter q, scaled by total assets (#6) at the end of quarter q. To avoid problems with outliers, we winsorize $ROA_{j,t+1}$ values at the sixth median absolute deviation from the sample median.

We also test the explanatory power of environmental strengths and concerns in predicting future firm performance after controlling for “hard information”. We define hard information as quantitative information easily processed from annual reports. We select hard information variables from the set of earnings predicting covariates identified by Fama and French (2006), each defined in Tables 5.3 and 5.4.

We include firm size $MC_{j,t}$, which is measured as the natural logarithm of market value of equity (#25·#199) at the end of the fiscal year. We expect smaller firms to be less profitable (Fama and French 1995). The book-to-market ratio $BTM_{j,t}$ is known to be negatively related to profitability (firms with lower $BTM_{j,t}$ tend to be more profitable). We define book-to-market as the book value of equity (#6 − #18),

Table 5.3 Variable definitions–Compustat/CRSP items

Item	Item name	Compustat/CRSP item #
$CSTI_{j,t}$	Cash and short term investments	#1
$CA_{j,t}$	Current assets	#4
$CL_{j,t}$	Current liabilities	#5
$A_{j,t}$	Total assets	#6
$Y_{j,t}$	Income before extraordinary items	#18
$CSHO_{j,t}$	Common shares outstanding	#25
$Div_{j,t}$	Total dividends per share by ex date	#26
$DCL_{j,t}$	Debt in current liabilities	#34
$L_{j,t}$	Total liabilities	#181i
$P_{j,t}$	Closing price fiscal year t	#199
$B_{j,t}$	Book value of equity	$A_{j,t} - L_{j,t}$

Table 5.4 Variable definitions–dependent and control variables

Variable	Expected sign	Variable name	Definition
$ROA_{j,t+1}$		The sum of quarterly Y over the four quarters after the SEC filling quarter q, divided by $A_{j,q,t+1}$ at the end of quarter q	$\sum_{i=1}^{4} Y_{j,q+i,t+1}/A_{j,q,t+1}$
$ROA_{j,t}$	+	Return on assets over fiscal year t	$Y_t/A_{j,t-1}$
$\sigma_{ROA,j,t}$	+	Standard deviation of ROA over the 5 years preceding the end of fiscal year t	$\sqrt{\frac{1}{5}\sum_{i=0}^{4}\left(ROA_{j,t-i} - R\hat{OA}_{j,t-i}\right)}$
$NegY_{j,t}$	–	Negative earnings dummy	$I\left[Y_{j,t} \leq 0\right]$
$MC_{j,t}$	+	Market capitalization (in bil.$)	$P_{j,t} \cdot CSHO_{j,t}$
$BTM_{j,t}$	–	Book to market ratio	$B_{j,t}/MC_{j,t}$
$AC_{j,t}$		Accruals	$\Delta CA_{j,t} - \Delta CSTI_{j,t} - \Delta CL_{j,t} + \Delta DCL_{j,t}$
$+AC_{j,t}$	–	Positive accruals	$+AC_{j,t} = AC_{j,t}$ if $AC_{j,t} > 0$, else 0
$-AC_{j,t}$	–	Negative accruals	$-AC_{j,t} = AC_{j,t}$ if $AC_{j,t} < 0$, else 0
$AG_{j,t}$	–	Growth of assets	$\frac{dA_{j,t}}{A_{j,t-1}} = \left(A_{j,t} - A_{j,t-1}\right)/A_{j,t-1}$
$D_{j,t}$	+	Total dividends	$Div_{j,t} \cdot CSHO_{j,t}$
$NoD_{j,t}$	–	No dividends	$I\left[D_{j,t} = 0\right]$
$Ret_{j,t-1}$	+	Return over fiscal year t	$\left(P_{j,t} - P_{j,t-1}\right)/P_{j,t-1}$
$Ret_{j,t-2}$	+	Two-year return for the years up to the end of fiscal year $t-1$	$\left(P_{j,t-1} - P_{j,t-3}\right)/P_{j,t-3}$
$PT_{j,t}$	+	Firm strength	Piotroski (2000)
$OH_{j,t}$	–	Ohlson bankruptcy risk	Ohlson (1980)

divided by $MC_{j,t}$. There is also evidence that accruals forecast profitability (Fairfield et al. 2003a, b; Sloan 1996). We distinguish between positive accruals ($+AC_{j,t}$) and negative accruals ($-AC_{j,t}$), each scaled by the book value of equity. Investment ($AG_{j,t}$), defined as asset growth, is also included among the variables. We predict investment to be negatively related to future performance (Fama and French 2006). Previous work also shows that dividend-paying firms tend to be more profitable (Fama and French 2001). We include the ratio of dividends to book equity ($D_{j,t}$), as well as dummy for firms that do not pay dividends ($NoD_{j,t}$). Dividend is defined as the number of shares outstanding (#25), times the total dividend per share (#26).

We also include past accounting and stock market profitability as control variables. The return on assets ($ROA_{j,t}$) is measured as the earnings before extraordinary items at the end of fiscal year t, scaled by the total assets at the beginning of the year. The $ROA_{j,t}$ coefficient is predicted to be positive and lower than 1, consistent with prior research documenting mean reversion in performance metrics (Barber and Lyon 1997). We also include a dummy variable $NegY_{j,t-1}$ for negative earnings in fiscal year t. Based on Fama and French (2006), we predict that past stock market performance is positively related to future firm performance. We define $Ret_{j,t-1}$ as the firm's stock return for fiscal year t and $Ret_{j,t-2}$ as its combined return for years $t-1$ and $t-2$.

Our model also includes a composite measure of firm strength $PT_{j,t}$ defined by Piotroski (2000) to predict stock returns. $PT_{j,t}$ is the sum of a firm's scores on the nine variables at the end of fiscal year t, with higher values indicating a stronger past performance. $OH_{j,t}$ is defined as the probability of debt default. Developed by Ohlson (1980) and used by Griffin and Lemmon (2002) to predict stock returns, $OH_{j,t}$ is the fitted value from Ohlson's (1980) cross-section logit regression that uses accounting fundamentals for year t to assess the probability of default on debt, with higher values implying weaker firms. We expect a positive and negative correlation between $PT_{j,t}$ and $OH_{j,t}$, respectively.

Finally, based on Core et al. (1999), we also include $\sigma_{ROA,j,t}$ as a control to firm risk. $\sigma_{ROA,j,t}$ is defined as the standard deviation of $ROA_{j,t}$ over the preceding 5 years. We expect a positive relation between future firm performance and past volatility.

5.3.3 Energy Firms

We distinguish between firms in the energy industry and non-energy industries. Following Patari et al. (2012), we select firms in the energy and non-energy industries based on their sector identified by the primary Standard Industrial Classification (SIC) code.

A first group, referred as *energy firms*, consists of firms for which environmental issues are of key interest and the sector's primary SIC code is as follows: 130 (Oil and gas extraction), 131 (Crude petroleum and natural gas), 132 (Natural gas liquids), 138 (Oil and gas field services), 290 (Petroleum Refining And Related Industries), 291 (Petroleum refining), 295 (Asphalt Paving And Roofing Materials), 299 (Miscellaneous Products Of Petroleum And Coal), 49 (Electric, Gas, And Sanitary Services), 491 (Electric services), 492 (Gas production and distribution), 4930 (Combination Electric And Gas, And Other Utility Services), 494 (Water Supply), 495 (Sanitary Services), 496 (Steam And Air-conditioning Supply), 497 (Irrigation Systems).

The second group consists of firms for which the sector's SIC code does not start with 13, 29 or 49. This sample is referred to as the *non-energy firms*.

5.3.4 Sample Selection

We merge the firms from the Compustat database with the KLD database to obtain the sample used for the analysis. Our final sample contains 17,937 firm-year observations, of which 16,119 are part of the non-energy sample and 1,818 are energy firms. Two thousand seven hundred and seventy one firms are included in the non-energy sample, while the total number of firms for the energy sample is 278.[1] Table 5.5 reports the summary statistics of the different financial and accounting variables used as controls in our regression models (see Sect. 5.5) and

Table 5.5 Summary statistics

	Total sample		Energy firms		Non-energy firms		
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	*t*-Test
$ROA_{j,t+1}$	0.029	0.102	0.037	0.068	0.028	0.105	***
$ROA_{j,t}$	0.020	0.181	0.031	0.118	0.019	0.186	***
$\sigma_{ROA,j,t}$	0.133	2.949	0.093	1.599	0.137	3.064	
$AG_{j,t}$	0.133	0.426	0.165	0.477	0.129	0.420	***
$BTM_{j,t}$	0.501	2.681	0.582	0.397	0.492	2.824	***
$MC_{j,t}$	6.649	22.580	9.695	32.366	6.306	21.169	***
$D_{j,t}$	0.044	0.689	0.040	0.039	0.044	0.726	
$NoD_{j,t}$	0.433	0.495	0.307	0.461	0.447	0.497	***
$NegY_{j,t}$	0.207	0.405	0.152	0.359	0.213	0.410	***
$+AC_{j,t}$	0.140	3.292	0.045	0.163	0.151	3.473	***
$-AC_{j,t}$	−0.144	1.844	−0.049	0.261	−0.154	1.943	***
$Ret_{j,t-2}$	1.460	60.288	0.633	9.382	1.554	63.519	***
$Ret_{j,t-1}$	0.535	40.253	0.135	0.856	0.580	42.461	
$PT_{j,t}$	5.369	1.452	5.795	1.361	5.321	1.454	***
$OH_{j,t}$	0.318	0.277	0.293	0.215	0.320	0.283	***
$wStrength_{j,t}$	0.043	0.126	0.096	0.161	0.037	0.120	***
$wConcern_{j,t}$	0.041	0.113	0.165	0.186	0.027	0.091	***

This table reports the mean and standard deviation of the variables defined in Tables 5.3 and 5.4 for the whole sample and distinguishes between energy and non-energy firms. The *last column* reports the significance of a two-tailed *t*-test for each control variable between the energy and non-energy samples

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

[1] The list of firms used in the energy sample is reported in Appendix table.

distinguishes between energy and non-energy firms. Energy firms appear to have a significantly stronger future performance $ROA_{j,t+1}$ and past firm performance ($ROA_{j,t}$), higher asset growth ($AG_{j,t}$), lower book-to-market ration ($BTM_{j,t}$), higher market capitalization ($MC_{j,t}$) and seem to distribute dividends more frequently ($NoD_{j,t}$). In addition, energy firms seem to report negative earnings less frequently, which is in line with the significant difference between the Ohlson probability of default ($OH_{j,t}$) and the Piotroski firm strength ($PT_{j,t}$) measures. Energy firms thus seem to have a better financial past and future performance, as measured by return on assets, as well as a lower risk and higher financial stability than non-energy firms.

5.4 The 1995–2011 Evolution of Average Environmental Strengths and Concerns for Energy and Non-energy Firms

We first investigate the dynamics of environmental strengths and concerns over the period 1995–2011 for energy and non-energy firms. We report in Fig. 5.1a the average weighted environmental strength between 1995 and 2011. The average strength of non-energy firms equals 3.7 %, and has substantially changed over time. Starting with a high 6.5 % in 1996, strengths of non-energy firms reach a low peak of 1.9 % in 2006. We test this evolution statistically through a *t*-test for the overall difference between 1995 and 2006 and find that the overall decrease in environmental strengths is significant at a 99 % confidence level. From 2007 and on, it increases again to reach 8.4 % in 2011, an increase that is also highly significant at a 99 % confidence level. Strengths for energy firms follow a similar pattern but with a cyclicality that is even more pronounced. Starting with a high 16.8 % in 1996, strengths decrease to 2.7 % in 2006 to increase again to 20.2 % in 2011, both significant at a 99 % confidence level.

The increasing trend between 2006 and 2011 resonates the raised concerns related to environmental issues over the last 10 years (Oehme and Kemp 2013). Specifically, the pattern in Fig. 5.1a reflects the factors that lead firms to increase their commitment to environmental protection, through stricter environmental policies, greater attention to climate change, the need to move away from fossil fuels and the rising demand for green products and companies accepting environmental responsibility. It is striking that this pattern is even more important for energy firms than for non-energy firms. While the average strength for non-energy firms equals 3.7 %, the average strength for energy firms is substantially higher with 9.6 %; a difference that is significant at a 99 % confidence level.

The decrease in environmental strengths between 1995 and 2006 of both energy and non-energy firms could be explained by Wood and Jones (1995). They note in their review that poor CSR performance tends to inflict financial harm, however they do not show that a stronger CSR leads to a financial advantage. Similarly, Meijer and Schuyt (2005) find that while consumers expect a firm's CSR not to fall below some minimum threshold, at the expense of being boycotted, high levels of social responsibility do not cause a significantly increase in product sales. More

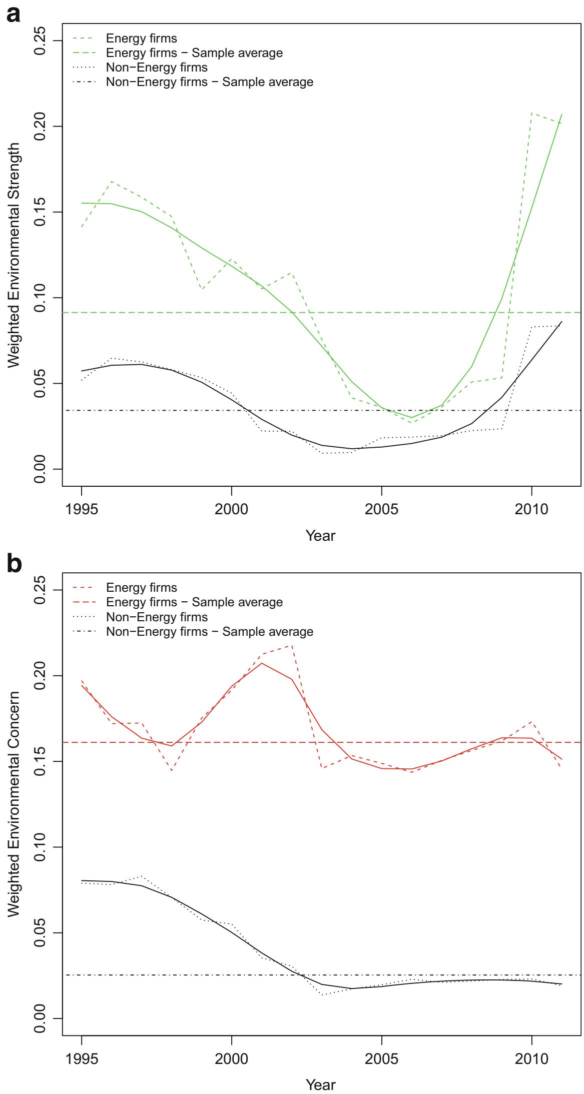

Fig. 5.1 KLD environmental strengths and concerns between 1995 and 2011. (**a**) Average environmental strengths of energy and non-energy firms. (**b**) Average environmental concerns of energy and non-energy firms. The full lines are non-parametric regression fits

recently, Lankoski (2009) evidences that the economic impact of CSR is more positive for issues reducing negative externalities than for issues generating positive externalities. This means that, *ceteris paribus*, a firm is likely to improve its economic performance more if it manages to decrease its social/environmental concerns rather than increasing its respective strengths.

This would explain the decreasing trend in concerns in Fig. 5.1b. For both energy and non-energy firms, environmental concerns decrease between 1995 and 2011. Although energy firms show a slight increase in concerns between 1995 and 2002, the average level of environmental concerns has since progressively decreased from 19.7 % in 1995 to 14.5 % in 2011. Similarly, non-energy firms show a substantial decrease in concerns from 7.9 % in 1995 to 2.9 %, a difference that is significant at a 99 % confidence level. The statistically significant gap in environmental concerns between energy and non-energy firms also puts forward the particularity of the energy sector concerning environmental matters.

The difference in dynamics between environmental strengths and concerns and the substantial gap in strengths and concerns between energy and non-energy firms raises two questions on the impact of environmental performance on firm performance: (1) Do environmental strengths/concerns have an impact on a firm's future performance and is the impact of environmental strengths different from the impact of environmental concerns? Given the decrease in environmental strengths between 1995 and 2006 and the decrease in environmental concerns, one could question the importance of firms improving environmental matters. (2) To what extent is this impact different between energy and non-energy firms? Regarding their lower level of environmental strengths and concerns, relative to energy firms, are non-energy firms also concerned about environmental strengths/concerns to improve their future performance?

5.5 Does Environmental Consciousness Increase Firm Performance?

The previous section shows that environmental strengths and concerns of energy and non-energy firms have gone through substantial changes throughout the years, with strengths and concerns constantly being larger for energy firms than for non-energy firms. We now investigate whether energy firms' environmental strengths (concerns) improve (decrease) their future performance and compare this relationship with non-energy firms. If environmental strengths or concerns help predict future firm performance, it not only means that environmental initiatives pay off by improving a firm's profitability, but it also indicates that scores provided by KLD contain information value.

Table 5.6 presents the correlation matrix for all accounting, financial market and environmental score variables. The correlation factors for the (non-) energy firm sample are reported (below) above the diagonal. For non-energy firms, both $wStrength_{j,t}$ and $wConcern_{j,t}$ variables are significantly correlated with future firm performance. However, both variables have positive signs, meaning that the higher the environmental strengths and concerns, the higher the future performance. The positive sign for concerns is at odds with our expectations. Concerning energy firms, only environmental concerns are positively and significantly correlated to future firm performance. The magnitude of the correlations is the strongest for the concerns of energy firms, with a coefficient of 8.8 %. Although we expected environmental concerns to be negatively correlated with future firm performance, environmental performance thus seems to be a good indicator of a firm's future performance.

Table 5.6 Correlation table

		1	2	3	4	5	6	7	8	9
1	$wStrength_{j,t}$	1.000	0.239***	0.019	0.049*	0.004	−0.068**	0.044	0.173***	0.190***
2	$wConcern_{j,t}$	0.338***	1.000	0.088***	0.094***	−0.030	−0.082***	0.050*	0.417***	0.218***
3	$ROA_{j,t+1}$	0.062***	0.049***	1.000	0.386***	−0.030	−0.049*	−0.219***	0.192***	0.109***
4	$ROA_{j,t}$	0.056***	0.044***	0.559***	1.000	−0.088***	−0.005	−0.010	0.141***	0.127***
5	$\sigma ROA_{j,t}$	−0.009	−0.009	−0.015	−0.021**	1.000	0.042	−0.031	−0.010	−0.046*
6	$AG_{j,t}$	−0.038***	−0.030***	−0.002	−0.026**	0.026***	1.000	−0.076**	−0.021	−0.157***
7	$BTM_{j,t}$	−0.005	−0.001	−0.050***	0.022**	−0.002	−0.003	1.000	−0.089***	−0.043
8	$MC_{j,t}$	0.291***	0.265***	0.108***	0.083***	−0.009	0.017*	−0.012	1.000	0.111***
9	$D_{j,t}$	0.008	0.008	0.024**	0.019*	−0.002	−0.009	−0.002	0.022**	1.000
10	$NoD_{j,t}$	−0.120***	−0.166***	−0.174***	−0.174***	0.039***	0.075***	−0.030***	−0.164***	−0.055***
11	$NegY_{j,t}$	−0.062***	−0.041***	−0.456***	−0.530***	0.025**	−0.077***	−0.015	−0.112***	−0.015*
12	$+AC_{j,t}$	0.000	−0.006	−0.004	−0.008	−0.001	0.005	−0.004	−0.002	0.014
13	$-AC_{j,t}$	0.003	−0.001	0.031***	0.054***	0.000	0.006	0.001	0.009	0.018*
14	$Ret_{j,t-2}$	−0.006	−0.005	0.003	0.002	0.013	0.005	0.001	−0.005	−0.001
15	$Ret_{j,t-1}$	−0.003	−0.003	0.003	0.106***	0.003	0.001	0.001	−0.003	−0.001
16	$PT_{j,t}$	0.092***	0.069***	0.333***	0.337***	−0.006	0.085***	−0.017*	0.063***	0.006
17	$OH_{j,t}$	−0.127***	−0.095***	−0.422***	−0.519***	0.007	−0.077***	−0.030***	−0.165***	0.016*

(continued)

Table 5.6 (continued)

		10	11	12	13	14	15	16	17
1	$wStrength_{j,t}$	−0.275***	−0.128***	−0.037	0.039	−0.026	−0.013	0.069**	−0.146***
2	$wConcern_{j,t}$	−0.274***	−0.092***	−0.015	0.000	−0.023	−0.052*	0.034	−0.203***
3	$ROA_{j,t+1}$	−0.183***	−0.253***	−0.057*	0.058*	−0.024	0.058*	0.272***	−0.355***
4	$ROA_{j,t}$	−0.191***	−0.563***	−0.161***	0.090***	−0.007	0.034	0.404***	−0.627***
5	$\sigma ROA_{j,t}$	0.062**	0.081***	0.002	−0.055*	0.010	−0.006	−0.005	0.074**
6	$AG_{j,t}$	0.148***	−0.012	−0.006	0.032	0.077**	0.109***	0.061**	−0.103***
7	$BTM_{j,t}$	−0.004	0.054*	−0.078***	0.101***	−0.016	−0.134***	−0.079***	−0.048*
8	$MC_{j,t}$	−0.154***	−0.086***	−0.040	0.030	−0.013	−0.010	0.042	−0.245***
9	$D_{j,t}$	−0.682***	−0.273***	−0.032	0.057*	−0.023	−0.095***	0.032	0.038
10	$NoD_{j,t}$	1.000	0.322***	0.082***	−0.059*	0.029	0.107***	−0.081***	0.126***
11	$NegY_{j,t}$	0.301***	1.000	0.152***	−0.112***	0.014	0.014	−0.491***	0.517***
12	$+AC_{j,t}$	0.007	0.015	1.000	0.051*	−0.007	−0.032	−0.072**	0.202***
13	$-AC_{j,t}$	−0.013	−0.052***	0.003	1.000	0.001	−0.069**	0.099***	−0.206***
14	$Ret_{j,t-2}$	0.017*	0.001	−0.001	0.002	1.000	−0.006	−0.021	0.015
15	$Ret_{j,t-1}$	0.012	−0.005	0.000	0.000	0.000	1.000	0.102***	−0.034
16	$PT_{j,t}$	−0.009	−0.448***	−0.005	0.029***	−0.001	0.009	1.000	−0.400***
17	$OH_{j,t}$	0.010	0.457***	0.042***	−0.086***	−0.012	−0.011	−0.399***	1.000

This table reports the Pearson correlation factors of the variables defined in Tables 5.3 and 5.4. The correlation factors for the (non-)energy firm sample are reported above (below) the diagonal

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Environmental strengths and concerns are both highly correlated with the earnings-predicting variables used in Fama and French (2006). We thus define a multivariate regression model that tests whether environmental performance explains future firm performance above and beyond hard information. In the following regression, we define $x_{j,t}$ as the set of control variables defined in Table 5.4 and estimate this regression for energy and non-energy firms separately:

$$ROA_{j,t+1} = \alpha + \beta_1 \cdot wStrength_{j,t} + \beta_2 \cdot wConcern_{j,t} + \gamma' \cdot x_{j,t} + \sum_{y=1}^{Y} \rho_y \cdot Year_{y,t} + \sum_{h=1}^{H} \delta_h \cdot Sector_{h,j} + \varepsilon_{j,t+1}, \tag{5.3}$$

$Sector_{h,j}$ and $Year_{y,t}$ are included in the model to capture any sector and year fixed effects. $Year_{y,t}$ is an indicator variable taking the value of one if the fiscal year of the KLD score is for year t and zero otherwise. $Sector_{h,t}$ is an indicator variable taking the value of one if KLD score is for a firm in sector h, zero otherwise. We test for the significance of the coefficients using Newey–West standard errors.

Table 5.7 presents the estimation results for Eq. (5.3), where we suppress the estimated coefficients on the sector and year dummy variables for presentation purposes. For energy firms, the results of Model (2) indicate that only $wConcern_{j,t}$ is negative and significant at a 95 % confidence level, suggesting that reducing environmental concerns increases future firm performance. On the other hand, $wStrength_{j,t}$ is positive but insignificant. The fact that environmental concerns (strengths) do (not) influence future firm performance is in line with the results of Fig. 5.1a, which show a significant decrease in environmental strength between 1995 and 2006 and a substantial decrease in environmental concerns in Fig. 5.1b. In addition, the significant coefficient of $wConcern_{j,t}$ indicates that there is at least some information in KLD scores that is incremental to that captured by other earnings predicting variables.

However, these results hold for energy firms only. In Model (4), we report the regression results for non-energy firms and show that, after correcting for "hard" accounting and financial market variables, none of the $wStrength_{j,t}$ and $wConcern_{j,t}$ significantly predict the future performance of non-energy firms. Neither environmental strengths nor environmental concerns seem to hold information value to predict future firm performance. This could explain the substantially lower level of $wStrength_{j,t}$ and $wConcern_{j,t}$ found in Fig. 5.1, as compared to energy firms.

We test the sensitivity of Model (2) to changes in the choice of earnings-predicting variables and select the variables that maximize the adjusted R^2 of our model. The advantage of the adjusted R^2 is that it adjusts the R^2 for the number of explanatory terms relative to the number of data points.[2] Figure 5.2

[2] R^2 is not a suitable criterion to choose the optimal model as adding a variable can only increase its value.

Table 5.7 Environmental and future firm performance

	Energy firms		Non-energy firms	
$ROA_{j,t+1}$	Model 1	Model 2	Model 3	Model 4
α	0.032***	0.056***	0.025***	0.009
	(0.004)	(0.012)	(0.002)	(0.011)
$wStrength_{j,t}$	−0.001	0.001	0.045***	0.000
	(0.010)	(0.008)	(0.008)	(0.006)
$wConcern_{j,t}$	0.033**	−0.017**	0.036***	−0.010
	(0.015)	(0.007)	(0.011)	(0.009)
$ROA_{j,t}$		0.122***		0.211***
		(0.034)		(0.025)
$\sigma_{ROA,j,t}$		0.000		0.000
		(0.000)		(0.000)
$AG_{j,t}$		−0.012***		−0.001
		(0.004)		(0.004)
$BTM_{j,t}$		−0.037***		−0.002***
		(0.007)		(0.001)
$MC_{j,t}$		0.000***		0.000***
		(0.000)		(0.000)
$D_{j,t}$		0.102		0.001*
		(0.063)		(0.001)
$NoD_{j,t}$		−0.017***		−0.017***
		(0.005)		(0.002)
$NegY_{j,t}$		0.011		−0.039***
		(0.008)		(0.004)
$+AC_{j,t}$		−0.003		0.000***
		(0.009)		(0.000)
$-AC_{j,t}$		0.004		0.000
		(0.009)		(0.000)
$Ret_{j,t-2}$		0.000		0.000
		(0.000)		(0.000)
$Ret_{j,t-1}$		0.001		0.000***
		(0.002)		(0.000)
$OH_{j,t}$		−0.060***		−0.032***
		(0.013)		(0.008)
$PT_{j,t}$		0.005***		0.006***
		(0.001)		(0.001)
Year fixed effects	No	Yes	No	Yes
Sector fixed effects	No	Yes	No	Yes
R^2	0.008	0.329	0.005	0.410
Adj. R^2	0.007	0.316	0.005	0.407
Num. obs.	1,818	1,818	16,119	16,119

This table presents estimation results for Eq. (5.3). The $wStrength_{j,t}$ and $wConcern_{j,t}$ measures are defined by Eqs. (5.1) and (5.2), respectively. The control variables are defined in Tables 5.3 and 5.4. The significance of coefficients is tested using Newey–West standard errors. *, **, and *** denote statistical significance at the 10 %, 5 %, and 1 % levels, respectively, based on a two-tailed *t*-test

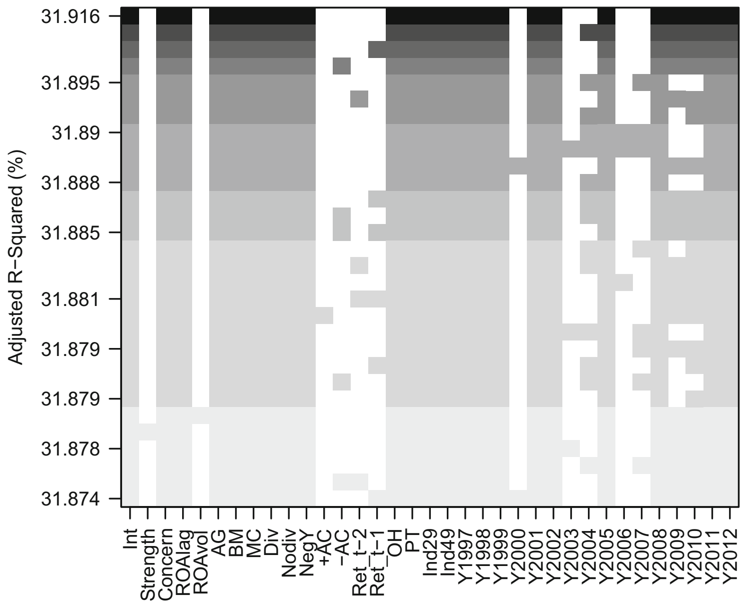

Fig. 5.2 Model selection—30 best models based on Adjusted R-Squared. This figure depicts the sensitivity of Model 5.1 to changes in the choice of earnings-predicting variables by plotting a table of the 30 best models following the adjusted R2 criteria. The *squares* indicate which variables belong to the model. A *black squares* means that a variable is included in the model and a *white square* means that they are not

plots a table of the 30 best models showing which variables belong to each model. The black (white) squares indicate that a variable is (not) included in the model. The results show that the maximum adjusted R^2 possible given our set of covariates is 32 % and reduces the number of variables to 24 out of 35. Reducing the number of variables will not only limit the collinearity that is caused by having too many estimators but also reduce the risk of over-fitting and increase the degrees of freedom of the model. The optimal model includes the environmental concerns as $wConcern_{j,t}$. In fact, all the 30 best models in the figure include $wConcern_{j,t}$, suggesting that the environmental variable from KLD is a key variable to predict a firm's future performance. On the other hand, $wStrength_{j,t}$ is included only once out of 30. $wStrength_{j,t}$, $\sigma_{ROA,j,t}$, $Ret_{j,t-2}$, $+AC_{j,t}$, $-AC_{j,t}$, the years 2000, 2003, 2004, 2005, 2006 and 2007 are removed from the best model.

Conclusion

This chapter provides evidence in favor of a positive relationship between corporate financial performance and environmental efforts for firms belonging to the energy sector. Our findings lend support to our initial expectations by showing that the juxtaposition between stakeholders' value on shareholders' value results in higher accounting performance for the energy sector.

We find that for both energy and non-energy firms, environmental strengths have substantially fluctuated between 1995 and 2011. Moreover, the difference between environmental strengths and concerns of energy firms is much larger than that of the firms that do not belong to the energy sector. We examine whether this variability explains future firm performance and find that environmental performance has predictive value of a firm's future performance that is incremental to a group of financial earnings-predicting variables. However, this result does not apply for environmental strengths and only holds for firms in the energy sector. We concur that a firm's environmental performance does not impact its future performance if it does not belong to the energy industry. In addition, the economic impact of environmental performance is more positive for issues reducing negative externalities than for issues generating positive externalities, explaining the decreasing trend in environmental concerns. This means that, *ceteris paribus*, a firm in the energy industry improves its economic performance more if it manages to decrease its environmental concerns rather than increasing its strengths.

Our results provide guidance to managers of energy firms on how to attain a competitive advantage in the industry, in the light of increased public awareness and regulations on environmental issues. Our findings also have implications for the investors seeking higher returns by showing that energy firms that aim to depress and control environmental concerns are to be targeted.

As a recommendation for further research, future studies may aim at tackling whether decreasing environmental concerns uplifts accounting performance of energy firms through either decreasing costs or increasing revenues.

Appendix: List of Energy Firms in the Sample

This table reports the list of names of the energy firms contained in the sample. This list also reflects the eventual change in the official name of the firm.

1	Abraxas Petroleum Corp.	71	Crosstex Energy Inc.	141	Magnum Hunter Resources Inc.	211	Royale Energy Inc.
2	AES Corporation (The)	72	CVR Energy Inc.	142	Marathon Oil Corp.	212	RPC Inc.
3	AGL Resources Inc.	73	Delek US Holdings Inc.	143	MarkWest Hydrocarbon Inc.	213	SandRidge Energy Inc.
4	Allegheny Energy Inc.	74	Denbury Resources Inc.	144	McMoRan Exploration Co.	214	SCANA Corp.
5	ALLETE Inc.	75	Devon Energy Corp.	145	MCN Energy Group Inc.	215	Schlumberger Ltd.
6	Alliant Energy Corp.	76	Diamond Offshore Drilling Inc.	146	MDU Resources Group Inc.	216	SEMCO Energy Inc.
7	Allied Waste Industries Inc.	77	Dominion Resources Inc.	147	Meridian Resource Corp. (The)	217	Sempra Energy
8	Allis-Chalmers Energy Inc.	78	Double Eagle Petroleum Co.	148	MGE Energy Inc.	218	SJW Corp.
9	Alon USA Energy Inc.	79	DTE Energy Co.	149	Middlesex Water Co.	219	SM Energy Co.

(continued)

10	Ameren Corp.	80	Duke Energy Corp.	150	Mobil Corp.	220	Sonat Inc.
11	American Oil & Gas Inc.	81	Duquesne Light Holdings Inc.	151	Murphy Oil Corp.	221	South Jersey Industries Inc.
12	American States Water Co.	82	Duratek Inc.	152	Nabors Industries Ltd.	222	Southern Co. (The)
13	American Water Works Company Inc.	83	Eastern Enterprises	153	New Century Energies Inc.	223	Southern Union Co.
14	Amoco Corp.	84	Edge Petroleum Corp.	154	New Generation Biofuels Holdings Inc.	224	Southwest Gas Corp.
15	Anadarko Petroleum Corp.	85	Edison International	155	Newfield Exploration Co.	225	Southwest Water Co.
16	Apache Corp.	86	El Paso Corp.	156	NextEra Energy Inc.	226	Southwestern Energy Co.
17	Approach Resources Inc.	87	El Paso Electric Co.	157	NGAS Resources Inc.	227	Spectra Energy Corp.
18	Aqua America Inc.	88	Empire District Electric Co.	158	Niagara Mohawk Holdings Inc.	228	Spinnaker Exploration Co.
19	Aquila Inc.	89	Encore Acquisition Co.	159	Nicor Inc.	229	Stericycle Inc.
20	Arena Resources Inc.	90	Endeavour International Corp.	160	NiSource Inc.	230	Stone Energy Corp.
21	Artesian Resources Corp.	91	Energen Corp.	161	Noble Energy Inc.	231	Sunoco Inc.
22	Atlantic Richfield Co.	92	Energy East Corp.	162	Noram Energy Corp.	232	Superior Energy Services Inc.
23	ATP Oil & Gas Corp.	93	EnergySolutions Inc.	163	Northeast Utilities	233	Superior Well Services Inc.
24	Avista Corp.	94	Entergy Corp.	164	Northern Oil and Gas Inc.	234	Swift Energy Co.
25	Baker Hughes Inc.	95	EOG Resources Inc.	165	Northwest Natural Gas Co.	235	Targa Resources Partners LP
26	Basic Energy Services Inc.	96	EQT Corp.	166	NorthWestern Corp.	236	TECO Energy Inc.
27	Berry Petroleum Co.	97	EXCO Resources Inc.	167	NRG Energy Inc.	237	Tesoro Corp.
28	Bill Barrett Corp.	98	Exelon Corp.	168	NSTAR	238	TETRA Technologies Inc.
29	Black Hills Corp.	99	Exxon Mobil Corp.	169	NV Energy Inc.	239	Texaco Inc.
30	Boots & Coots Inc.	100	FirstEnergy Corp.	170	Occidental Petroleum Corp.	240	TGC Industries Inc.
31	BPZ Resources Inc.	101	Florida Progress Corp.	171	Ocean Energy Inc.	241	Toreador Resources Corp.
32	Brigham Exploration Co.	102	Forest Oil Corp.	172	Oceaneering International Inc.	242	Transmeridian Exploration Inc.
33	Bronco Drilling Company Inc.	103	Frontier Oil Corp.	173	OGE Energy Corp.	243	Transocean Ltd.
34	Burlington Resources Inc.	104	FX Energy Inc.	174	ONEOK Inc.	244	Tri-Valley Corp.
35	Cabot Oil & Gas Corp.	105	Gasco Energy Inc.	175	Ormat Technologies Inc.	245	TXCO Resources Inc.
36	Cadiz Inc.	106	Gastar Exploration Inc.	176	Oryx Energy Co.	246	UIL Holdings Corp.
37	Cal Dive International Inc.	107	GenOn Energy Inc.	177	Otter Tail Corp.	247	Ultra Petroleum Corp.

(continued)

38	California Water Service Group	108	Geoglobal Resources Inc.	178	Parallel Petroleum Corp.	248	Unicom Corp.
39	Callon Petroleum Co./ DE	109	Geokinetics Inc.	179	Parker Drilling Co.	249	Union Drilling Inc.
40	Calpine Corp.	110	GeoMet Inc.	180	Patina Oil & Gas Corp.	250	Union Pacific Resources Group
41	Carrizo Oil & Gas Inc.	111	Giant Industries Inc.	181	Patterson-UTI Energy Inc.	251	Unit Corp.
42	CenterPoint Energy Inc.	112	Global Industries Ltd.	182	Penn Virginia Corp.	252	Unitil Corp.
43	Central & South West Corp.	113	GMX Resources Inc.	183	Pepco Holdings Inc.	253	Unocal Corp.
44	Central Vermont Public Service Corp.	114	Goodrich Petroleum Corp.	184	Perma Fix Environmental Services Inc.	254	US Ecology Inc.
45	CH Energy Group Inc.	115	GPU Inc.	185	Petroquest Energy Inc.	255	Vaalco Energy Inc.
46	Cheniere Energy Inc.	116	Great Plains Energy Inc.	186	PG&E Corp.	256	Valero Energy Corp.
47	Chesapeake Energy Corp.	117	Grey Wolf Inc.	187	Pinnacle West Capital Corp.	257	Vantage Drilling Co.
48	Chesapeake Utilities Corp.	118	Gulfport Energy Corp.	188	Pioneer Natural Resources Co.	258	Vectren Corp.
49	Chevron Corp.	119	Halliburton Co.	189	Plains Exploration & Production Co.	259	Venoco Inc.
50	China Natural Gas Inc.	120	Harvest Natural Resources Inc.	190	PNM Resources Inc.	260	Vintage Petroleum Inc.
51	Cimarex Energy Co.	121	Hawaiian Electric Industries Inc.	191	Pogo Producing Co.	261	Warren Resources Inc.
52	Clayton Williams Energy Inc.	122	Helix Energy Solutions Group Inc.	192	Portland General Electric Co.	262	Waste Connections Inc.
53	Clean Harbors Inc.	123	Hercules Offshore Inc.	193	PostRock Energy Corp.	263	Waste Industries USA Inc.
54	Cleco Corp.	124	Heritage-Crystal Clean Inc.	194	PowerSecure International Inc.	264	Waste Management Inc.
55	CMS Energy Corp.	125	Hess Corp.	195	PPL Corp.	265	Waste Services Inc.
56	Columbia Energy Group	126	Houston American Energy Corp.	196	Pride International Inc.	266	Weatherford International Ltd.
57	Complete Production Services Inc.	127	Houston Exploration Company (The)	197	PrimeEnergy Corp.	267	Westar Energy Inc.
58	Comstock Resources Inc.	128	IDACORP Inc.	198	Public Service Co Of Colo	268	Western Gas Resources Inc.
59	Concho Resources Inc.	129	Integrys Energy Group Inc.	199	Public Service Enterprise Group Inc.	269	Western Refining Inc.
60	Conectiv Inc.	130	Isramco Inc.	200	Puget Energy Inc.	270	W–H Energy Services Inc.
61	Connecticut Water Service Inc.	131	ITC Holdings Corp.	201	Pyramid Oil Co.	271	Whiting Petroleum Corp.
62	ConocoPhillips	132	KCS Energy Inc.	202	Quaker Chemical Corp.	272	Williams Cos Inc. (The)

(continued)

63	Consolidated Edison Inc.	133	Kerr-McGee Corp.	203	Questar Corp.	273	Wisconsin Energy Corp.
64	Consolidated Natural Gas Co.	134	Key Energy Services Inc.	204	Quicksilver Resources Inc.	274	W&T Offshore Inc.
65	Consolidated Water Co. Ltd.	135	Keyspan Corp.	205	Range Resources Corp.	275	Xcel Energy Inc.
66	Constellation Energy Group Inc.	136	Kodiak Oil & Gas Corp.	206	Raser Technologies Inc.	276	XTO Energy Inc.
67	Continental Resources Inc.	137	LG&E Energy Corp.	207	Remington Oil & Gas Corp.	277	York Water Company (The)
68	Core Laboratories NV	138	Louisiana Land & Exploration	208	Republic Services Inc.	278	Zion Oil & Gas Inc.
69	Covanta Holding Corp.	139	Lubrizol Corp. (The)	209	Rex Energy Corp.		
70	Crimson Exploration Inc.	140	Magnum Hunter Resources Corp.	210	Rosetta Resources Inc.		

References

Barber B, Lyon J (1997) Detecting long-run abnormal stock returns: the empirical power and specification of test statistics. J Financ Econ 43:341–371

Brammer S, Brooks C, Pavelin S (2006) Corporate social performance and stock returns: UK evidence from disaggregate measures. Financ Manage 35:97–116

Brinkmann T, Scholles C, Wind J, Wolff T, Dengel A, Clemens W (2008) Processing of coal mine gas with low methane concentrations for use in high-temperature fuel cells. Desalination 224:7–11

Chen K, Metcalf R (1980) The relationship between pollution control record and financial indicators revisited. Account Rev 55:168–177

Cohen A, Fenn S, Naimon J (1997) Environmental and financial performance: are they related? Investor Responsibility Research Center

Cordeiro J, Sarkis J (1997) Environmental proactivism and firm performance: evidence from security analyst earnings forecasts. Bus Strategy Environ 6:104–114

Core J, Holthausen R, Larcker D (1999) Corporate governance, chief executive officer compensation and firm performance. J Financ Econ 51:371–406

Derwall J, Guenster N, Bauer R, Koedijk K (2005) The eco-efficiency premium puzzle. Financ Anal J 61:51–63

Earnhart D, Lizal L (2007) Effect of pollution control on corporate financial performance in a transition economy. Eur Environ 17:247–266

EPA (2013) Environmental protection agency. Technical report. http://www.epa.gov

Fairfield P, Whisenant S, Yohn T (2003a) Accrued earnings and growth: implications for future profitability and market mispricing. Account Rev 78:353–371

Fairfield P, Whisenant S, Yohn T (2003b) The differential persistence of accruals and cash flows for future operating income versus future profitability. Rev Account Stud 8:221–243

Fama E, French K (1995) Size and book-to-market factors in earnings and returns. J Finance 50: 131–155

Fama E, French K (2001) Disappearing dividends: changing firm characteristics or lower propensity to pay. J Financ Econ 60:3–43

Fama E, French K (2006) Profitability, investment and average returns. J Financ Econ 82:491–518

Filbeck G, Gorman R (2004) The relationship between the environmental and financial performance of public utilities. Environ Res Econ 29:137–157

Freedman M, Jaggi B (1998) An analysis of the association between pollution disclosure and economic performance. Account Audit Account J 1:43–58

Griffin J, Lemmon M (2002) Does book-to-market equity proxy for distress risk or mispricing? J Finance 57:2317–2336
Grimmer M, Bingham T (2013) Company environmental performance and consumer purchase intentions. J Bus Res 66(10):1945–1953
Guenster N, Bauer R, Derwall J, Koedijk K (2010) The economic value of corporate eco-efficiency. Eur Financ Manage 17:679–704
Harrison J, Freeman R (1999) Stakeholders, social responsibility, and performance: empirical evidence and theoretical perspective. Acad Manage J 42:479–485
Hart S, Ahuja G (1996) Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Bus Strategy Environ 5:30–37
Hillman A, Keim G (2001) Shareholder value, stakeholder management, and social issues: What's the bottom line? Strateg Manage J 22:125–139
Iatridis G (2013) Environmental disclosure quality: evidence on environmental performance, corporate governance and value relevance. Emerg Mark Rev 14:55–75
Jensen M (1986) Agency costs of free cash flow, corporate finance, and takeovers. Am Econ Rev 76:323–329
Johnson R, Greening D (1999) The effects of corporate governance and institutional ownership types on corporate social performance. Acad Manage J 42:564–576
King A, Lenox M (2002) Exploring the locus of profitable pollution reduction. Manage Sci 48: 289–299
Klassen R, McLaughlin C (1996) The impact of environmental management on firm performance. Manage Sci 42:1199–1214
Kolk A, Levy D (2001) Winds of change: corporate strategy, climate change and oil multinationals. Eur Manage J 19:501–509
Konar S, Cohen M (2001) Does the market value environmental performance? Rev Econ Stat 83: 281–289
Lankoski L (2009) Differential economic impacts of corporate responsibility issues. Bus Soc 48: 206–224
Liston-Heyes C, Ceton G (2008) An investigation of real versus perceived CSP in S&P 500 firms. J Bus Ethics 89:283–296
Mahapatra S (1984) Investor reaction to a corporate social accounting. J Bus Finance Account 11: 29–40
McGuire JB, Sundgren A, Schneeweis T (1988) Corporate social responsibility and firm financial performance. Acad Manage J 31:854–872
McWilliams A, Siegel D, Wright P (2006) Corporate social responsibility: strategic implications. J Manage Stud 43:1–18
Meijer M, Schuyt T (2005) Corporate social performance as a bottom line for consumers. Bus Soc 44:442–461
Oehme N, Kemp R (2013) Ecoactivity and innovativeness: what is their relation to environmental performance in consumer firms and industrial firms? In: Costantini V, Mazzanti M (eds) The dynamics of environmental and economic systems. Springer, Dordrecht
Ohlson J (1980) Financial ratios and the probabilistic prediction of bankruptcy. J Account Res 18: 109–131
Oikonomou I, Brooks C, Pavelin S (2012) The impact of corporate social performance on financial risk and utility: a longitudinal analysis. Financ Manage 41:483–515
Orlitzky M, Schmidt FL, Rynes S (2003) Corporate social and financial performance: a meta-analysis. Organ Stud 24:403–441
Palmer K, Oates WE, Portney P (1995) Tightening environmental standards: the benefit-cost or the no-cost paradigm? J Econ Perspect 9:119–132
Patari S, Jantunen A, Kylaheiko K, Sandstrom J (2012) Does sustainable development foster value creation? Empirical evidence from the global energy industry. Corp Soc Responsib Environ Manage 19:317–326

Piotroski J (2000) Value investing: the use of historical financial statement information to separate winners from losers. J Account Res 38:1–42
Porter M, van der Linde C (1995) Toward a new conception of the environment-competitiveness relationship. J Econ Perspect 9:97–118
Reinhardt F (1999) Market failure and the environmental policies of firm. J Ind Ecol 3:9–21
Renneboog L, Ter Horst J, Zhang C (2008) Socially responsible investments: institutional aspects, performance, and investor behavior. J Bank Finance 32:1723–1742
Russo MV, Fouts P (1997) A resource-based perspective on corporate environmental performance and profitability. Acad Manage J 40:534–559
Servaes H, Tamayo A (2013) The impact of corporate social responsibility on firm value: the role of customer awareness. Manage Sci 59:1045–1061
Sharfman M, Fernando C (2008) Environmental risk management and the cost of capital. Strateg Manage J 29:569–592
Sloan R (1996) Do stock prices fully reflect information in accruals and cash flows about future earnings? Account Rev 71:289–315
Smolarski J, Vega J (2013) Extreme events: a study of small oil and gas firms. Account Finance 53: 809–836
Statman M, Glushkov D (2009) The wages of social responsibility. Financ Anal J 65:33–46
Tait C (2010) Exxonmobil shareholders to demand oil-sands risk information. Financial Post
Waddock S, Graves S (1997) The corporate social performance – financial performance link. Strateg Manage J 18:303–319
Wood D, Jones R (1995) Stakeholder mismatching: a theoretical problem in empirical research on corporate social performance. Int J Organ Anal 3:229–267

Electricity Consumption, GDP and Renewables

6

M. Erdinc Telatar

Abstract

This chapter analyzes the relationship between renewable and non-renewable electricity consumption and economic growth for 130 countries categorized into four groups based upon the World Bank income classification (high, upper middle, lower middle, and low income). The main motivation for this study is to find out whether the causality relationships change depending on the income level of countries. For this purpose panel causality tests are used. Electricity consumption data is disaggregated into renewable and non-renewable sources with the aim of providing more information for policy makers to use in designing energy policies in the context of environmental and sustainable development. The results of the study show that the conservation hypothesis is supported for high, upper-middle and lower-middle income groups, while the neutrality hypothesis is supported for low-income countries. The main finding of this chapter is that the causality relationship between electricity consumption and economic growth disappears for lower-income levels. We can conclude that implementing green economy policies in the context of sustainable development is a reasonable choice for developing countries, provided that it is supported by developed nations.

Keywords

Economic growth • Electricity consumption • Renewables

M.E. Telatar (✉)
Okan University, Istanbul, Turkey
e-mail: erdinc.telatar@okan.edu.tr

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_6

6.1 Introduction

Economic growth has always been a key fundamental concept in economic theory and policy. The importance of investigating the determinants of economic growth stems mainly from its pivotal role to play in measuring well-being of people and nations. It is for this reason that investigating the causal relationship between GDP growth and other important macroeconomic variables has always been a major subject of interest among most researchers and policymakers around the world. Energy is one of the important variables to be analyzed in order to understanding the dynamics of economic growth. Electrical energy consumption is the driving force for economic development, and one of the primary determinants of a country's standard of living (Joyeux and Ripple 2004). Electricity is equally important for every country regardless of their economic well-being: It is needed for developed countries to run their industrial sector while for developing countries to catch-up economically with industrialized countries.

Determination of the factors affecting economic growth process is an empirical issue. There are many factors that have so far been identified as the determinants of economic growth in the empirical literature. Inclusion of energy consumption in economic growth models as an explanatory variable is considered to be a relatively new phenomenon. Investigating the relationship between energy and economic growth, and more generally the role of energy in economic production, has attracted significant attention following the 1970s oil crises. Energy crises enhanced the importance of including energy as an explanatory variable in production functions and forced governments to take necessary policy actions towards reducing energy consumption. Analyzing the relationship between energy consumption and economic growth has become a hot issue in academic research since the 1970s.

Besides concerns about increasing production costs, population dynamics have been another key factor that all research studies and policy makers should take into account when deciding which energy source to use and which energy policy to be implemented. The world population has reached 7.2 billion in mid-2013, after having been growing continuously since 1950. According to the *2012 Revision* of the official United Nations population estimates and projections, the world population is projected to increase by almost one billion people within the next 12 years, reaching 8.1 billion in 2025, and to further increase to 9.6 billion in 2050 and 10.9 billion by 2100. This means that the world will need greatly increased energy supply in the near future. According to the BP Statistical Review of World Energy (2013), although the growth rate of global energy consumption has decreased in recent years as a result of slower economic growth, it continues to increase due primarily to the development needs of emerging countries such as India and China, which are the most populated countries and are among the top 10 energy consumers in the world (Shaari et al. 2012: 17).

Along with increases in the world population, industrialization needs and changing lifestyles have been additional factors that caused the global energy demand to increase. However, increases in energy consumption have some unintended consequences on the environment. This is especially true for non-renewable energy sources such as coal, petroleum and natural gas. Using non-renewable sources generates carbon emissions, which create the greenhouse effect, causing global warming.

In recent years, interest in environmental issues has significantly increased. Raised awareness on environmental degradation and related problems has accelerated the efforts to find new ways to produce energy. Renewable energy sources have become popular as a result of this trend. According to the estimates of International Energy Agency, the strong rise of renewables will reduce the share of fossil fuels to around 75 % in 2035 from 82 % in 2011. The share of renewables is estimated to rise to 18 % in 2035 from 13 % in 2011. Using renewable sources in generating electricity has several benefits such as reducing carbon dioxide (CO_2) emissions and other pollutants, enhancing energy security, lowering fossil-fuel import costs and fostering economic development. Energy efficiency, along with renewable energy, is the major features of sustainable energy policy. One of the purposes of this study is to investigate if there is a causal relationship between renewables and economic development and, if this is the case, how this relationship changes depending on different levels of income.

In order to reduce harmful effects of energy consumption, policy changes towards cutting energy consumption or increasing energy efficiency proved to be necessary. Although necessary, it is not an easy way for policymakers to change their energy policy towards decreasing energy consumption, since this type of policy changes might have some unfavorable consequences for their economic growth prospects. Because the production processes depend heavily on energy/electricity usage, any policy change reducing energy consumption can be detrimental for the economy. Therefore, one of the problems for policymakers is to find out the relationship between electricity consumption and economic growth in their country. The first step towards finding a solution to this problem is to estimate the relationship empirically.

In this study, renewable and nonrenewable sources of energy are differentiated.[1] The most important reason behind this categorization is energy security and sustainability. Energy security deals with the issue of whether an energy source has limited quantity and can be regenerated. This group includes crude oil, coal, petroleum products and nuclear fuels. Therefore, the degree of exhaustibility of an energy source can be used as a good indicator of its sustainability. Energy sustainability, by definition, is the provision of energy that meets the needs of the present generations without worrying about future generations. Sustainable energy sources are also environment-oriented, which means that they do not damage to the environment. All energy sources classified into "sustainable" are also renewable sources since sustainability not only covers renewability but also relates to environmental protection. Nonrenewable energy consumption has serious impact on the

[1] In recent years, several studies have been conducted on the relationships between economic growth and different sources of energy. See, for example, Apergis and Payne (2010a, b), Apergis and Payne (2012b) and Sadorsky (2009).

environment by releasing carbon dioxide and other gasses in atmosphere. Renewable energy consumption taken from natural flows like wind has in general no detrimental effects on the environment. Therefore, energy policies aimed at protecting environment also protects the health of future generations.

This study aims to examine empirically the relationship between electricity consumption and economic growth for country-groups based on their income-levels by using panel data estimation methods. As far as we know, this is one of the most extensive empirical investigations on the related literature covering 130 countries categorized into four panels based on the World Bank's income classification (high, upper-middle, lower-middle, low). Grouping countries with respect to their income levels will allow us (1) to interpret empirical findings in a more realistic way, and (2) to bring out appropriate and feasible policy recommendations. The main motivation for this approach is the idea that feasible policy recommendations can be useful only if we take into consideration the relative financial capabilities of the countries. Implementing investment strategies for development of renewable energy production requires large expenditures that a low-income country can hardly afford. If this is the case, financial aid from outside sources will be needed. Therefore, it seems to be the best way to use data for country-groups on their income-levels in order to develop reasonable energy policy strategies.

The chapter is organized in the following way. In Sect. 6.2 provides the theoretical basis of the study and explains main arguments in the literature. Section 6.3 introduces a methodological framework, while Sect. 6.4 presents empirical results. Section 6.5 provides concluding remarks.

6.2 Theoretical Basis and Main Arguments

The neoclassical economic growth models developed by Solow (1956) had not included energy as an input, assuming that capital and labor are the only factors of production. As Erbaykal (2008) points out, the oil crises during the 1970s made it necessary to include energy as a factor in a production function. Since then, energy consumption has become an important variable to examine the production process in addition to traditional factors of production, capital and labor. Therefore, extending production functions to include energy as an additional factor does not have a long history.

Following Zhixin and Xin (2011), we can write the Cobb–Douglas production function, which includes energy consumption (EC) as an input, as follows:

$$Y = AK^{\alpha}L^{\beta}EC^{\gamma}e^{c_1+\mu} \tag{6.1}$$

where α, β and γ, represent the elasticity of output of capital, labor and energy consumption, respectively. This production function can be transformed into a linear function:

$$L_nY_t = c + \alpha L_nK_t + \beta L_nL_t + \gamma L_nEC_t + \mu_t \tag{6.2}$$

where Y represents aggregate output at time t, K_t is capital and L_t is labor, and A is the technology parameter. The constant term is $c = c_1 + L_nA$.

Although there is a huge literature on the subject, empirical studies on the relationship between electricity consumption and economic growth have not come to a conclusion on the direction of the causality between two variables. There are four hypotheses in the related theoretic literature regarding the direction of the relationship between energy/electricity consumption and economic growth (Apergis and Payne 2011a: 770): (1) *The Growth Hypothesis* asserts that there is a causality relationship between two variables running from electricity consumption to economic growth, whereby the sign of the relationship is supposed to be positive indicating that higher electricity consumption promotes economic growth, (2) *The Conservation hypothesis* asserts that changes in the economic growth causes electricity consumption to change and the sign of the causality is supposed to be positive, indicating that electricity consumption increases as economic growth increases, (3) *The feedback hypothesis* asserts that there is a bi-directional causality between the two variables, indicating that changes in one of these causes the other to change and so on, (4) The *Neutrality hypothesis* asserts that there is no causality relationship between electricity consumption and economic growth, which means that electricity consumption does not play a role in economic growth processes.

Each one of the hypotheses has its own policy implications. First of all, since the neoclassical growth model does not contain energy as an input in the production process, it foresees no causal relationship between energy consumption and economic growth. Therefore, rejecting the neutrality hypothesis can be interpreted as invalidity of the neoclassical model in regard to the energy-growth nexus.

Finding evidence for the growth hypothesis indicates that policies aimed at cutting energy consumption will reduce economic growth. If the energy conservation hypothesis is found to be true, this means that electricity consumption could be decreased without reducing economic growth. In the case that non-renewables are being used to generate electricity, energy conservation policy will help to save the limited energy resources from depletion. The feedback hypothesis implies a bidirectional relationship between the two variables having the same policy implications as the previous two. If the neutrality hypothesis is found to be correct, we can conclude that there is no causality relationship between electricity consumption and economic growth, so there is no need to worry about unfavorable consequences of conservation policies for economic growth.

The pioneering study in the empirical literature on the subject is that of Kraft and Kraft (1978). Their purpose was to investigate the causality relationship between energy consumption and aggregate income. They found evidence of a causal relationship running from economic growth to energy consumption for the US over the period of 1947–1974. Following the seminal paper of Kraft and Kraft (1978), there has been considerable interest in the relationship between energy consumption and economic growth. At the start of empirical research, a basic Granger causality test had been employed. Yu and Jin (1992) is the first study in which cointegration tests were used to examine the long-run relationship between the two variables.

The test results obtained in the related literature are mixed mainly due to (1) different econometric methods, and (2) different data sets, (3) different time periods, (4) different model specifications, and (5) different countries' characteristics.[2]

In the empirical studies on the causality relationship between consumption for different sources of energy and economic growth, several econometric methodologies have been employed, such as forecast error variance decomposition analysis, bivariate error correction analysis, autoregressive distributed lag (ARDL) bounds testing, the Toda–Yamamoto procedure and multivariate error correction models within a production function framework (Pao and Fu 2013: 794). Related research can also be differentiated with respect to their data sets. Some of the studies have been conducted by using country-specific data while others are using multi-country data sets.

One of the deficiencies of the Granger causality test is that it requires the time series to be stationary. Therefore, before conducting causality tests, the variables found to be non-stationary should be converted into stationary series by losing some useful information contained in the original (rough) data sets. The modeling approach of this study allows us to use both stationary and non-stationary variables so that we can keep all available information carried by raw time series into the model. However, as time goes by, new techniques have been developed and used in empirical literature, one of which is Perron's (1989) test. According to Perron (1989), one should take into account the possibility that it might be structural breaks in the series that cause the null hypothesis of a unit root not to be rejected even if the series are stationary. Therefore, the existence of a structural break in the series should be investigated if the series is found to be non-stationary before employing standard Granger causality tests. As shown by Özturk (2010) and Payne (2010a, b), there are quite a few studies in the literature in which cointegration tests for the possibility of long-run relationships among non-stationary time series have been explored.

Another reason to reach contradictory results in the empirical studies might be the time span of data used in them. As Payne (2010b: 729) points out, the power and size properties of standard unit root and cointegration tests are reduced as the time span of data shortens. This fact gave rise to many studies panel estimation methods are used. The panel data analysis technique allows researchers to work with data long enough to find powerful results by combining cross-section and time series data. Using panel data also has the advantage of exploiting the dynamics in the cross-section data. In recent years, empirical literature on the relationship between

[2] See Özturk (2010) and Payne (2010a) for excellent surveys on energy-growth nexus and Payne (2010b) on the causality relationship between electricity consumption and economic growth. Also see Al-Mulali et al. (2014) and Apergis and Payne (2011b) for a summary of the studies on the relationship between GDP growth and electricity consumption.

electricity consumption and economic growth has been extended to employ panel data analysis. However, the tradition of finding mixed results has not changed.

6.3 Econometric Methodology

Several empirical studies have shown that electricity consumption and economic growth are correlated with each other. This implies that a researcher who tries to explain the growth pattern of a country should take consideration of the electricity consumption. However, it is impossible to say exactly which variable causes the other to change based on the results for correlation, since it doesn't imply causality. Researchers aimed at getting some policy implications are supposed to conduct econometric tests in order to find out if there is a causal relationship between the two variables.

Equation (6.2) gives a theoretical argument on the relationship between electricity consumption and economic growth. It comes from a priori theory on a possible causal mechanism, which is assumed to run from electricity consumption to economic growth. Therefore, by using standard regression methods, one can only conclude if electricity consumption affects economic growth, since regressing one variable on another explains nothing about causal relationships between an independent (electricity consumption) and a dependent variable (economic growth).

The first step in empirically testing the growth-energy consumption nexus is to find out whether the series have a unit root and are co-integrated. One of the methods for studying causality relationships is the Granger causality test, which involves using F-tests to test whether lagged information on an independent variable, electricity consumption in our study, provides any statistically significant information about a dependent variable, economic growth, in the presence of a lagged independent variable. If not, then "electricity consumption does not Granger-cause economic growth". In other words, if the prediction error of current economic growth decreases by using past values of electricity consumption in addition to past values of economic growth, then "electricity consumption is said to Granger-cause economic growth".

We start the analysis by examining whether the variables contain a unit root or not before proceeding to test panel unit root. Two types of panel unit root tests are used, namely Levin, Lin and Chu (LLC) (2002) and Im, Pesaran and Shin (IPS) (2003). The LLC unit root test assumes homogeneity in the dynamics of autoregressive coefficients while the IPS unit root tests allow heterogeneity in the dynamics of autoregressive coefficients. The null hypothesis for both LLC and IPS is that there is a unit root while the alternative hypothesis is that there is no unit root.

The Panel Auto Regressive Distributed Lag (ARDL) method developed by Pesaran et al. (2001) is used to estimate cointegration parameters of the model. An ARDL model uses both the lags of independent and dependent variables, assuming that the short-run effect can be directly estimated. The ARDL method has same advantages in comparison with other cointegration tests. The most important advantage of the model is that ARDL approach can be implemented regardless of whether the structure of the underlying data-generation process is integrated order zero, I(0), or integrated order 1, I(1).

The ARDL modeling approach involves estimating the following models:

$$\Delta Y_t = \propto_{10} + \sum\nolimits_{i=1}^{n} \beta_{2i} \Delta Y_{t-i} + \sum\nolimits_{i=1}^{m} \gamma_{1i} \Delta X_{t-i} + \sigma_{1Y} Y_{t-1} + \sigma_{1X} X_{t-1} + \epsilon_{1t} \quad (6.3)$$

$$\Delta X_t = \propto_{20} + \sum\nolimits_{i=1}^{m} \gamma_{2i} \Delta X_{t-i} + \sum\nolimits_{i=1}^{n} \beta_{2i} \Delta Y_{t-i} + \sigma_{2X} X_{t-1} + \sigma_{2Y} Y_{t-1} + \epsilon_{2t} \quad (6.4)$$

where X and Y represent electricity consumption and economic growth, respectively. The long-run relationship between electricity consumption and economic growth is tested by showing if the estimated parameters of σ for the lagged values of Y and X are statistically significant. The null hypothesis of no cointegration among the variables in Eqs. (6.3) and (6.4) are $H_0 : \sigma_{iX} = \sigma_{iY} = 0$, against the alternative hypothesis $H_1 : \sigma_{iX} \neq \sigma_{iY} \neq 0$ for $i = 1, 2$. Instead of using standard F-statistics, the upper [for I(1)] and lower [for I(0)] bounds statistics given in Pesaran et al. (2001) are used. If the calculated test statistics exceeds a critical value, the null hypothesis is rejected. If calculated test value smaller than the lower bound value, the null hypothesis cannot be rejected. If the calculated test statistics falls into the bounds, the result becomes inconclusive. If we find that the series are cointegrated, we should proceed to the next step in which the sign and magnitude of the short-run relationship is found. To do this, we use the residuals of the estimated long-run regression models.

A VEC representation is used to examine both the short-run and the long-run dynamics of the variables. The model constructed as follows:

$$\Delta Y_t = \propto_{10} + \sum\nolimits_{i=1}^{n} \beta_{1i} \Delta Y_{t-i} + \sum\nolimits_{i=1}^{m} \gamma_{1i} \Delta X_{t-i} + \delta_Y EC_{t-1} + u_{1t} \quad (6.5)$$

$$\Delta X_t = \propto_{20} + \sum\nolimits_{i=1}^{m} \gamma_{2i} \Delta X_{t-i} + \sum\nolimits_{i=1}^{n} \beta_{2i} \Delta Y_{t-i} + \delta_X EC_{t-1} + u_{2t} \quad (6.6)$$

where the error terms (u_{1t} and u_{2t}) are normally distributed with mean zero and constant variance. EC_{t-1} is the error correction term showing the adjustment of the long-run relationship to the equilibrium after a shock to the model obtained from the long-run estimation. The lag lengths are determined according to the Schwarz-Bayesian Information criteria (SBC). The F-statistics on the lagged dependent variables of Eqs. (6.5) and (6.6) indicate the significance of the short-run effects. The t-statistics on the coefficients of the lagged error correction terms indicate significance of the long-run causal effect. The error correction models, Eqs. (6.5) and (6.6), are estimated using the panel fixed effect estimation method.

6.4 Estimation and Test Results

As Al-Mulali et al. (2014) point out, there are few studies in the related literature that disaggregate electricity consumption to renewable and nonrenewable sources, even though the relationship between energy consumption and growth is widely analyzed in the literature. In this study, the ARDL bounds testing procedure of Pesaran et al. (2001) is employed in order to analyze the long-run relationship between electricity consumption and economic growth. After testing for cointegration and estimating long-run relationships among the variables, Granger-causality tests between variables are carried out. We now turn to data description and estimation results.

Panel data sets for the 130 countries according to their World Bank income groups are used (see also the Appendix). The Data we gathered from the World Bank's World Development Indicators cover the period of 1960–2013. The data consist of real GDP (Y) in billions of constant 2005 U.S. dollars. Electric power production (EPP) is defined in million kilowatt hours. Electricity power production from renewable sources (EPPR) is also measured in million kilowatt hours. All variables are measured in their logarithms.

Besides using total electricity consumption (ELEC), we also used differentiated series of renewable energy sources (ELECR) and nonrenewable energy sources (ELECNR). We consider "renewables" as a part of green economy policies in the context of sustainable development. Therefore, we use data on electricity consumption from renewable energy sources excluding-hydroelectric power since it has some environmental disadvantages such as disturbing the natural life.

The results of the panel unit root tests are displayed in Table 6.1.

As shown from the results in Table 6.1, it is clear that there is no unique conclusion for the existence of unit root in the series. Some series are found to be stationary in levels while the first differences of others are taken to make them stationary. The mixed results from the panel unit root tests based on the LLC and IPS approaches fail to provide a conclusive decision on the order of integration —I(0) and I(1)—, which suits to apply the ARDL bounds testing approach to cointegration.[3] Before estimating ARDL, we determined the appropriate lag order in order to use in the model based on the Bayesian Information criterion.

ARDL test results are given in Table 6.2.

As shown from Table 6.2, the long-run ECT's are statistically significant in all cases, except for the model in Eq. (6.3) with LELECNR being explanatory variable for high-income group, and the model in Eq. (6.3) with LELECR being independent variable for low-income country panel. This means that the long-run causality relationship between total and differentiated sources of electricity consumption and economic growth has been shown to be true for all panels with a few exceptions.

[3] Similar mixed results are obtained in energy economics by Narayan and Smyth (2009) and Narayan and Prasad (2008).

Table 6.1 Panel unit root tests

	IPS		LLC	
Variables	Intercept	Intercept and trend	Intercept	Intercept and trend
High income country panel				
LGDP	−2.99*	1.07	−12.14*	−1.04
LELEC	−11.99*	1.88	−20.66*	−5.35*
LELECR	5.05	0.57	0.66	0.64
LELECNR	−11.64*	0.10	−18.97*	−6.21*
Δ LGDP	−15.31	−14.77*	−13.24*	−13.66*
Δ LELEC	−14.83	−19.08*	−10.94*	−14.93*
Δ LELECR	−24.40*	−17.07*	−27.13*	−25.83*
Δ LELECNR	−17.77*	−21.99*	−13.37*	−17.21
Upper-middle income country panel				
LGDP	0.65	−3.14*	−2.35*	−5.68*
LELEC	−4.59*	−3.64*	−9.84*	−8.26*
LELECR	−1.11	−0.82	−2.09	−2.10
LELECNR	−1.75	3.48*	−8.59*	9.80*
Δ LGDP	−15.34*	10.85*	17.58*	13.63*
Δ LELEC	−13.47*	13.04*	10.74*	−9.20*
Δ LELECR	−26.31*	−16.23*	−44.38*	−40.51*
Δ LELECNR	−16.91*	16.26*	12.51*	−10.87*
Lower-middle income country panel				
LGDP	4.54	2.26	2.30	0.14
LELEC	−0.27	1.16	−5.74*	−0.36
LELECR	−9.12*	−10.37*	−11.11*	−37.10*
LELECNR	−0.91	−0.73	−4.22*	−0.087
Δ LGDP	−13.84*	−12.60*	−9.30*	−8.29*
Δ LELEC	−16.50*	−13.94*	−12.95*	−13.73*
Δ LELECR	−30.03*	−18.14*	−54.21*	−46.89*
Δ LELECNR	−15.73*	−13.51*	−13.91*	−13.73*
Low income country panel				
LGDP	3.43	0.03	1.90	−1.35
LELEC	−0.49	−0.14	−3.04*	0.25
LELECR	1.43	0.86	−0.51	−1.48
LELECNR	−1.61	−1.07	−2.88	−0.57
Δ LGDP	−8.05*	−8.22*	−4.64*	−4.69*
Δ LELEC	−10.55*	−9.37*	−7.51*	−6.19*
Δ LELECR	−4.63*	−2.45*	−8.35*	−10.03*
Δ LELECNR	−12.60*	−10.96*	−12.14*	−10.37*

LELEC log of electricity consumption, *LGDP* log of gross domestic product, *LELECR* log of electricity from renewables, *LELECNR* log of electricity from non-renewables
*Significance at the 1 % level

Table 6.2 Panel causality tests

	High income country panel		Upper-middle income country panel		Lower-middle income country panel		Low income country panel	
	Long run ECT	Short-run F-values	Long run ECT	Short-run F-values	Long run ECT	Short-run F-values	Long run ECT	Short-run F-values
LELEC→LGDP	−0.035* (0.000)	1.835(−) (0.10)	−0.056* (0.000)	2.079(+) (0.065)	−0.043* (0.000)	0.163(+) (0.975)	−0.047* (0.000)	1.408(+) (0.203)
LGDP→LELEC	−0.051* (0.000)	1.640(+) (0.146)	−0.021* (0.005)	3.055*(+) (0.005)	−0.071* (0.000)	0.837(−) (0.541)	−0.104* (0.000)	0.030(+) (0.970)
LELECR→LGDP	−0.031* (0.000)	0.023(+) (0.132)	−0.035* (0.000)	0.063(−) (0.370)	0.094* (0.000)	1.744(−) (0.176))	−0.039 (0.195)	0.005(+) (0.06)
LGDP→LELECR	−0.110* (0.000)	1.636(+) (0.195)	−0.058* (0.000)	0.592(+) (0.553)	−0.052* (0.000)	4.158*(−) (0.001)	−0.356* (0.000)	2.216(−) (0.051)
LELECNR→LGDP	0.004 (0.225)	1.962(+) (0.140)	−0.045* (0.000)	0.928(−) (0.461)	−0.056* (0.000)	0.483(+) (0.788)	−0.029* (0.012)	1.082(+) (0.365)
LGDP→LELECNR	−0.099* (0.000)	4.198*(+) (0.002)	−0.126* (0.000)	3.068*(+) (0.046)	−0.133* (0.000)	0.794(−) (0.529)	−0.143* (0.000)	0.198(+) (0.819)

F-statistics reported with respect to short-run causality. Lag lengths are selected according to SBC. The sum of the coefficients is reported in parenthesis
*Significance at the 1 % level

For high-income group, the results for them as given in column 1, we found that the short-run causality running from economic growth to electricity consumption from non-renewable sources is statistically significant with a positive sign. This means that as the economy expands, the usage of non-renewable forms of energy is increased in high-income countries, supporting the conservation hypothesis. However, Apergis and Payne (2011a, b) reports bidirectional causality between electricity consumption, without decomposing it, and economic growth for high income level country panel by using linear techniques. Similarly, Apergis and Payne (2012a, b) provides some evidence that there is a bidirectional causality between renewable and non-renewable energy consumption and economic growth in both the short-run and the long-run, without making any distinction of countries income level.

The results of the study show that the conservation hypothesis is supported for both total electricity consumption and electricity usage from non-renewable sources for upper-middle income countries. This means that the causality relationship runs from economic growth to electricity consumption with no indication for the effect of electricity consumption on economic growth in the short run. These results contradict with the findings of Apergis and Payne (2011a, b, c, 2012a, b) that support the feedback hypothesis.

As regards the lower-middle income panel, there is a causality relationship running from economic growth to electricity consumption from renewable energy sources in the short run. However, this result needs to be interpreted carefully, since the sign of the parameter is negative, meaning that increases in economic growth cause electricity consumption from renewables to decrease. The negative causal relationship might be seen as economically meaningless, but it turns out to be meaningful when the series of total electricity consumption is differentiated into two groups as we do in this study.

As for low-income countries, we do not find any causal relationship between economic growth and electricity consumption. This means that the neutrality hypothesis is supported for this group of countries. This result might be attributed to the fact that the countries in this group are in the initial phase of economic development, in which traditional methods have still been used in production.

Concluding Remarks

We analyzed the causal relationships between electricity consumption and economic growth for the countries according to the World Bank income group classification. We differentiated total electricity consumption in two groups as renewable and non-renewable. We used ARDL bounds testing procedure of Pesaran et al. (2001) to test the causality relationship between two variables. There are four hypotheses in related literature: (1) the growth hypothesis, (2) the conservation hypothesis, (3) the feedback hypothesis, and (4) the neutrality hypothesis.

Our results show that the conservation hypothesis is supported for high, upper-middle and lower-middle income groups, and the neutrality hypothesis is supported for low-income countries.

The conservation hypothesis is found to be true for the high-income country group for the electricity consumption from nonrenewable energy sources. The short-run causality relationship running from economic growth to non-renewable electricity consumption makes energy conservation policies aimed at reducing usage of non-renewable sources of energy a reasonable option for these countries. In this group of countries, any decreases in electricity consumption from non-renewable do not have harmful effects on economic growth. Therefore, energy conservation policies can be used to protect environment and be a part of sustainable development programs in this group of countries.

Our results show that conservation policies are also supported for upper-middle income countries as regards electricity consumption from non-renewable sources, making energy conservation policies to be economically meaningful for these countries.

We found for the lower-middle income panel that the conservation hypothesis is supported for electricity consumption from renewables. This result should be interpreted by taking into account the specific features of the countries in this group. The lower-middle income group includes countries where investments in renewable sources are small in amount because of high initial costs, and average standards of living are low since real income per capita is low. Therefore, increases in income level might be expected to increase expenditures on more expensive goods and services, and to use non-renewable energy sources than renewable ones.

We found no evidence for a causal relationship in the short run between electricity consumption and economic growth for low-income countries, giving support to the neutrality hypothesis. This means that renewable sources of energy can be used in the production process without creating harmful effect on economic growth. This can be seen as an opportunity to support green economy policies to promote the economy in these countries. However, given the fact that investment in renewable energy requires large expenditures that developing countries can hardly afford, the efforts of these countries for implementing green economic policies needs to be supported financially by developed countries and international economic development organizations.

As a further research, the study can be extended by applying non-linear panel causality techniques which allow for nonlinearity and heterogeneity of units to be utilized, along with using all information carried by both cross-section and time series data.

Appendix

High income countries	Upper-middle income
Australia	Angola
Austria	Albania
Belgium	Argentina
Bahrain	Azerbaijan
Belarus	Bulgaria
Brunei Darussalam	Bosnia and Herzegovina
Canada	Brazil
Switzerland	Botswana
Caribbean small states	Chile
Cyprus	China
Czech Republic	Colombia
Germany	Costa Rica
Denmark	Cuba
Spain	Dominican Republic
Estonia	Algeria
Finland	Ecuador
France	Gabon
United Kingdom	Hungary
Greece	Iran, Islamic Republic
Hong Kong SAR, China	Iraq
Croatia	Jamaica
Ireland	Jordan
Iceland	Kazakhstan
Israel	Lebanon
Italy	Libya
Japan	Mexico
Korea, Republic.	Macedonia, FYR
Kuwait	Malaysia
Liechtenstein	Namibia
Lithuania	Panama
Luxembourg	Peru
Latvia	Portugal
Monaco	Romania
Malta	Serbia
Netherlands	Turkmenistan
Norway	Tunisia
New Zealand	Turkey
Oman	Venezuela, RB
Poland	
Qatar	
Russian Federation	

(continued)

High income countries	Upper-middle income
Saudi Arabia	
Singapore	
Sweden	
Trinidad and Tobago	
United Arab Emirates	
United States	

Lower-middle income	Low income
Armenia	Benin
Bolivia	Bangladesh
Cote d'Ivoire	Eritrea
Cameroon	Ethiopia
Congo, Rep.	Haiti
Egypt, Arab Republic	Kenya
Georgia	Kyrgyz Republic
Ghana	Cambodia
Guatemala	Liberia
Honduras	Mozambique
Indonesia	Nepal
India	
Kosovo	
Sri Lanka	
Lesotho	
Morocco	
Moldova	
Mongolia	
Nigeria	
Nicaragua	
Pakistan	
Philippines	
Paraguay	
Sudan	
Senegal	
El Salvador	
Syrian Arab Republic	
Ukraine	
Uzbekistan	

References

Al-Mulali U, Fereidouni HG, Lee JYM (2014) Electricity consumption from renewable and non-renewable sources and economic growth: evidence from Latin American countries. Renew Sust Energ Rev 30:290–298

Apergis N, Payne JE (2010a) Renewable energy consumption and economic growth: evidence from a panel of OECD countries. Energy Policy 38(1):656–660

Apergis N, Payne JE (2010b) Renewable energy consumption and growth in Eurasia. Energy Econ 32(6):1392–1397

Apergis N, Payne JE (2011a) A dynamic panel study of economic development and the electricity consumption-growth nexus. Energy Econ 33:770–781

Apergis N, Payne JE (2011b) The renewable energy consumption–growth nexus in Central America. Appl Energy 88(1):343–347

Apergis N, Payne JE (2011c) Renewable and non-renewable electricity consumption–growth nexus: evidence from emerging market economies. Appl Energy 88(12):5226–5230

Apergis N, Payne JE (2012a) The electricity consumption-growth nexus: renewable versus non-renewable electricity in Central America. Energy Sources Part B Econ Plann Policy 7 (4):423–431

Apergis N, Payne JE (2012b) Renewable and non-renewable energy consumption-growth nexus: evidence from a panel error correction model. Energy Econ 34(3):733–738

BP Statistical Review of World Energy (2013) http://www.bp.com

Erbaykal E (2008) Disaggregated energy consumption and economic growth: evidence from Turkey. Int Res J Financ Econ 20:172–179

Im KS, Pesaran HM, Shin Y (2003) Testing for unit roots in heterogeneous panels. J Econ 115:53–74

Joyeux R, Ripple RD (2004) The evaluation of standard of living and the role of household electricity consumption: a panel cointegration analysis. Paper presented in the New Zealand association of economists annual conference, 30 June–2 July 2004

Kraft J, Kraft A (1978) On the relationship between energy and GNP. J Energy Dev 3:401–403

Levin AC, Lin F, Chu CSJ (2002) Unit root tests in panel data: asymptotic and finite-sample properties. J Econ 108:1–24

Narayan PK, Prasad A (2008) Electricity consumption—real GDP causality nexus: evidence from a bootstrapped causality test for 30 OECD countries. Energy Policy 36:910–918

Narayan PK, Smyth R (2009) Multivariate Granger-causality between electricity consumption, exports, and GDP: evidence from a panel of Middle Eastern countries. Energy Policy 37:229–236

Özturk I (2010) A literature survey on energy-growth nexus. Energy Policy 38:340–349

Pao HT, Fu HC (2013) The causal relationship between energy resources and economic growth in Brazil. Energy Policy 61:793–801

Payne JE (2010a) Survey of the international evidence on the causal relationship between energy consumption and growth. J Econ Stud 37:53–95

Payne JE (2010b) A survey of the electricity consumption-growth literature. Appl Energy 87:723–731

Perron P (1989) The great crash, the oil price shock, and the unit root hypothesis. Econometrica 57:1361–1401

Pesaran M, Shin Y, Smith R (2001) Bounds testing approaches to the analysis of level relationships. J Appl Econ 16:289–326

Sadorsky P (2009) Renewable energy consumption and income in emerging economies. Energy Policy 37:4021–4028

Shaari MS, Hussain NE, Ismail MS (2012) Relationship between energy consumption and economic growth: empirical evidence for Malaysia. Bus Syst Rev 2(1):17–28

Solow RM (1956) A contribution to the theory of economic growth. Economics 70(1):65–94

Yu ESH, Jin JC (1992) Cointegration tests of energy consumption, income and employment. Resour Energy 14:259–266

Zhixin Z, Xin R (2011) Causal relationships between energy consumption and economic growth. Energy Proc 5:2065–2071

Renewable Energy in Indonesia: Integrating Human Capital and Money Flows

7

Niek Verkruijsse, Bartjan Pennink, and Wim Westerman

Abstract

In developing countries, renewable energy plays an important role. Applying the available natural resources in conjunction with a technology push may help to solve energy sourcing issues and to develop remote areas in such countries. Whereas many large-scale projects have been taking place, small-scale projects that bring a technology push are rare to find. This study investigates the possibilities of implementing renewable energy sources in the form of Mobile Biodiesel. We construct a conceptual model in which local economic development is infused with money flows and group entrepreneurship aspects in order to realise the implementation of this energy source. Our field research was conducted in remote villages in the Pulang Pisau area in Central Kalimantan, Indonesia. The results indicate a large shortage of technical, managerial, and financial knowledge and skills in the remote villages, resulting in a lack of human capital. Furthermore, the occurrence of frequent electricity blackouts with long durations disturbs the local communities in their daily activities. To address these problems, this study argues for the integration of community empowerment, social capital, social franchising and especially group entrepreneurship in combination with a transparent financial system on the flow of money while introducing a new technology. Although our model is based on empirical results in a remote Indonesian area and on the Mobile Biodiesel technology, the model is also applicable in developing areas throughout and it can be integrated with other renewable energy technologies.

Keywords

Human capital • Indonesia • Money flows • Renewable energy

N. Verkruijsse • B. Pennink (✉) • W. Westerman
Faculty of Economic and Business, University of Groningen, Groningen, The Netherlands
e-mail: n.j.w.verkruijsse@alumnus.rug.nl; b.j.w.pennink@rug.nl; w.westerman@rug.nl

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_7

7.1 Introduction

Throughout the globe, and especially in developing countries, there is huge potential for improving energy efficiency. In some countries this potential is progressively being exploited, however, there are a number of obstacles to overcome, including financing the investment (public vs. private), mitigating risks, managing the projects, ensuring maintenance, and mobilizing the appropriate human resources (Chevalier and Quédraogo 2013). This study focuses on the importance of a transparent money flow system and the development of group entrepreneurship to overcome these obstacles.

To develop access to energy in a limited area, one should evaluate local energy resources and their potential (Chevalier and Quédraogo 2013). Especially in the remote parts of developing countries, much of the energy supply is locally organized. Renewable energy sources prevail. Examples include hydro-based, agricultural waste and wood-based sources. These kinds of energy sources are important on a national scale in, for example, Eastern Africa, Latin America and Southeast Asia. Central Kalimantan is a remote part of Southeast Asia, in particular Indonesia. Our field study recognized the potential of conversion of waste products from rubber trees into biodiesel as a local energy resource here. There is a substantial amount of rubber plantations available for the collection of these waste products. More specifically, the communities in the researched remote villages alone already own around 6,000 ha of rubber plantations and they do not use the waste products for useful purposes.

In many low income countries, with often a high population growth, the already low electrification rate is actually declining because of lack of investment and poor management and maintenance of the existing plants. As a result, blackouts and outages are very frequent (Chevalier and Quédraogo 2013). Our field research in the rural Pulang Pisu area of Central Kalimantan clearly showed signs of poor management and maintenance (e.g. lack of structure on the plantations) and electricity blackouts and outages are indeed frequent occurrences. Since electricity blackouts and outages with long duration occur frequently they disturb local community's daily activities. It can be fairly stated that they suffer from energy poverty. Energy poverty is linked with economic poverty and, at the same time, energy is an important factor for triggering economic development (Chevalier and Quédraogo 2013).

The aim of this study is to construct a Local Economic Development (LED) model that builds upon factors from a conceptual model by Stimson et al. (2009), additional theoretical insights, and empirical findings from a field research in Central Kalimantan, Indonesia. The main focus in this model is on value creation via group entrepreneurship and creating transparent money flows to develop and organize actions, processes and activities necessary to achieve the social goal of increasing LED in remote areas. Furthermore, this study briefly elucidates which factors are essential to achieve group entrepreneurship for the introduction of a technology push with locally available renewable energy sources. The next section lays the foundation for the conceptual model. It focuses on local economic development with a mix of technology push, community activities and the flow (s) of money. In Sect. 7.3 we focus within this model on the group entrepreneurship and the flow of money factors. In Sect. 7.4 we discuss several examples in Indonesia in order to find how community empowerment and social franchising can be beneficial when implanting new technologies to achieve a social goal. In Sect. 7.5, the field research methodology will be described and in Sect. 7.6 our field study findings are put central. In Sect. 7.7, we develop, based on the work of Stimson et al. (2009), a new model for local economic development and the introduction of new technologies. In the new model, we have added explicitly financial management factors. Section 7.8 concludes.

7.2 LED via Technology Push, Community Activities and Transparent Money Flows

Through the processes of globalization, remote rural areas become connected to the outside world, which provides the potential to gain access to large markets for locally produced goods (Pike et al. 2006; Simister and Smith 2010). However, this is not necessarily beneficial to remote communities, since many rural communities are unable to control their own development process without outside interference. In addition, enclave formation could form a sincere threat for these local communities. With enclave formation, a significant part of the supply chain is controlled by large (private) firms and not by the local community. This is often the consequence of the inability of the community to effectively analyse its own development needs, not knowing how to harness the resources to meet these needs (Sesay et al. 2010). Basically, it does not possess the techniques, financial capital, knowledge and skills to operate and produce more efficiently than large corporations. Besides this, it is also widely acknowledged that if remote rural areas fail to develop adequate institutions and human capital stock, their development potential is at risk in the competitive national, regional, and global economies (Stiglitz 2002; Nissanke and Thorbecke 2006; Pike et al. 2006; Simister and Smith 2010). This indicates that a lack of technical, managerial and financial knowledge and skills among the community in a remote area often results in genuine limitations to a remote community's ability to develop itself (for instance, by implementing a technology push) even though having good access to larger markets due to their globalization.

Moreover, many developing countries suffer from "energy poverty": The absence of sufficient choice that allows access to adequate energy services, affordable, reliable, effective and sustainable in environmental terms to support the economic and human development (Reddy 2000).

One solution to these limitations could be offered by LED. According to the World Bank (2011), the purpose of LED is to build up the economic capacity of a local community and to improve its economic future and the quality of life for all. LED is essentially a process in which local governments and community-based groups manage their existing resources and enter into partnership arrangements with the private sector, or with each other, to create new jobs and stimulate economic activity in an economic area (Zaaijer and Sara 1993). The above emphasizes the importance of quality relationships and cooperation between various institutions and the local community in order to promote and to increase LED.

Basically, networks need to be formed between stakeholders, such as local communities, local governments, national governments and non-governmental organizations, to establish a specific level of collaboration, knowledge-sharing and trust. To create a collaborative environment, wherein various actions to stimulate group entrepreneurship are taken to increase LED, financial capital (money flows) plays a central role. Investments in various purposes, products and services need to be made, but remote localities often do not possess sufficient amounts of financial capital to purchase equipment, implement new techniques or pay fees to a franchisor. Therefore, external financial capital is essential to enhance the ability to improve an economic situation by increasing LED. In addition, it is important to make flows of money explicit. This will not only clarify how much funding is required, but the local communities will also gain a better understanding of how the financial capital will be spent. In other words, the transparency of money flows will help to support group entrepreneurship.

7.3 Group Entrepreneurship and Flow of Money Factors

This chapter argues for the ability of creating transparent flows of money in combination with group entrepreneurship to increase LED while introducing a technology push with renewable energy and a Mobile Biodiesel project as a catalyst. The project strives to develop new ways of generating biodiesel from the waste of rubber trees (being used for latex production). The rubber nuts are used as a base and the production of biodiesel has to be mobile in such a way that it can be used in local (remote) areas. More specifically, the technical equipment (e.g. the generator running on biodiesel), producing additional electricity should be mobile in order to be able to cover a larger area of remote villages in need for a better access to electricity.

This section provides a theoretical examination on factors considered to be relevant for developing group entrepreneurship and making the flow of money explicit in order to realize the embeddedness of this new knowledge in the local communities. These factors include: networks and collaboration, trust, social capital, community participation, social franchising, community empowerment and social entrepreneurship. The main focus is on how these factors could be useful in establishing and maintaining relationships and collaborations between stakeholders which are essential for the development of group entrepreneurship.

To address the obstacles of financing the investment (public vs. private), mitigating risks, managing projects, ensuring maintenance, and mobilizing appropriate human resources, the project in Central Kalimantan requires collective action-joint activities by a wide group of actors on the basis of mutual interests (Emery and Trist 1965; Marwell and Oliver 1993). This is beyond the capacity of individual actors or even a small number of key entrepreneurs. Institutional change in such domains requires "collective institutional entrepreneurship", which is the process of overcoming collective inaction and achieving sustained collaboration among numerous dispersed actors to create new institutions or transform existing ones (Möllering 2007). The establishment of networks could be useful in this matter to achieve a specific level of trust, knowledge-sharing, co-operation, and shared ownership and control.

However, to form a network between the project's stakeholders, the stakeholders need to be connected first. Social capital and social franchising have the ability to connect people and capital. Adler and Kwon (2002, p. 23) define social capital as "the goodwill available to individuals and groups; its source lies in the structure and content of the actor's social relations and its effects flow from the information, influence, and solidarity it makes available to the actor". In addition, it facilitates the creation of intellectual capital (Hargadon and Sutton 1997; Nahapiet and Ghoshal 1998) and entrepreneurship (Chong and Gibbons 1997) and strengthens regional production networks (Romo and Schwartz 1995). One of the mechanisms through which social capital impacts economic efficiency is by enhancing the prevailing level of trust (Guiso et al. 2004). Trust affects the level of financial development since financial contracts are the ultimate trust-intensive contracts. Since social capital is an important determinant of the level of trust, it should also affect the level of financial development. Trust and co-operation are essential for achieving indigenous efforts at community development (Nel 2001) and thus both trust and co-operation amongst the involved local communities in villages and other stakeholders need to be created to ensure proactive participation by them. One way to achieve a higher participation rate is via social franchising which seeks to fulfill a social benefit. This social benefit is represented by providing job opportunities, technological knowledge for maintenance of plantations and care for the people in the localities. Access to electricity in this matter is a prerequisite for economic and social development and access to modern energy sources is a condition for setting up new productive activities, generating jobs, saving time for work and education (Chevalier and Quédraogo 2013). Furthermore, franchising has the ability to overcome the three scarce resources of managerial skills, local market knowledge, and financial capital (Willis and Castrogiovanni 2012). Thereby, it could pitch a solution to the troubles related to the lack of technical, managerial and financial knowledge and skills in Central Kalimantan. In order to create an efficient collaborative environment between the stakeholders (with less information asymmetry and more equal levels of power, status, knowledge and competences), and to address issues caused by enclave formation, localities need to be "empowered".

Community empowerment in the context of local development requires increasing the quantity and the quality of their opportunities to participate in local governance and local service delivery (Helling et al. 2005). More specifically, it implies a special emphasis on redressing inequities in voice, choice, and access across segments of the local population. Also, it is a process, progressing along a dynamic continuum including: Individual empowerment; small groups; community organization; partnerships; and political action (Labonte 1990; Rissel 1994).

This means that small-holder rubber farmers need to be treated as co-producers, with authority and control over decisions and resources devolved to the lowest appropriate level. Once the local community is empowered and collaborations between stakeholders are established, social entrepreneurship comes into play. Social entrepreneurship refers to the development of innovative, mission-supporting, earned income, job creating or licensing, ventures undertaken by individual social entrepreneurs, nonprofit organizations, or nonprofits in association with for profits (Pomerantz 2003). The main steps in social entrepreneurship exercised by a group are; (1) creating social value; (2) recognize and take advantage of opportunities to create that value ("envision"); and (3) employ innovation to take advantage of opportunities to create social value (Peredo and Mclean 2006). Social value (via social change and community social equity) is created by cooperation and collaboration, honest and ethical dealings, reliability and innovation.

Concerning the flow of money, Nel (2001) stresses the role for government in regional economic development is that of facilitating, supporting, part-financing and devolving control. Therefore, governments and related institutions should maintain better control over the allocated subsidies by making it their responsibility to ensure that the money flows are observed. Furthermore, governmental institutions should monitor and offer support by the implementation of plans and actions. This way they will be increasingly able to provide better understanding of intended plans and actions and the issues regarding spoiled subsidies and information asymmetry can be partly addressed. In short (governmental), institutions and (strong) leadership (Stimson et al. 2009) are crucial in allocating, regulating and monitoring cash flows in the form of subsidies and its purposes in order to ensure that the financial support is used properly to accomplish goals of a specific LED project.

7.4 Finance and LED: Current Examples in Indonesia

Small scale technology projects such as the Central Kalimantan Mobile Biodiesel project are rare in developing countries. Nevertheless, several comparable initiatives have been taken in various countries, including Brazil, Tanzania and Indonesia. These projects often result from joint initiatives by international (foreign) government bodies, central and local governments, development organizations and none the least the local entrepreneurs. This section discusses several examples in Indonesia that help to find out how community empowerment and social franchising can be beneficial when implementing new technologies to achieve a social goal.

7.4.1 Introducing Jatropha in Marginal Land: The Importance of Long-Term Contracts

The first example refers to a program close to the current project. Outreach International Bio-energy, registered in the Forestry Clean Development Mechanism (CDM) of the United Nations Framework Convention for Climate Change (UNFCCC), is an organization that provides training and seeds for planting and maintaining “Jatropha” plants. Outreach International Bio-energy introduced a strategic cooperative concept of planting Jatropha in marginal land of East-Indonesia. It established partnerships with local farmers via community organizations. These partnerships include support and trust from both parties, and the farmers obtain a specific degree of ownership in the form of company shares. The partnerships utilize nonfood-crop areas in order to gain support from both the local farmers and the community. Furthermore, the project expects the farmer’s willingness to last for a long-term, signified through a binding contract agreement, for at least 35 years. In order to optimize local farmers’ knowledge regarding the seeds/nuts and harvesting Jatropha, training sessions and education programs are constructed and provided to the local community. The interviewed university expert Dr. Suwido Limin argues that the government should guarantee the purchase of biodiesel after the implementation of the Mobile Biodiesel project, Outreach International Bio-energy guarantees the purchase of the farmers’ Jatropha beans. Moreover, community organizations are hired to cooperate with the existing social structures of the farming society.

7.4.2 Installing Micro-Hydro Generators in Remote Villages: The Importance of Cooperation

PT Bumimas is a logging company operating in Central Kalimantan. It provides, in exchange for using land in a mountainous sub-district, electricity to the local community in remote villages in that area. The amount of electricity is determined by an agreement which is based on proposals from the head of villages, head of district and the company itself. PKBM Karunia is a NGO defining itself as “community organizer”. It provides and installs micro-hydro generators in remote villages in the Gunung Mas area to support them in gaining access to electricity. PKBM Karunia cooperates with the well-known international WWF organization. The above is not necessarily a proper example of social franchising, although according to interviewee Pak Setiadi of PKBM Karunia, it elucidates which parties are involved. His non-governmental organization is helpful in setting up this project in the Gunung Mas area.

7.4.3 Institutional Development and Infrastructure: The Importance of Support Projects

REDD+ and PNPM are two organizations focusing on improving the economic situation in remote villages located in areas such as Pulang Pisau and Gunung Mas in Central Kalimantan. They organize various projects closely related to LED by creating co-operation between local smallholder rubber farmers or helping local society with preparing financial statements, financial administration and official documents in order to be able to apply for financial support from (local) governments. The improvement and development of the (hard) infrastructure is an important item on the agenda and therefore, the government is investing heavily in the infrastructure. Data collected in the region Pulang Pisau revealed that the local government spent an amount equal to Rp. 630 million (€50,000) on developing and improving the hard infrastructure in the region in 2011.

7.4.4 Collecting and Separating Garbage: The Importance of a Social Franchising Model

A proper example of social franchising in Indonesia is the one called "Garbage Bank Indonesia". It is a collaborative operation between multiple actors. A volunteer collects the all kinds of garbage in various small villages and separates different types of garbage in a storage place. A distinction is made between green waste and recyclable waste, such as plastic, glass, and paper. Some of the waste is used to produce compost, which will eventually be sold to the community. Profits coming from this selling activity will be distributed among the local people where the waste was collected, or be spent on several types of services or products that will be provided to the local community. A social benefit is created in terms of keeping the environment clean, by developing a "positive" circle of sustainability and benefits in the forms of cash, services or products that are provided to the people involved; that is, the community.

7.5 Field Research Methodology

The empirical research was conducted in Central Kalimantan, Indonesia, in 2012. More specifically, the main research location is named the Pulang Pisau area, including multiple remote villages such as: Henda, Jabiren, Mantaren, Buntoi and Taruna Jaya. This area is located south from Palangkaraya, which is the capital of the district. From this location, multiple meetings and interviews were arranged with potential stakeholders from both community and institutional level. The act of data collection consisted of three phases. Firstly, the preparation phase where interviews were conducted with professors and master students from the Institut Teknologi Bandung (ITB). Secondly, the field research interviews were held with (potential) stakeholders from both community and institutional levels such as the head of districts, head of villages, an organization called CIMPTROP and people from the local government. Finally, in the third phase, sessions of reflection and assessment of the empirical findings were arranged with experts from the University of Palangkaraya (Kalimantan, Indonesia), the University of Groningen (The Netherlands) and Institut Teknologi Bandung (Java, Indonesia). In addition to all the data obtained via interviews, personal observation and a variety of reports provided useful insights.

Our fieldwork has some limitations. There is a small sample size and short collection period and another limitation to be considered is the language barrier for the involved parties. In remote rural areas, it often occurs that the local community has a different dialect than the researcher's native tongue or the national language. Although a translator was arranged, different interpretations or misunderstandings could damage of the richness of the data. Finally, obtaining official and confidential documents from the (local) government could provide very useful data regarding rubber plantations. However, this type of data is difficult to access, especially for foreign researchers. As a result, obtained data could be incomplete or little detailed. Drawing conclusions for all remote areas in developing countries for all times will not be possible, but the empirical findings and the development of the new model will serve as propositions or as starting points where other studies related to LED and technology push could continue from.

7.6 Field Study Findings

A typical "Dayak village" in the area studied counts 135 households and every single family owns 10–20 ha of land used to grow rubber trees. As a result, the total amount of hectares of plantations used for rubber trees is significant and provides great potential for the mobile biodiesel project. One kilo of latex is sold on the local market for a price fluctuating between Rp. 8,000–9,000, or $0.82–0.93 per kilo. A common system often used in Kalimantan to sell rubber is one where the local farmers harvest rubber trees on their own plantations and tap the trees themselves as well. Depending on the size of the village, a trader will collect and purchase the rubber and sell the total amount to multiple middlemen. These middlemen will eventually sell the total amount of rubber collected from the remote villages to a company specialized in processing the rubber into latex products (end-products).

The Dayak community is familiar with the rubber plantations for centuries and rubber is still one of the main sources of income. Despite the fact that the government introduced "the superior tree" (a type of rubber tree which could be tapped in a shorter amount of years and producing a higher quality of latex), Dayak people prefer to work with their own traditional trees. Our observations revealed that there is rather little structure applied to the rubber plantations owned by Dayak communities, which partly can be explained by their working methods. In addition, the seeds and other waste products are not used for special purposes other than a negligible percentage used for replanting, construction of bridges and houses and as firewood. This indicates that the Mobile Biodiesel project has great opportunities to collect nuts and other waste products for conversion into biodiesel without disturbance from local communities. Put differently, the suggested technology push could benefit local societies.

The best time to collect the nuts of the rubber trees is in the dry season, especially August and September. So, the best time to collect the waste products only last for 2 months of the year. This could cause problematic issues on the long run for the conversion of waste products into biodiesel. Therefore, it can be argued that this action (collecting the waste products) only offers a temporary solution to the electricity blackout problem; however the act of collecting can be continued for the remaining months of the year, but it will deliver a smaller amount of waste products. Even though the villages are considered as remote, they already have access to electricity, provided by an operator called PLN. The monthly price for electricity varied among the villages from Rp. 40,000 ($4.13) up to Rp. 200,000 ($20.46) depending on the amount used by electronic devices such as a television, refrigerator or ventilator. However, as indicated before, the local communities suffer from electricity disturbances caused by frequent electricity blackouts and outages with long durations. Therefore, all the heads of villages showed a sincere interest in the project, but stressed the following.

The socialization process, which should lead to group entrepreneurship, is crucial in order to obtain social support, based on trust, acceptance and participation by the local community. Firstly, it is important to ensure that people understand why the project could have positive consequences for the economic situation in their respective villages and the Pulang Pisau area as a whole. This could be done by making clear what a technical innovation (technology push) is for local societies, showing them the value creation chain and indicators of success. Secondly, the knowledge and capabilities to implement such a technical innovation should be increased. Educating, coordinating, supporting and monitoring the local farmers are key aspects in the process of developing skills and competencies so that ultimately the local farmers have the ability to continue executing the project plans and actions on their own. One efficient method to achieve this is by establishing a close collaboration with the various "farmer groups" and to establish a network between them. This way, knowledge sharing is stimulated and hopefully trust is created. Trust is vital in effective and efficient cooperation and collective learning activities. However, first a formal meeting needs to be set up with both the head of the village and the local farmers. After this meeting, a proposal is written and eventually sent to the (local) government. Multiple institutions assess and discuss the proposal and a recommendation letter has to be prepared. After this phase, the project can start according to the terms recorded in the final recommendation letter.

An important topic of interest concerns the plantations. Collectively, the villages included in this research own over 6,000 ha of rubber plantations. It needs to be specified how many hectares are to be allocated to the creation of biodiesel and thus the project. Regarding prices per kilo of latex, it was observed that the price heavily fluctuates between Rp. 8,000–9,500 ($0.68–0.81) which is mainly the result of fluctuating exchange and inflation rates and demand-supply ratios. We find that 47 % of the cost price of diesel is reserved for transportation costs in Kalimantan. This study suggests a reward system for the farmers who decide to start producing biodiesel by converting the waste products from their rubber plantations. This reward system should stimulate local farmers to produce a specific percentage of biodiesel and for this activity they are to be rewarded by receiving a certain percentage of the 47 % transportation costs. Finally, it was indicated that local small-holder rubber farmers are not necessarily willing and able to invest 'hard cash'. They prefer to invest in the project by offering and assigning a (yet non-specified) percentage of their rubber plantations for the creation of biodiesel. However, these plantations need to be "cleaned" and restructured first. This is in line with Michel and Meuter (2008), who stated that the social franchisor must be prepared to settle for reduced fees or find alternatives to financial compensation.

It often occurs that franchisees in developing countries do not generate sufficient income to be able to pay fees to the franchisor. For this reason, external capital and financial support is highly essential; a financial assistance package designed by the national government is considered as one of the most important sources of (financial) capital and thus as flow of money. Similarly, one respondent argued that the government should offer a (financial) injection in the project; not only in the form of loans and funding, but more importantly, it should guarantee that it will be the purchaser of the final product (biodiesel). Thereby, an industry could be developed and opportunities to decrease government expenses on petroleum products (fossil fuels) arise. Another important money flow to consider is the subsidy policy by the government; in the case of Indonesia covering approximately 50 % of the real price of a liter of gasoline. This policy is highly under pressure nowadays and therefore introducing renewable energy could be a useful alternative.

We conclude this section with a comprehensive Table 7.1 showing the suggested responsibilities of the mobile biodiesel project's stakeholders. This is based on empirical results from a field research in Central Kalimantan held in 2012, as an example guide list for other situations in developing countries where renewable energy techniques are introduced at a local community level.

Table 7.1 Suggested responsibility of stakeholders based on findings of the field research

Stakeholder	Activity/responsibility/action
Local community	Provide the rubber plantations
Governmental institutions	Organize, monitor and control money flows
Non-governmental institutions	Organize and facilitate community empowerment, social capital, etc.
Processors and operators	Facilitate production processes and marketing activities of biodiesel and compost
Local leaders (e.g. head of village)	Facilitate meetings and communication between community and institutional level (e.g. contract agreement negotiation)

7.7 Model Development

This study started with the basic conceptual model of Stimson et al. (2009) and the World Bank model on LED (2011) and argued that, in addition to the regional level, it is relevant to add a national and local level. In a next step the Financial Assistance Package (FAP) was added. It consists of multiple components, namely investment packages, loan guarantees, tax incentives and investments in infrastructure. All these components will contribute to a transparent flow of money. Financial assistance refers to various measures taken by governments with the intention to positively affect economic activities, situations or projects. Financial assistance empowers and stimulates communities and NGOs to execute plans and action in their pursuit of increasing the local economic situation. Investment packages are sets of presentation materials and documents used to secure capitalization. They can be considered as the act of raising capital for the project and thus as preparation package needed to execute the plan. International donors and other external investors are fundamental for raising capital. Developing countries attract a huge flow of foreign direct investments and external investors are primarily interested in access to natural resources or the development of infrastructure (Chevalier and Quédraogo 2013). Therefore, financial support from international donors and investors are included in the model.

Loan guarantees refer to the ability of the local community to obtain a loan-agreement at the bank; the borrowed capital can, for instance, be used to fulfill the (equipment) lease-payments or for the purchase of new technical equipment. However, banks are not keen on providing these loans, since many people from remote communities barely keep records and do not prepare financial statements and financial plans; therefore, it is difficult to evaluate loan requests. Despite this fact, banks could define a solution in order to simplify the act of obtaining a loan as smallholder rubber farmer. This may be done via specific arrangements or deals with the local governments regarding accountability or payback methods. In addition to loan guarantees, the government could decide to develop specific tax incentives. Tax incentives refer to the extent a national government encourages a particular economic activity; this could involve the act of deduction, exclusion or exemption from a tax liability.

The local community has little capital. When indicating willingness to be a stakeholder in the mobile biodiesel project, by offering financial support for it, the government expects that economic development will be realized. Once this is the case, the government has an option to generate additional tax income, whereas before it was not able to obtain tax income from these types of communities. In other words, changing or adapting tax incentives could create both tax advantages for the community and for the government itself. A highly essential governmental capital expenditure is the investment in (both hard and soft) infrastructure. Improvement of the infrastructure allows remote areas to be connected to more developed locations and this could be beneficial to the domestic resource mobilization and public sector activity. In case of the mobile biodiesel project, it is assumed that subsidies are one of the most important forms of financial capital. However, as stated earlier, information asymmetry problems should be avoided to ensure that plans and actions are implemented as intended. The local community should have full knowledge regarding the issues discussed.

In addition, it is critical that governmental institutions monitor the money flows (subsidies) between parties, and remain partly in control over them. The allocation of financial capital (mainly subsidies) and support from the FAP to stakeholders (often NGOs; e.g. community organizers) should be done on a regional level. Local leaders often have substantial power and control over decisions in their respective areas and they possess better knowledge about opportunities and room for improvements in remote rural villages in their region. Collectively, the local leaders and entrepreneur are responsible for the act of decision-making regarding the investment of the capital obtained from the government and international donors (FAP). More specifically, they decide what percentage will be invested and assigned to each type of activity, process or equipment. These decisions will mainly affect plans and actions taken on a local level. Training and education programs will be developed in order to address one of the main problems; the lack of technical, managerial and financial knowledge and skills to implement plans and actions to improve the economic activities in the region.

The above action can be referred to as an act of community empowerment and this process is basically a capacity development activity, providing the local community with adequate skills and competencies. Therefore, this factor is also incorporated in the model. As a result, it enhances the quality of the local community and increases the "readiness" of the stakeholders to implement renewable energy and thus, a technology push in their respective areas. In addition, once adequate knowledge and skills are developed, training and education programs indirectly pitch a solution to the problem of spoiled financial capital (subsidies) due to inefficient and lack of implementation of plans and action. Furthermore, entrepreneurship is stimulated and, in underdeveloped areas, it might be more a matter of group entrepreneurship: Collectively, people are better able to devise or develop new entrepreneurial activities.

In short, the allocation of financial capital obtained via the FAP to this specific purpose will positively affect the quality of local community and its readiness for the introduction of the technology push (renewable energy) on a local level. However, this is just the first step towards the act of increasing LED via group entrepreneurship. Another important step in this process is the establishment of networks and collaboration. It is highly essential to form partnerships and relationships between the stakeholders in order to achieve a specific level of trust, knowledge sharing, cooperation, and shared ownership and control. The literature labels this as social capital and this concept will therefore also be included in the model.

To increase the project's ability to establish networks, participation and social interaction is required. Fredriks et al. (2014) argue for the use of social franchising to implement a technology push. In doing so, the technical equipment can be (partly) owned by groups of local people and be part of entrepreneurial activities in the local area. The characteristics of the resources (on a local level) refer to the resources available in the respective remote area for the introduction of renewable energy. This includes natural resources (rubber plantations), technical resources (new technologies) and human resources (social and human capital). Field research indicated a vast availability of rubber plantations and waste products from rubber trees, but a lack of technical, managerial and financial knowledge, skills and expertise exists. Put differently, whereas natural resources are vast, technical and human resources are lacking. The introduction of the renewable energy source integrated in the LED process is referred to as Value Creation Chain in the model.

Waste products from the rubber trees are collected on plantations. The waste products are to be converted into biodiesel by extracting useful substance. This conversion results in residuals and useful biodiesel. The residuals could be converted into compost and this compost could be either returned to the local farmers and then be used for replanting activities or be sold on the (local) market with a part of the financial gain to be returned to the local farmers. Both situations are beneficial to the local farmers. The useful biodiesel will be mainly used for the generation of electricity. This extra electricity could be used for various purposes, such as pitching a solution to the frequent electricity blackouts. Once the local community has better access to electricity, its ability to work more efficiently increases and this may eventually result in an improved economic situation. This is in line with the argument by Chevalier and Quédraogo (2013) that energy is an important factor for triggering economic development.

In short, a collaboration between multiple actors who utilize local resources to achieve a social goal that does not harm others, as the situation described above, is a good example of a social franchise activity. The introduction of renewable energy (technology push) in remote rural areas, via social franchise and group entrepreneurship, eventually has the ability to increase social capital, add more structure to the rubber plantations and to diminish waste products on rubber plantations. Most importantly it generates (and thereby provides) additional electricity to the local communities in remote rural areas, referred to as output/outcome in the model. As a result, the local community is increasingly able to achieve the social goal of having better access to electricity by diminishing the number and duration of the electricity blackouts. Moreover, it allows them to convert waste products of rubber trees into biodiesel that could be used to run machines and generators.

The new local economic development model that has been developed as a result of the present study is shown in Fig. 7.1. The model combines local development, money flows and group entrepreneurship. Its independent variables (inputs) are ordered along the three levels involved: The national, regional and local level. The intervening variable or throughput of the model is referred to as the value creation chain. The dependent variables (outcomes) of the model are multiple-faced.

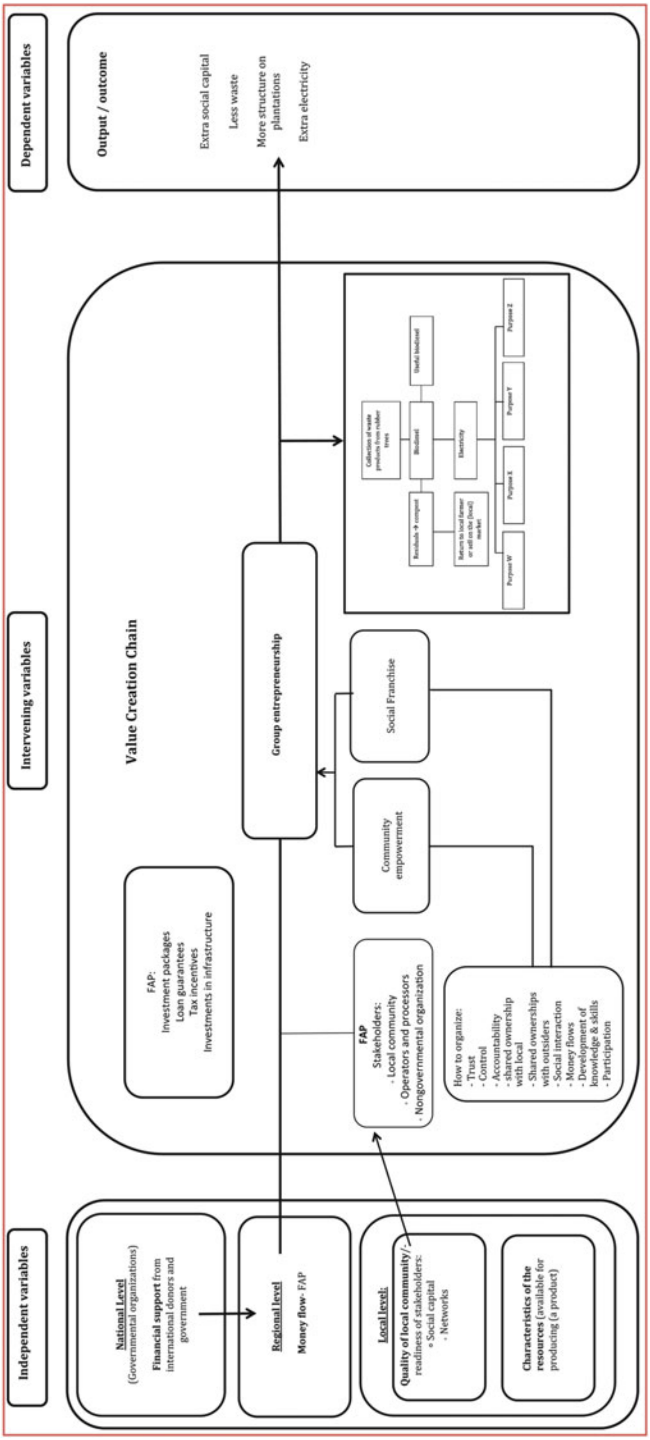

Fig. 7.1 New local economic development model

Conclusion

The main focus of this study is on developing a new LED model, as can be seen in Fig. 7.1, including relevant factors from the Stimson et al. model (2009): The multi-level aspect (including the national and local level), a group entrepreneurship dimension and a financial dimension (money flows). Field research indicated a sincere lack of technical, managerial, and financial knowledge and skills in Central Kalimantan. Furthermore, the occurrence of frequent electricity blackouts with long durations forms considerable problems to communities and their plantations. The former finding causes several problems such as: Inefficient implementation of plans and actions by various stakeholders in their pursuit of increasing LED; indications of spoiled capital obtained via government (energy) subsidies; unstructured plantations; and inefficient use of waste products from the rubber trees. Basically, there is a great lack of human capital in Central Kalimantan, as in other remote areas in developing countries. The latter finding regarding the electricity blackouts causes problems in the communities' daily lives and limits their ability to work more efficiently with current equipment and techniques. Put differently, the socio-economic problem of lack of access to electricity has negative consequences for the community. This problem does not only reflect the situation in Central Kalimantan, it refers to a general issue of concern in developing countries.

This study, based on theoretical insights, examples from Indonesia and field research in Central Kalimantan, has argued that social capital, community empowerment and group entrepreneurship are highly important when introducing new technologies and should be combined with LED in the respective areas. Social capital has the ability to bridge the various stakeholders involved and to increase the level of trust needed for collaboration and the establishment of networks. Community empowerment is crucial for developing a community's skills and competences, increasing one's knowledge regarding specific issues and to diminish negative consequences caused by enclave formation. However, to include both factors properly, social franchising and group entrepreneurship need to be integrated in the process. Social franchising has the ability to overcome the three scarce resources of managerial skills, local market knowledge, and financial capital. Group entrepreneurship strengthens the economic position of the community by creating social value via recognizing and taking advantage of opportunities to create that value ("envision") and to employ innovation to enhance one's ability to take advantage of opportunities to create social value.

These factors and a better access to financial capital together should pitch a solution to the lack of human capital and lack of access to electricity (energy poverty). A better access to financial capital is provided by a financial support package developed by the government. This financial assistance package (FAP) consists of loan guarantees, tax incentives, investment packages and infrastructure improvements. The introduction of renewable energy sources can be a catalyst for LED if it is combined with attention for the group entrepreneurial activities and a transparent and worked out flow of money. It is therefore that this study has developed a new LED model, incorporating factors of the Stimson et al. model (2009) and a financial and a group entrepreneurship dimension. Although being based on research in Indonesia, it is believed that the developed ideas can be transposed to situations in other parts of the world, including Eastern Africa (e.g. Tanzania) or Latin America (e.g. Brazil). In Eastern Africa, there is a huge movement on LED with the help of renewable energy sources and Brazil shows, already for a long time, a technology push on mobile bio-fuel installations.

In addition, this research mainly incorporated two levels of analysis; namely the community and institutional levels. It is interesting to include extra levels, such as an enterprise level. Moreover, future research may include the subsidy policies concerned with the national Indonesian oil company PERTAMINA and study the possibilities of biodiesel as alternative. Finally, future researchers have to establish collaboration based on trust and common interest with both the community and nongovernmental organizations to help to increase the LED.

References

Adler PS, Kwon SW (2002) Social capital: prospects for a new concept. Acad Manag Rev 27 (1):17–40

Chevalier JM, Quédraogo A (2013) In: Chevalier JM, Geoffron P (eds) The new energy crisis: climate, economics and geopolitics, 2nd edn. Palgrave Macmillan, Basingstoke

Chong L, Gibbons P (1997) Corporate entrepreneurship: the roles of ideology and social capital. Group Organ Manag 22:10–30

Emery F, Trist E (1965) The causal texture of organizational environments. Hum Relations 1:21–35

Fredriks J, Pennink BJW, Simatupang TM, Siswanto J (2014) Modeling a technology push by using hybrid franchising. Int J Entrep Small Bus 22(1):64–88

Guiso L, Sapienza P, Zingales L (2004) The role of social capital in financial development. Am Econ Rev 94(3):526–556

Hargadon A, Sutton RI (1997) Technology brokering and innovation in a product development firm. Adm Sci Q 42:716–749

Helling L, Serrano R, Warren D (2005) Linking community empowerment, decentralized governance, and public service provision through a local development framework. SP discussion paper no 0535, pp 1–93

Labonte R (1990) Empowerment: notes on professional and community dimensions. Can Rev Soc Policy 26:64–75

Marwell G, Oliver P (1993) The critical mass in collective action: a micro-social theory. Cambridge University Press, New York

Möllering G (2007) Collective institutional entrepreneurship? The recursive interplay of action, networks and institutions in market constitution. Paper presented at the institutional embeddedness of markets conference, Max Planck Institute, Cologne, February

Michel S, Meuter ML (2008) The service recovery paradox: true but overrated? Int J Serv Ind Manag 19(4)

Nahapiet J, Ghoshal S (1998) Social capital, intellectual capital, and the organizational advantage. Acad Manag Rev 23:242–266

Nel E (2001) Local economic development: a review and assessment of its current status in South Africa. Urban Stud 38(7):1003–1024

Nissanke M, Thorbecke E (2006) Channels and policy debate in the globalization-inequality-poverty nexus. World Dev 34(8):1338–1360
Peredo AM, McLean M (2006) Social entrepreneurship: a critical review of the concept. J World Bus 41(1):56–65
Pike A, Rodríquez-Pose A, Tomaney J (2006) Introduction: local and regional development in a global context. In: Pike A, Rodriquez-Pose A, Tomaney J (eds) Local and regional development. Routledge, London/New York
Pomerantz M (2003) The business of social entrepreneurship in a down economy. Business 25 (3):25–30
Reddy AKN (2000) Energy and social issues. In: Goldemberg J (ed) World energy assessment: energy and the challenges of sustainability. UNDP, New York, pp 39–60
Rissel C (1994) Empowerment: the holy grail of health promotion? Health Promot Int 9(1):39–47
Romo FP, Schwartz M (1995) Structural embeddedness of business decisions: a sociological assessment of the migration behavior of plants in New York State between 1960 and 1985. Am Sociol Rev 60:874–907
Sesay S, Amara V, Lebbi JA (2010) Strengthening social capital: the GoBifo approach in rural Sierra Leone. Royal Tropical Institute (KIT), Amsterdam, pp 1–72
Simister N, Smith R (2010) Monitoring and evaluating capacity development: is it really that difficult? Praxis paper 23, International NGO Training and Research Centre (INTRAC), pp 1–31
Stiglitz J (ed) (2002) Globalization and its discontents. Norton, New York
Stimson R, Stough RR, Salazar M (2009) Leadership and institutions in regional endogenous development. Edward Elgar, Northampton
Willis G, Castrogiovanni GJ (2012) The franchising business model: an entrepreneurship growth alternative. Int Entrep Manag J 8(1):75–98
World Bank (2011) What is local economic development (LED)? World Bank, Washington, DC
Zaaijer M, Sara LM (1993) Local economic development as an instrument for urban poverty alleviation: a case from Lima and Peru. Third World Plann Rev 15:127–142

Part III

Fossil Fuel Regulation

Liberalization Process and Legal Aspects of the Turkish Natural Gas Market

8

Cafer Eminoğlu

Abstract

This chapter aims to study the liberalization process, legal aspects and especially reform plans of Turkish natural gas market with a critical approach. The natural gas market of Turkey is growing consistently. Although Turkey stands next to the important fossil fuel producing countries, its natural gas resources are very limited. Nevertheless, Turkey's geographical position is a key link between the world's largest energy resources and the European markets. Therefore the regulation and liberalization of Turkish Natural Gas Market is of not only national but also global importance. Currently, Turkey's natural gas market is in the early stages of liberalization. First significant steps regarding the liberalization of the market were taken with the Natural Gas Market Law (NGML) of 2001. Since then there has been a slow but gradual progress. The pricing strategy of Turkish governments, unrealistic targets of the NGML and capacity problems of the Turkish private sector are some of the important reasons why the planned liberalization stage could not be reached considerably. The legally unbundling of market activities and a significant decrease in market share of BOTAŞ, which is the state owned and market dominant natural gas company, are exemplifying the failed targets of the NGML. After 13 years of enforcement of the NGML, the law maker plans to reform the NGML in order to ensure the compliance with the EU regulations and to bring dynamism in the liberalization process. However, realistic targets and a change in the pricing policy of the government seem to be necessary in order to achieve a certain stage of market liberalization. It can also be recommended to take more effective measures to ensure a fair access to the natural gas transmission system for all of the market players. At that point the unbundling of market activities is indispensable. The unbundling of market activities can be carried out through different methods such as "a legal

C. Eminoğlu (✉)
Faculty of Law, Ankara Yıldırım Beyazıt University, Ankara, Turkey
e-mail: cafereminoglu@hotmail.com

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_8

separation of transmission activities", "an independent system operator" and "an independent transmission operator." On the other hand, establishing and keeping strong energy companies will be necessary for Turkey in order to reach its long declared target of being an international trade hub for natural gas.

Keywords
Gas market • Liberalization • Turkey

8.1 Introduction

Turkey, as a country dependent on natural gas import, aims on one hand at liberalizing its natural gas market. On the other hand, it has enough reasons to have state-controlled mechanisms over the market, for example because of the necessity to ensure the supply security. With its current 30 % private sector participation, the Turkish domestic gas market seems to be in the early stages of liberalization. The milestone in the liberalization process of Turkish natural gas market was the enacting of the Natural Gas Market Law (NGML) in 2001, which abolished the monopoly rights of State owned BOTAŞ, the Turkish Petroleum Pipeline Company.

Despite all the important steps in the direction of market liberalization, the NGML of 2001 failed in some of its significant targets. Especially the plan of the law maker regarding the legally unbundling of market activities by 2009 could not be realized. In order to bring innovation and movement in liberalization process and to ensure the supply security, the government has taken a reform of the NGML in sight. The Ministry of Energy and Natural Resources of Turkey announced a new draft of the NGML, which was presented to the cabinet in May 2013. The draft includes significant reforms for the Turkish natural gas market. One of the key points of the draft is again the legal unbundling of BOTAŞ. Another important point of the NGML Draft is concerned with reducing BOTAŞ's major share in the natural gas market.

The question whether Turkey should create a fully liberalized domestic natural gas market is not being answered in full conformity. While some represent the idea of a completely liberalized market and fully unbundled market activities, others assert that an advanced degree of liberalization in the natural gas sector will not be in the national interest of the country and therefore, because of its strategic importance for the economy, the government should stay in control of the market.

One of the main reasons why some are against a liberalization of the natural gas market has closely to do with the domestic energy resources capacity of Turkey. It is, in terms of energy resources, an unlucky country. Only about 2 % of the total natural gas demand is being met by domestic resources (TUSIAD 2009; Cagaptay and Evans 2013). Despite this fact, a liberalized natural gas market is clearly a need for Turkey. But at the same time the necessary measures should be taken by the government in order to secure the supply. For example the "supplier of last resort" formulation may help to secure the supply for consumers.

Despite this fact, Turkey has a very strategic geographical position and because of that, it has good prospects to become a key country in ensuring energy security of Europe in the future. Its geographical position is a key link between the world's largest energy resources and one of the biggest energy markets (MENR 2009). The close proximity to more than 70 % of the world's proven oil and gas reserves in Middle East and Caspian Basin on one hand and the closeness to the industrialized European Market with great demand on energy on the other hand, make Turkey to become a natural bridge in terms of oil and natural gas transmission Shaffer (2006). The dependence of European Countries on certain natural gas exporting countries, especially on Russia and on limited pipeline routes, makes it necessary to find new supply sources and routes. In light of that diversification need, Turkey has gained increasingly significance as the "fourth corridor" or "southern corridor" for the transmission of natural gas from the Middle East, the Caspian Basin and Central Asia to the European markets. In this regard, major pipeline projects are planned which will contribute to the energy supply security of Europe.

Additionally, the Natural Gas Transmission System of BOTAŞ plays and most probably will play an important role in enhancing Turkey's significance as a transit country. Therefore the liberalization of the Turkish natural gas market and any change in regulations will affect not only the national markets, but also the international transmission of natural gas, the import strategies of European countries and the export plans of natural gas producing countries in Middle East, Caspian basin and Central Asia (Cagaptay and Evans 2013).[1]

In light of the mentioned international significance of Turkey, this chapter aims to examine the legal aspects of the Turkish domestic natural gas market in connection with the natural gas policy of Turkey. Within this frame, the draft of the new Turkish Natural Gas Market Law, its critic and possible impacts for Turkey and the international energy markets will constitute an important component of the chapter. Furthermore, the historical background of natural gas related regulations will also be examined.

This chapter is structured as follows: Sect. 8.2 looks at the natural gas market of Turkey with its significant components, such as BOTAS and the Natural Gas Transmission System. Section 8.3 examines the regulations of the Turkish natural gas market. The liberalization process of the market is issued in the same section. Section 8.4 deals with the planned reform of the Natural Gas Market Law of Turkey. Section 8.5 contains the conclusion.

[1] For an analysis of geopolitical position of Turkey regarding natural gas sources, see also Cagaptay and Evans (2013), pp. 25–35.

8.2 The Turkish Natural Gas Market

8.2.1 Natural Gas in Turkey

The import of natural gas in Turkey started in 1987. During early years after that Turkey's total natural gas import and consumption amounts were less than 1 bcm[2] (Cagaptay and Evans 2013). Since then there was a very rapid increase of consumption reaching its highest level in 2013 with annual volume of 46.1 bcm.[3] That means an increase of almost 150 % in comparison with consumption one decade ago (EMRA 2012). At the same time, the share of natural gas in total energy consumption of Turkey reached a 33 % level (IEA 2009). These numbers correspond to the parallel growth of the economy and the results of BOTAŞ's investments for expansion of natural gas to the entire area of Turkey. Furthermore Turkey is also becoming a destination for spot LNG to fill the gaps in supply (Cagaptay and Evans 2013).

A remarkable feature of the Turkish natural gas market is the sector distribution of the natural gas consumption. In this respect, the high consumption in power plants for the purpose of electricity generation, with almost half of entire national consumption, draws attention (Turkel et al. 2009). That makes natural gas the major source for the electricity generation, although Turkey produces annually only less than 2 % of its total consumed natural gas.[4] The industrial consumption takes the second place with almost 27 %. Lastly, the household consumption is approximately 25 %. It seems that parallel to the policy of the Turkish Government to bring natural gas to every part of country, the rapid increase in residential consumption will continue.

In the natural gas market of Turkey, the regulation regarding the rights and liabilities of market actors concerning natural gas transmission through transmission network within the scope of NGML and the legislation in line with this law has been specified by Network Operation Principles (Network Code). The charges for national gas transmission through the transmission network are determined by transmission and dispatch control tariffs. It is of great importance to bring forward the legislation and the problems related to multiple-supplier market after BOTAŞ lost its identity as the only supplier of Turkish natural gas market.

Within the scope of unbundling provisions of NGML, BOTAŞ has separated accounts for transmission and commercial activities as the first step for a fully unbundling in future. In this respect the responsibility of BOTAŞ Natural Gas Operations District Management is the granting access to third parties who want to benefit from natural gas transmission service and providing equal service to all stakeholders within the tariff models to be formed in line with Network Code.

---

[2] *billion cubic meter

[3] *billion cubic meter

[4] See also Cagaptay and Evans (2013, p. 8).

8.2.2 The Petroleum Pipeline Corporation (BOTAŞ)

BOTAŞ, the Petroleum Pipeline Corporation, which is a 100 % state-owned company, is the operator of natural gas transmission system of Turkey. BOTAŞ is also the major natural gas importer, wholesaler and exporter in Turkey and therefore is a vertical integrated structure in terms of variety of its activities within natural gas market.

BOTAŞ was originally established by the Turkish Petroleum Corporation (TPAO) in 1974, for the purpose of transporting Iraqi crude oil to the Ceyhan (Yumurtalık) Marine Terminal. This mission relied on the Iraq-Turkey crude oil pipeline agreement signed in 1973 between the Republic of Turkey and the Republic of Iraq. Turkey's increased need for diversification of energy sources lead to an expansion of activities of BOTAŞ. In this respect BOTAŞ began with its activities of transporting and trading of natural gas in 1987, which are today the major fields of business for BOTAŞ.

8.2.3 The Natural Gas Transmission System of Turkey

Turkey's main natural gas transmission grid is owned and operated by BOTAŞ. BOTAŞ's investments to expand its transmission network to cover the whole area of Turkey have been largely completed. The length of high-pressure pipelines has exceeded 13,000 km and reached almost all of the provinces. Current and future investments of BOTAŞ are expected to mainly focus on the completing of national transmission pipelines, the construction of loop connections within the system and underground storages and the installation of new compressor stations.

The Natural Gas Network System of Turkey has nine entry points. The main entries are the four connections with other transmission networks connected from neighboring countries (Bulgaria, Georgia and Iran) and the Black Sea. The other entry points are the connections points with two LNG Terminals (Aliağa in İzmir and Marmara Ereğlisi), two domestic production sites and one underground storage facility.

Furthermore there are nine compressor stations in operation within the transmission system. One of the most important ones of these is the Erzincan Compressor Station, which was completed in 2013. This Compressor Station has a key position for the transmission of natural gas from east to west. It will not only eliminate a weakness of the BOTAŞ Transmission System for national transmission service, but it will also play an important role for the transit-flows of natural gas from Middle East and Caspian Region to Europe through Turkey.

Currently there are many ongoing projects and construction works which aim to improve the transmission network of Turkey. One of these projects is the loop connection of the West line to the Greece line. With this loop connection the circle in the transmission system of the Marmara Region will be completed. Furthermore, eight new entry points are planned for three local production sites (Lüleburgaz-Şarköy and Mardin), three LNG terminals (in Adana, Aliağa and Çandarlı) and two underground Storages (in the Aksaray salt lake and the Mersin salt lake) in the future. With the two natural gas underground storage projects, the storage capacity will be increased from 2.2 bcm to at least 4 bcm within next years.

8.3 Natural Gas Market Regulations and the Liberalization Process

8.3.1 In General

BOTAŞ was for a long time the monopoly structure regarding vertically integrated import, trade, transmission and distribution activities of natural gas. The opening of the market started in 1990s with the privatization of distribution units of BOTAŞ.[5] However, the milestone in the liberalization process of Turkish natural gas market was the enacting of Natural Gas Market Law (NGML) in 2001, which abolished the monopoly rights of BOTAŞ in the natural gas market.

However, the legal process of the Turkish natural gas market began in 1988 with the enforcement of the Statutory Decree with Number 350, regarding natural gas use (EMRA 2012). Based on that statutory decree and the decree with number 7/781, BOTAŞ was established as the subsidiary of TPAO[6] in 1974. With these regulations, BOTAŞ was appointed as the only authorized body for natural gas import. After that the Statutory with Number 397 under the title "Natural Gas Use" authorized BOTAŞ for natural gas and LNG import, sales, distribution and also its pricing in Turkey (EMRA 2012).

8.3.2 The Natural Gas Market Law (NGML)

The Turkish Natural Gas Market Law with law number 4646 (NGML) covers the import, transmission, distribution, storage, marketing, trade and export of natural gas and the rights and obligations of all real and legal persons relating to these activities.[7] This Law describes its target as the liberalization of the natural gas market and the formation of a financially strong, stable and transparent market along with institution of an independent supervision and control mechanism over the same, so as to ensure supply of good-quality natural gas at competitive prices to consumers in a regular and environment friendly manner under competitive conditions (EMRA 2012).[8] The NGML meets especially with the requirement of the 2003 EU Gas Directive.[9]

[5] For detailed information regarding privatization of natural gas sector facilities, see TUSIAD (2009), pp. 30–39.

[6] *Turkish Petroleum Corporation.

[7] Art 2 of the NGML.

[8] Art 1 of the NGML.

[9] Number: 2003/55/EC; IEA, Turkey Review, 69. For detailed information, see Aslan (2009).

The NGML empowered the Energy Market Regulatory Authority (EMRA) in this respect with broad competences to prepare and enact the necessary secondary legislation. Furthermore it charged EMRA with the duty to regulate and control especially in connection with the necessities of liberalization of the natural gas market.

Although the NGML contributed to the improvement and partly liberalization of the market, there are many reasons to categorize some of its regulations as an unsuccessful undertaking (TUSIAD 2009). This is mostly because of its unrealistic targets. For example, the annual import amount of BOTAŞ should have been decreased to 20 % of the annual national consumption amount by 2009, which at the end didn't happen. The market share of BOTAŞ is still over 70 %.

Another reason why the liberalization targets couldn't be met has nearly to do with the pricing strategy of Turkish government (Rzayeva 2014). Turkey followed for decades a strategy to keep the natural gas sector under state control. On the one hand, governments used natural gas as an instrument for political interest. So they subsidized BOTAŞ, which sold the natural gas with lower prices. On the other hand, the importance of natural gas for electricity production and industry was presented as a legitimate way for such a control. As a result, the private sector had difficulties to compete with BOTAŞ and was unable to enter into the market easily.

In order to speed the liberalization process up and meet the expectations of the market, in 2012, the Ministry of Energy and Natural Recourses announced the intention of the Government to reform the NGML and publicized a new draft in this regard.

8.3.3 The Energy Market Regulatory Authority

The Energy Market Regulatory Authority (EMRA) is the key institution in the Turkish energy market. It is the independent regulator for electricity-, natural gas-, petroleum- and LPG markets. The main task of EMRA is to set up and implement regulatory measures to ensure the establishment of a liberal and competitive natural gas market. It should especially ensure the equal entrance for all equal shippers and fair conditions for all market players. EMRA also regulates and approves storage, transmission and all retail tariffs (IEA 2009).

8.3.4 The Natural Gas Market Transmission Network Operation Regulation

The Natural Gas Market Transmission Network Operation Regulation was prepared and published by the Energy Market Regulatory Authority in 2002. Its preparation and enacting was ordered by the NGML of 2001. The Regulation came into force in 2002.

The main aim and regulation subject of the Natural Gas Market Transmission Network Operation Regulation is specifying the principles and procedures, which should be included in the network operation rules of natural gas transmission companies.[10] The rules and principles of network operation are prepared by BOTAŞ, as being the only Natural Gas System Operator in Turkey, and approved by EMRA.

The Natural Gas Market Transmission Network Operation Regulation includes the principles and procedures concerning issues such as system access, notification of transportation amount and scheduling of the transportation service, determination of transportation amount, service interruptions, dispatch, system balancing, communication system, capacity allocation, natural gas delivery and metering.[11]

8.3.5 The Network Code

The Principles on Natural Gas Transmission System Operation (Network Code),[12] which is based on the Natural Gas Market Transmission Network Operation Regulation, is prepared by BOTAŞ and approved by EMRA (Özen 2012).

The Network Code is prepared to set out specific rights and obligations of parties using transmission system. These parties are especially wholesale companies as the shippers and BOTAŞ as the transmission system operator. The Network Code includes the system entry and network operation rules in line with the principles of equal parties and prohibition of discrimination and an economically efficient operation.

The Network Code entered into force in 2004. It was amended in 2007 and almost every year after that as a result of market needs and the liberalization process.[13] It consists of two parts, namely the basic practices and operation provisions. The first part regulates especially obligations of transporters and shippers, application conditions regarding system entry and system entry disputes.

The second part of the Network Code, under the heading "operational provisions", covers and regulates especially following issues: definitions and interpretations; reservation, transfer, takeover and usage of capacity; dispatch control and system balancing; internal consumed gas; system entry and exit conditions; notification and program of transportation amount; delivery, possessory and responsibility regarding transported natural gas; allocation of natural gas; measurement and analysis provisions; quality and pressure provisions; system planning and maintenance; provisions regarding emergency case, difficult day and limited capacity day; settlement of disputes and finally invoicing and payment.

[10] Art 1 of the Natural Gas Market Transmission Network Operation Regulation.

[11] Art 2 of the Natural Gas Market Transmission Network Operation Regulation.

[12] Also known as BOTAŞ Network Code.

[13] For more information, see Ünal (2012), pp. 77–83.

8.3.6 Liberalization Process and Third Party Access

Within the scope of the EU integration process, Turkey has undertaken important steps to create a liberal competitive natural gas market. As mentioned above, the first step in this respect was the Natural Gas Market Law, which came into force in 2001. The aim of this Law was to liberalize the market and to encourage privatization and competition. Before this, the poor legal and technical groundwork made it almost impossible to accomplish widespread privatization in the natural gas market (Cagaptay and Evans 2013; Atias 2009).

One of the challenges for the NGML was to set up an equal access to the transmission service. The main problem was the position of BOTAŞ as both the monopoly natural gas trader and the monopoly transmission operator at the same time. The Law regulates the access of third parties to the transmission infrastructure based on certain tariffs, which should be set by EMRA.

Although the Network Code came into force in 2004, the first shipper other than BOTAŞ accessed the transmission system in 2007. As a result of contract release auctions in that year and the following 2 years, four new importers entered the Turkish natural gas market with an annual total volume of 4 bcm (Rzayeva 2014, pp. 29–30). The total consumption of natural gas in Turkey in 2007 was 35.4 bcm (Rzayeva, p. 5). After this first access, the process moved fast in following years and the number of shippers that signed a "Standard Transmission Agreement" with BOTAŞ as transmission system operator increased rapidly.[14]

Another important step in the direction of liberalization was taken in August of 2012 as Gazprom, the Russian Natural Gas Company, signed supply contracts with four Turkish companies at an amount of 6 bcm per year. This agreement replaced the contract between Gazprom and BOTAS, which dated back to 1986 and expired in December 2011. Currently, there are 31 shippers in the BOTAŞ Transmission System, 8 of which are importers. In spite of this increase in the share of private sector, BOTAŞ takes on its activities still as a major market player (Fig. 8.1).

8.3.7 Unbundling of Market Activities

An important characteristic of a liberalized natural gas market is the unbundling of a natural gas company owning transmission system infrastructure and conducting trade activities as a shipper in the same system. The main ratio of such an unbundling is the ensuring of fair competition among system users. There are three main types of unbundling in this regard. These are from weak to strict, in the following forms: account separation, functional separation and legal unbundling.

[14] For detailed information about the regulatory and legal improvement of natural gas transmission system of Turkey, see Özen (2012), pp. 34–53.

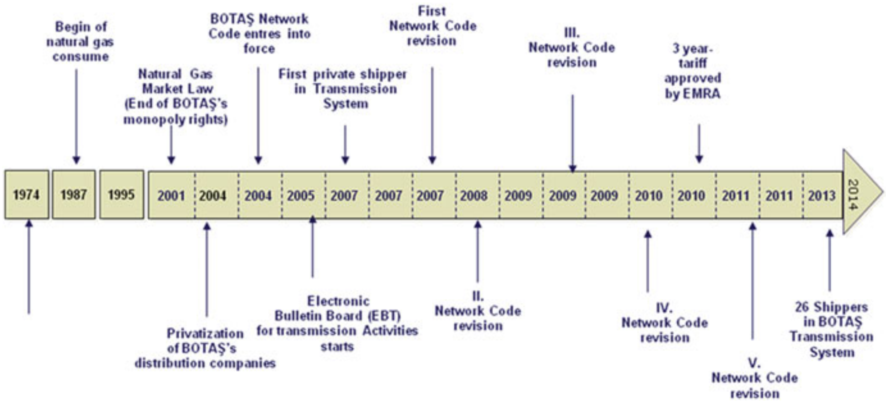

Fig. 8.1 History of some developments in natural gas market of Turkey

The NGML includes provisions regarding unbundling of BOTAŞ, which is still a vertical integrated company. But as a preparation for the unbundling, the NGML set forth the separation of accounts of BOTAŞ regarding the transmission, storage, sales and import activities, within a certain time. This provision was fulfilled by BOTAŞ, even if not on time.

However, the unbundling provisions of NGML were more advanced than just an account separation. The vertically integrated legal entity structure of BOTAS should have continued until 2009. After this date, BOTAŞ should have been restructured into a horizontally integrated legal entity. Furthermore, according to this provision, among the legal entities to be formed as a result of restructuring, only the company which has the gas purchase and sale contracts and which will perform import activities should represent BOTAŞ and should have been called BOTAŞ. The companies, other than the one involved in transmission activities, should be privatized within 2 years. This provision is not applied up so far. BOTAŞ still undertakes its activities as a vertically integrated entity. The goal to unbundle BOTAŞ will be pursued also in the new draft of NGML.

8.4 The New Draft of the Natural Gas Market Law

8.4.1 In General

The NGML of 2001 had clearly aimed to liberalize the Natural gas market in Turkey. If we look back to the developments of last 10 years in the natural gas market, we can say that this law was by and large successful. But despite all important steps in the direction of market liberalization, the NGML has failed in some of its targets. As mentioned above, a significant decrease in market share and unbundling of BOTAŞ are two important examples of failed targets.

In order to bring innovation and movement in the liberalization process, the Government has taken a reform of the NGML in sight. The Ministry of Energy and Natural Resources of Turkey announced a new draft of the NGML, which includes very important steps for the natural gas market of Turkey.

Regarding the aims of the NGML reform, it can be understood that especially the demands of the private sector have been taken in consideration. These demands are mostly linked with an establishment of a fully liberalized natural gas market. But on the other hand, there are clear signs showing that the Ministry of Energy and Natural Recourses of Turkey has some suspicions regarding the liberalization of the market. These doubts can especially be seen through the provisions, which regulate some mechanisms regarding the supply security of the country. Some of the important changes in the NGML-Draft will be handled below briefly.

8.4.2 Reforms in the New NGML Draft

8.4.2.1 Unbundling of BOTAŞ

One of the key points of the draft is the legal unbundling of BOTAŞ. According to the second provisional article of the draft, the vertically integrated structure of BOTAS will continue for 1 year after the draft comes into effect. After 1 year,[15] BOTAŞ will be unbundled in three different legal entities, in another word: in three companies. The first entity will operate the transmission system. The second company will be responsible for the operation of LNG facilities and storage activities. The last one will carry out, according to the description of the NGML Draft, "other activities". These activities will clearly be the main activities of BOTAS besides of transmission and operation of LNG facilities and storage activities. These are namely the import, export and wholesale of natural gas. According to the draft the third company will keep on the brand name of "BOTAŞ" and will represent it.

According to the NGML Draft, the transactions for the restructuring process will be conducted by BOTAŞ, taking on the opinions of the Ministry and the Undersecretaries of Treasury. In this sense, it will be ensured that the BOTAŞ will perform its obligations in its licenses under financially strong and competitive conditions.

8.4.2.2 Prohibition of Natural Gas Import Contracts

Another important point of the NGML Draft is concerned with reducing BOTAŞ's major share in natural gas market. According to the draft, BOTAŞ will not be

[15] The draft regulates that the vertically integrated legal personality of the PPC will be preserved until January 1, 2015. After that date, the PPC will be re-structured as three separate legal entities to perform the transmission activities, the operations of LNG facilities, the storage activities and the other activities. But the given certain date will most probably be changed, because of extension of the enactment period.

allowed to make new Natural Gas import contracts until its share drops to 20 % of the national consumption.

Furthermore, an expired import contract can also not be renewed by BOTAŞ. But BOTAŞ will be allowed to make new import contracts with the permission of the Council of Ministers for the purpose of supply security and export.

However, it should be noted that also the current code includes a similar provision which could not be implemented yet. Therefore, instead of only creating provisions which are difficult to implement, it would be more helpful to support such legal intentions with political and economical steps. Changing the pricing policy and smoothing the way for the private sector may for example help to overcome the bureaucratic obstacles, which seem to play a significant role against liberalization targets.

Regarding the LNG import contracts, it should be stated that they are fully exempted from the contract-prohibition in the NGML Draft. In comparison to the NGML in force, the draft does not oblige but authorizes to contract release auctions. A new concept in that sense is the possibility of so called "amount transfer". The draft empowers BOTAŞ also to make auctions to release natural gas amounts. With these provisions, the law maker aims and hopes a supply-side reduction of BOTAŞ's share in the natural gas market.

8.4.2.3 Prohibition of New Natural Gas Sales Contracts

The Draft of the new NGML repeats in some of its provisions the targets of the existing NGML with different methods. According to the NGML Draft, BOTAŞ will not be able to sign new contracts for the sale of natural gas. However it will be allowed to renew the existing natural gas sales contracts.

The main target of such a provision is the decreasing of the market share of BOTAŞ, the market dominator, in the natural gas market. This regulation will provide also a demand-side decrease in the BOTAŞ's market share. That will be a policy change of the law maker regarding the liberalization process of the market, because the existing law includes only the supply-side precautions in the export, which prevents the decrease in the BOTAŞ's market share depending on the actions of the foreign companies as natural gas sellers. This strategy seems to have economic risks, because it is possible that BOTAŞ will own big volumes of natural gas in the future, which it will not be allowed to sell, as a result of that sale contact prohibitions.

8.4.2.4 The Ministry as the Responsible Authority for Supply Security

One of the reforms of the draft is the naming of an authority as the responsible subject for the security of the supply of natural gas. That is the Ministry for Energy and Natural Resources (MENR). In this respect the draft regulates that the ministry is liable for taking measures for the supply security of natural gas.[16] For that purpose, the Ministry should regulate the procedures and principles for the supply

[16] Art 22 of the Draft.

security of natural gas through bylaws. The duties and responsibilities of both the Ministry and EMRA are aimed to be clear through the coordination between the Natural Gas Market Code and MENR Law on the Organization and Duties.

8.4.2.5 Establishment of an Organized Wholesale Market

The NGML Draft aims to prepare the necessary ground for a natural gas bourse. For that purpose, it regulates the establishment of an organized natural gas wholesale market and explains some concepts and activities in this respect. Some of these are the operation of organized natural gas wholesale markets, the storage obligation and the natural gas operational activities including the financial reconciliation transactions of the activities occurring in these markets and the other financial transactions regarding the subject activities and also assuming the supplier of last resort function.

The most important function of an organized wholesale market will be the specification of the pricing according to the supply and the demand on such a market. The establishment of such a market is expected to provide the performing of the natural gas market activities under transparent and competitive conditions.

8.4.2.6 BOTAŞ as "The National Transmission System Operator"

BOTAŞ is the only Natural Gas Transmission System Operator of Turkey. In order to provide such a de facto situation a legal basis, the NGML Draft defines this concept and gives this mission to BOTAŞ. This provision should especially serve a competitive environment for the access of the third parties to this transmission system. In case that the other transmission companies rather than the BOTAŞ itself conduct transmission activities, this provision will help the network to operate together. However, after the planned unbundling of BOTAŞ, the legal entity which will operate the transmission system will have to give up the brand name of "BOTAŞ".

8.4.2.7 Separation of Storage Activities

As a reform, the NGML Draft separates the storage activities of natural gas in the gas form and in the form of the liquefied natural gas (LNG). This separation should ensure that for those two types of storage, which have different technical features, separate licenses and procedures will be regulated. According to the NGML Draft, before issuing a storage license the approval of the Ministry of Energy and Natural Resources is required.

The separation of storage activities will have also an effect in terms of identifying the conditions regarding the storage obligation. Furthermore, such a separation will probably include the Ministry in relation to the natural gas storage in the area of exploration and a production license based on the Turkish Petroleum Code and the other open areas.

Additionally, the draft provides that the Authority (EMRA) will set the tariffs for the license storage and LNG activities. However the LNG terminal and storage operators will have to prepare their tariffs, which should be in conformity with the procedures and principles identified by the Authority. Finally they will declare these tariffs after submitting them before the Authority. The Authority will approve then the appropriate tariffs and these tariffs will be applied without any discrimination against equal parties.

8.4.2.8 Storage Obligation and Guaranty of Supply

One of the important provisions regarding storage activities concerns the storage obligation of the natural gas suppliers. In this regard, the license owners supplying natural gas to distribution companies are required to take precaution for the storage and to guarantee the natural gas supply in their future contracts.

On the one hand, the storage obligation and guaranty of supply should serve the continuity and the security of natural gas supply for consumers, especially in case of interruption or curtailment of natural gas. On the other hand, this obligation should care for the security of national supply through the precautions to be taken by the license owners supplying natural gas to distribution companies to efficiently manage their own portfolios.

8.4.2.9 The Possibility of Division and Combination of Distribution Zones

The NGML Draft involves new provisions regarding the division and combination of distribution provinces. In this sense, EMRA will be authorized to identify several cities as one single distribution zone. Likewise, it will able to combine several distribution zones under one single license. Also, the existing distribution zones can be divided into several license zones. For last two cases, there should be a request of legal entities having distribution licenses, to move in that direction.

The NGML Draft provides that the procedure and principles regarding application of division and combination of distribution zones will be regulated by law. Although the combination of distribution zones may seem to be problematic regarding the competition law and may cause regional monopoly structures, such a regulation is necessary in order to provide distribution companies to bring natural gas service to smaller towns as well.

8.4.2.10 Expansion of the Definition of Eligible (Free) Consumers

The natural gas regulations in force have high limits regarding the free consumer specification. Currently only a consumer, who has more than 100,000 c^3 to consume is allowed to select his or her supplier. Within the frame of its liberalization targets, the draft aims to soften these limits. Therefore the definition of a free consumer is provided to expand through the aims and types of various uses of natural gas. Free trade areas and organized industrial areas, the consumers out of distribution zones, as well as compressed natural gas (CNG) and LNG users are added to the definition of the free consumer.

8.4.2.11 Account Separation for Distribution and Retail Sale Activities

Another step on the way of a fully liberalized natural gas market is the separation of natural gas distribution and retail activities. As a preparation for such a final stage, the NGML Draft provides the separation of accounts for distribution and retail sales activities of the natural gas market.

Another change in the Law is related to the shares of municipalities on the distribution companies. According to the NGML Draft, such shares of the municipalities can be sold. These changes should make it possible to track the expenditures for the distribution activities of natural gas and to make the structural changes on the shares of distribution companies with municipal partnerships.

8.4.2.12 Supplier of Last Resort

A very significant reform of the draft is the concept of "the supplier of last resort." This concept is defined as legal entities identified by the EMRA, which are liable for supplying natural gas to customers of import or/and wholesale companies, in case these companies are not able to fulfill their obligations. The same applies if a free consumer is not able to assure its need of natural gas. In order to meet these obligations, the supplier of last resort will be required to have storage facilities in order to meet seasonal natural gas needs of customers. In current market conditions, the only company which can fulfill these conditions is BOTAŞ, the state owned petroleum pipeline corporation.

The application of the concept of the supplier of last resort is the result of the liberalization process of natural gas market. It should serve to ensure the balance between competition and supply security. The supplier of last resort can find a ground to be applied especially in temporary and exceptional cases. So it will get on the stage for example in cases of urgency, the bankruptcy of the suppliers while consumers cannot find any supplier, or when the natural gas supply service suddenly stops.

The relevant EU Natural Gas Directive bears the concept of the supplier of last resort. The concept has its place in the last EU Natural Gas Directive within the scope of the Third Energy Package. However, a definition for the concept of the supplier of last resort is not made in the relevant Directive. So the application of this concept and its scope can be determined in the national legislations. The appointment of a supplier of last resort is not an obligation in the EU natural gas legislation. However, it is also necessary to state that this situation does not give member states the absolute freedom.

8.4.2.13 Provisions Related to CNG

The NGML Draft includes some new provisions about compressed natural gas (CNG). It provides that the Ministry will give the licenses for exploration and operation of natural gas and that the production companies can sell the gas produced to CNG companies. The aim of this provision is to ensure the harmony with the definition regarding the wholesale of natural gas. Furthermore it has been provided that natural gas can be filled up as CNG in motor vehicles as long as it is stated within the license and that EMRA will separately regulate the matters regarding the activities within this scope.

8.4.2.14 Administrative Sanctions

The sanctions have been re-regulated in order to eliminate irregularities and to meet the need regarding the implementation of administrative monetary penalties. The new regulations are provided in order to increase the efficiency and deterrence of the penalties implemented by EMRA concerning the natural gas market and also in order to ensure the functional operation of the market.

8.4.2.15 Agreements in Written Form

One of the new provisions of the NGML Draft is related to the obligation to form agreements in written form. The NGML Draft provides that every transaction in the natural gas market is required to be dependent on a written agreement. This requirement of the existence of a written agreement should ensure primarily the prevention of the conflicts that can or will occur due to the use of natural gas from the existing transmission system without any agreement in written form.

Other purposes of such a regulation are the protection of consumers and the security of natural gas supply for consumers and distribution companies. Written agreements should secure the legal basis for the resolution of the disputes between natural gas market actors with each other and consumers. Furthermore, such an obligation will create the opportunity to prevent some of the factors that restrain competition by providing a watch over natural gas market in which the number of players increases. Lastly, the obligation regarding agreements in written form should contribute to the predictions of demands and supplies of natural gas in Turkey.

8.4.3 Compatibility of the NGML Draft with the EU Third Energy Package

One of the main components of the Third Energy Package of the EU is the regulations regarding natural gas markets within the Union. A close look to the Third Energy Package will show that the main goals of these regulations are the effective separation of competitive activities from network activities, creating more efficient market oversight and regulation, the establishment of more transparent market structures and providing the integration of markets. In other terms, the EU aims with these regulations to bind the European markets and to strengthen the competition.

One of the main aims of the NGML reforms is the integration with the EU regulation regarding natural gas. The NGML Draft law is consistent with the EU Third Energy Package on quite a few matters. Some of these are related to the unbundling, the regulation of the access to transmission system, the supply of last resort and the regulation of the LNG terminals.

However, the draft includes also some incompatibilities with the Third Energy Package of the EU which may result because of specific characteristics of the natural gas market of Turkey. For example the definition of the “useable storage capacity” is inconsistent with the EU legislation and the definition should be regulated as “the storage capacity that can be put into use”. That is because the underground storage facilities depend on geological conditions. If this storage facility is the only one or has limited capacity for this purpose, it will be in a dominant position. For that reason, it will be a ‘compulsory element’ in terms of competition law and it should be open to third parties’ access and this access should be regulated.

Conclusion

Turkey has a dynamic and consistently growing natural gas market. However it largely depends, in respect of natural gas, on import. On the other hand, Turkey is a natural bridge between natural gas producing countries and Europe, which is one of the biggest consuming markets of the world. This geographic position brings a great opportunity for Turkey to be a natural gas transfer point from east to west. Exactly at that point Turkey is confronted with an important choice: should it be just a transit country, where it has no control over the great amounts of natural gas passing through its territory via major pipeline systems of future, such as TANAP,[17] or should it be a trade hub for natural gas.[18] Although historically Turkey always declared that it follows the policy of being a trade hub for natural gas (Üçok 2013), the conditions and the natural gas producers affected Turkey to accept international transmission projects thorough which natural gas will pass without intervention of Turkey. That is clearly a tragic change in natural gas policy of the country. In order to become a natural gas trade hub, Turkey will have to improve its technical infrastructure regarding natural gas transmission and give more importance to re-export activities.

With almost 30 % private sector shipping participation within the transmission system, the natural gas market of Turkey is in the early stages of liberalization. The beginning of this process was the enacting of NGML in 2001. This law abolished the monopoly rights of the state-owned BOTAŞ in almost all of the natural gas market activities. BOTAŞ kept its monopoly rights only regarding the license for the transmission system operation (Turkel et al. 2009). Despite the opening of the market years ago, the natural gas market is still dominated by the state-owned BOTAŞ. Maybe the most important reason for this is the pricing strategy of governments in Turkey. They subsidized BOTAŞ, which sold the natural gas at uncompetitive prices. Therefore, the private sector had difficulties with surviving in the market. The pricing policy is still the most important obstacle against the liberalization.

The NGML in force couldn’t meet some of its important targets regarding the liberalization of the natural gas market of Turkey. Two of these important failed targets were a significant decrease in market share and unbundling of BOTAŞ.

[17] TANAP: Trans Anatolia Gas Pipeline. The TANAP Project intends the transportation of the natural gas to be produced in Shah Deniz 2 field and other fields of Azerbaijan (and other possible neighboring countries) through Turkey to Europe from 2018 onwards.

[18] For detailed analyses regarding trade hub strategies of Turkey, see also Bilgin (2011).

In order to bring dynamism in liberalization process, the Turkish Government plans to reform the NGML comprehensively. On the one hand, the NGML Draft contains important changes in existing provisions and new regulations which are by and large compatible with respective regulations of EU. On the other hand, it also repeats some failed and unrealistic targets such as decrease of market share of BOTAŞ to 20 %. However the natural gas market of Turkey can only be liberalized with realistic regulations, necessary investments in transmission infrastructure and a change in pricing policy.

It is obvious that Turkey should urgently implement the planned market reform. That seems to be necessary in order to speed up the liberalization process of the natural gas market. A significant step in this regard will be an effective unbundling of market activities. Especially an independent gas transmission operator should be ensured. Another necessity is the reducing of market shares of dominant figures in the market. Furthermore, necessary legal bases should be created for long and short term supply security. In this respect, provisions regarding spot LNG trade and long term natural gas purchase agreements, especially in the interest of the private sector, should also be included in the regulations.

References

Aslan İY (2009) Enerji hukuku, vol 3. Ekin, Bursa

Atias I (2009) Recent privatization experience of Turkey: a reappraisal. Sabancı University, Istanbul

Bilgin M (2011) Energy and Turkey's foreign policy. Turkish Policy Q 9(2):81–92

BOTAŞ – Petroleum Pipeline Corporation. www.botas.gov.tr

Cagaptay S, Evans T (2013) Turkey's energy policy and future of natural gas. Harvard Kennedy School, James A, Baker III Institute for Public Policy of Rice University, Houston

EMRA (2012) Natural gas sector report 2011. EMRA, Ankara

EMRA – Energy Market Regulatory Authority. www.epdk.gov.tr

IEA (2009) Energy policies of IEA countries – Turkey review. IEA, Paris

Republic of Turkey Ministry of Foreign Affairs (2009) Turkey's energy strategy

Özen E (2012) Turkey's natural gas market: expectations and developments 2012. Deloitte, Ankara

Rzayeva G (2014) Natural gas in the Turkish domestic energy markets: policies and challenges. Oxford Institute for Energy Studies, Oxford

Shaffer B (2006) Turkey's energy policies in a tight global energy market. Insight Turkey 8:97–104

Turkel V, Demirtaş MA, Seralıoğlu M (2009) Turkish natural gas market and legal regulations. IGDAŞ, İstanbul

TUSIAD (2009) Liberalisation of energy sector: the case of Turkey and the EU. TUSIAD, Istanbul

Üçok MD (2013) The potential role of Turkey in a globalising gas market. Policy Brief

Ünal HH (2012) Türkish network code. Enerji Hukuku Dergisi 77–88

9 Efficiency and Service Quality Analyses of the Natural Gas Distribution Companies: A Case Study of Turkey

Okan Yardımcı and Mehmet Baha Karan

Abstract

The Energy Market Regulatory Authority (EMRA) sets the tariff that determines the revenue requirements of the Turkish natural gas distribution companies by using a popular type of an incentive regulation, the price cap method. Generally, incentive regulation improves efficiency and reduces costs; on the other hand the companies may not be willing to increase the service quality in this kind of regulation. This chapter analyzes the efficiency and service quality of the Turkish natural gas distribution companies. The findings should also be of interest to regulators in other developing countries that are at the early stage of their natural gas market regulation. The companies' efficiency scores are evaluated both by non-parametric and parametric methods, Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) respectively. The same distribution companies are ranked by the service quality scores that are obtained from service quality data. The results are used to determine the relationship between efficiency and service quality of the companies, to decide on the effectiveness of the regulation and to suggest a reward/penalty scheme for the tariff design.

Keywords

Efficiency • Natural gas distribution companies • Price cap • Regulation • Service quality

O. Yardımcı (✉)
Energy Market Regulatory Authority, Ankara, Turkey
e-mail: oyardimci@epdk.org.tr

M.B. Karan
Hacettepe University, Ankara, Turkey
e-mail: mbkaran@hacettepe.edu.tr

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_9

Abbreviations

AE	Allocative Efficiency
BOTAŞ	Boru Hatları ve Petrol Taşıma A.Ş.
CAPEX	Capital Expenditures
CE	Cost Efficiency
CRS	Constant Returns to Scale
crste	Technical Efficiency from Constant Returns to Scale
DEA	Data Envelopment Analysis
EMRA	Energy Market Regulatory Authority
HDD	Heating Degree Day
NGML	Natural Gas Market Law
OPEX	Operational Expenditures
ROR	Rate of Return
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
VRS	Variable Returns to Scale
vrste	Technical Efficiency from Variable Returns to Scale

9.1 Introduction

The process of opening monopoly markets to competition, so called liberalization, performed first in United Kingdom and then in some of the other European Countries, gradually gained momentum since the early 1980s. The competition level within the private sector in U.S. energy market was one of the main drivers of this restructuring. In parallel with this structural reform in Europe, the Turkish Natural Gas Market Law (NGML) (Law #4646, adopted on May 2, 2001 and in force since 2002, after a transition period) aims a liberal natural gas market, unbundling of the market activities and regulating the natural monopoly ones, i.e. distribution, transmission and storage.[1] The EMRA was appointed as the regulatory body in both the natural gas market and the electricity market. The tariffs applied by distribution, transmission and storage companies are determined by EMRA, due to their natural monopolistic feature.

Creating an effective competitive environment is a hard task, especially for public services such as electricity, natural gas and water. It is more difficult to regulate the natural monopoly company and expect from her to act as if she is operating in a competitive market. In a natural monopoly industry/sector, multiform production is more costly compared to production by a monopoly (Baumol 1977). In other words, duplicate network in the same geographical area is a highly

[1] Storage activity has to be regulated if there is no or limited competition especially due to insufficient storage capacity.

inefficient practice (Gomez and Rivier 2000). This is the case when fixed costs are relatively large compared to variable costs. Maximization of social benefits in these areas could be achieved only by maintaining an effective regulation. Definitely, efficiency and service quality improvements are the main indicators of effective regulation that creates social welfare. The "tariff design" that should promote both the efficiency and the service quality improvements, is the most important tool of the regulatory body to achieve these goals. In this chapter, we analyze the efficiency and the service quality performances of the natural gas distribution companies. The relationship between efficiency and service quality will be examined and the results will be useful for a better understanding of whether regulation of the natural gas distribution sector has been successful. In this study, the case of Turkey is discussed and the findings should also be of interest to regulators in other developing countries that are also at the early stage of their natural gas market regulation.

Generally one of two types of tariff design is preferred by regulators as a regulatory scheme: incentive regulation or cost-plus regulation. Incentive regulation, also known as performance based regulation, has two popular forms: price cap regulation and revenue cap regulation.

Price cap regulation, which is preferred by EMRA as a regulatory scheme for the Turkish natural gas distribution sector, was suggested first in the United Kingdom at the beginning of the 1980s under the name of RPI-X regulation. Its main features are the following (Kiss et al. 2006):

- Starting price levels are set following a cost review that determines the revenue requirement of the regulated utility. The aim is to cover the costs of the utility's operation and to provide a fair rate of return on its assets.
- Cost reviews do not occur for another 3–5 years. Instead, average price levels are indexed by the rate of inflation (usually the consumer—or "retail" price index) less an adjusted factor (X) that accounts for expected productivity improvements in the company's operations. The time of the next cost review is fixed.
- Only average price levels are regulated. The firm is given (partial) freedom to set the prices of individual services as it wishes, as long as the overall price cap is satisfied.

The company can increase the profit if it achieves the efficiency "x-factor" in the incentive regulation. On the other hand the commonly used incentive regulation method, price cap, does not promote better quality. It is like a fixed price contract between the regulated company and the regulatory body, which causes high powered incentives to reduce operating costs. In this regulatory scheme, one obvious way for regulated firms to save operating costs is to decrease the quality of the service provided to the consumers. Therefore, incentives that motivate cost reduction and more efficient operation will also motivate the degrading of service quality. This is an unfortunate side effect of incentive regulation and this issue should not be disregarded by regulators. Quality of commercial aspects could be deregulated under a new competitive framework, where customer choice and retail markets are being implemented. Hopefully, market rules will provide the adequate level of quality (Gomez and Rivier 2000). However, market rules are not working for the quality control mechanisms in the natural gas distribution sector due to its monopolistic feature.

Next to being preferred by EMRA for the Turkish natural gas distribution sector, many other countries such as Hungary, Argentina, Brazil, and Mexico are implementing price cap regulation particularly to regulate energy and telecommunication sectors. Apparently, the main objective of this preference is to achieve a price drop through an efficiency improvement by the state-owned or private companies. This achievement is much more important for the developing countries that are also trying to open their state-owned monopoly markets to competition. Mostly, the early outcomes are shown as an evidence for success of the liberalization process and presented as an effective regulation to the public. Side effects and late consequences are ignored by the regulators.

Similarly, revenue cap regulation, which is the other subtype of the incentive regulation, also creates an incentive to minimize costs. The only difference between a price cap and a revenue cap is the correction factor. A price cap gives an extra incentive for the incremental sales, but creates a risk for fewer sales. On the other hand, the revenue is corrected in the revenue cap regulation after the tariff period. Revenue cap regulation is more appropriate than price cap regulation when costs do not vary appreciably with units of sales (Jamison 2007). Revenue cap regulation is preferred by EMRA as a regulatory scheme for the Turkish natural gas transmission, natural gas storage, electricity distribution and electricity transmission sectors. The reason for the distinction between the regulatory schemes of the natural gas distribution and the other sectors is a mystery. The most reasonable estimate is the possibility to avoid Boru Hatları ve Petrol Taşıma A.Ş. (BOTAŞ)'s[2] take or pay obligations by motivating the natural gas distribution companies.

Cost-plus regulation is the most popular alternative way of the price/revenue cap and commonly known as rate of return (ROR) regulation. All operational and capital costs are paid to the company in the application of the pure ROR regulation. Incentives and opportunities to improve efficiency are generally larger under price cap regulation than under ROR regulation. This does not mean, however, that price cap regulation is the right form of regulation in all situations (Jamison 2007). The ROR provides incentives for over-capitalisation, but not for efficiency improvements and results in high quality. So, there is no explicit need for quality regulation under ROR application (Ajodhia and Hakvoort 2005). The ROR regulation makes quality provision costless to the utility in the sense that the extra costs of a higher quality of service will always be recognized in the upcoming cost review. In order to neutralize the disincentives for quality provision under price cap, the regulatory authority should introduce strict quality regulation and service quality monitoring at the same time as the price cap scheme takes effect (Kiss et al. 2006). Certainly, this is not an easy task.

[2] BOTAŞ is the state-owned wholesale company that imports around 75 % of the natural gas consumption and also the operator of the transmission system.

In the literature, some of the researchers (for example, Granderson and Linvill 1999; Carrington et al. 2002; Hollas et al. 2002; Erbertta and Rappuoli 2008) have used non-parametric methods and some of the researchers (for example, Hollas and Stansell 1988; Kim and Lee 1996; Bernard et al. 1998; Fabbri et al. 2000; Granderson 2000; Rossi 2001; Farsi et al. 2006) have used parametric methods, to measure the efficiency of the natural gas distribution companies. There are two studies (Bağdadioğlu et al. 1996; Bağdadioğlu et al. 2007) that analyzed the efficiency of the Turkish electricity distribution companies. On the other hand, there is only one study (Ertürk and Türüt-Aşık 2011) about the efficiency of the Turkish natural gas distribution companies. In this study, the performances of 38 Turkish natural gas distribution companies were analyzed by the DEA. Technical Efficiency (TE) scores, Allocative Efficiency (AE) scores and Cost Efficiency (CE) scores under the assumptions of both Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) were calculated. Also, new companies were compared to the old ones and large firms were compared to the small ones. Moreover, important parameters affecting the efficiency level were detected. The common characteristics of the most inefficient firms were found to be immaturity and low scale.

Apart from the above, the studies on the relationship between the efficiency and the service quality are limited and mostly on the electricity sector. Some researchers (such as Spence 1975; Sheshinski 1976) have shown that, under the incentive regulation, the quality is reduced in order to cut back costs. As a result of this, it is shown that the regulators give financial incentives to ensure quality (Simab and Haghifam 2012). Most regulators agree upon the need of quality control mechanisms associated with incentive regulation schemes. Penalties should be imposed if the utility reduces quality of services, such as reliability, voltage quality, employee safety, etcetera, below specific limits. The penalties should be commensurate with utilities' cost savings in the expense of power quality (Gomez and Rivier 2000). There are also some studies (such as, Xu et al. 2007; Mohammadnezhad-Shourkaei and Fotuhi-Firuzabad 2010; Simab and Haghifam 2012; Simab et al. 2012) that evaluate a mathematical model for optimally setting the parameters of the performance based regulation with a reward/penalty structure. In one of these studies (Mohammadnezhad-Shourkaei and Fotuhi-Firuzabad 2010) an approach is proposed to not only motivate the utilities to improve their service quality, but also to equalize the total rewards paid and total penalties received by regulators. The general form of the reward/penalty scheme consists of dead, penalty and reward zones. In the dead zone, reward and penalty are not considered (Brown and Burke 2000). Also DEA efficiency score and historical quality levels are used to set a quality target for each electric distribution company (Simab and Haghifam 2012) and the DEA used to define the efficiency frontier, which was combined with the dynamic cluster technique to set the expected network quality performance (Tanure et al. 2006).

Definitely, another area of critical concern is the level of the service quality. Do the consumers need high level quality for these public services? Are they willing to pay for this luxury service? Undoubtedly, consumer preferences vary by so many parameters and the more complex questions may arise due to the disintegration. A consumer may prefer to wait in a payment queue for a half hour instead of a 1 % increase in his or her natural gas or electricity price. Even he or she may consent to the outage or interruption. In one study (Fumagalli et al. 2004) insurance contracts based on the consumers signals to the distribution companies were proposed as a solution. Nevertheless, the regulator should determine the fundamental quality requirements. Expecting the solution amongst the consumers and companies is not a straightforward way of regulation.

This research is the first effort to deal with both efficiency and service quality of the Turkish distribution companies and the hypothesis of "*efficient Turkish natural gas distribution companies reduce the service quality whereas inefficient ones increase the service quality*" is tested under some assumptions and restrictions. The companies' efficiency scores are evaluated both by non-parametric and parametric methods, DEA and SFA respectively. The same distribution companies are ranked by the service quality scores that are obtained from the service quality data. Currently, 64 natural gas distribution companies are operating in Turkey and around half of them are new and immature.[3] In this study, 25 mature distribution companies' data are used for the analyses. Operational Expenditures (OPEX) of the companies are taken into account for the efficiency analysis. Maintenance of network installations, energy costs, personnel expenses are the main components of the OPEX. Efficiency or cost reduction in the Capital Expenditures (CAPEX), in other words: investment in network reinforcements, are not compared in this study, since the networks are generally brand-new and it is estimated that cost reduction does not affect service quality for now. The service quality data that is requested from the same 25 mature distribution companies is used for the service quality analysis.

This chapter has six sections. Following the comprehensive introduction part, a general framework of the Turkish natural gas market, specifically the liberalization process and the natural gas distribution sector, is presented in the second section. Data and the descriptive statistics about the variables are shown in the third section. Section 9.4 focuses on the DEA and SFA methods, efficiency and service quality measurements. In Sect. 9.5, the results are analyzed. Concluding comments are made in the last section.

9.2 The Turkish Natural Gas Market

The first commercial use of natural gas in Turkey began in 1976. A limited amount of consumption was provided by domestic production until 1986. After the gas delivery agreement signed with the Union of Soviet Socialist Republics in 1984, the studies for the construction of natural gas networks in the cities began. Residential use of natural gas began in 1988, in the capital Ankara. The natural gas market was

[3] Operating less than 5–6 years.

Fig. 9.1 Household natural gas consumption before 2002

expanded by including the other crowded cities, İstanbul, Bursa, Eskişehir, İzmit and Adapazarı. Before the enactment of the NGML, seven distribution companies were operating in six provinces (see Fig. 9.1). Four of them were municipal corporations (Ankara, İstanbul, İzmit, Adapazarı) and two of them (Bursa and Eskişehir) were the affiliated companies of BOTAŞ and the other one was a private company (Bahçeşehirgaz, operating in a small district in İstanbul).[4] The NGML stated the privatization of all of the distribution companies. The only gas supplier, BOTAŞ, determined the end-user prices at that time.

In parallel with the structural reform in European Countries, the NGML, which came into force in 2002, aims at a liberal natural gas market. Main targets of the NGML for the distribution sector are as follows; privatize state-owned companies, create new private distribution companies through tenders and promote the use of natural gas all over the country. So far, except for the distribution companies operating in İstanbul (İGDAŞ), the privatization process is completed. The privatization process of İGDAŞ still continues. Besides, the EMRA has accomplished 57 tenders and completed the licensing procedures for these private new distribution companies[5] (see Fig. 9.2). New companies are assigned a leading role in realizing gas distribution projects with no state funds involved in the process. Bidding evaluation was based on the unit service and depreciation charge (“distribution fee”) for supplying one kWh natural gas to consumers. During the first 8 years of operation, licensees are required to operate at fixed distribution fees determined under the tender. Tenders continued with reduction of connection fees after distribution fees reached to zero for 8 years. In one region, the tender

[4] In the rest of the chapter these seven companies will be referred as “old companies”.

[5] In the rest of the chapter, these 57 companies will be referred as “new companies”.

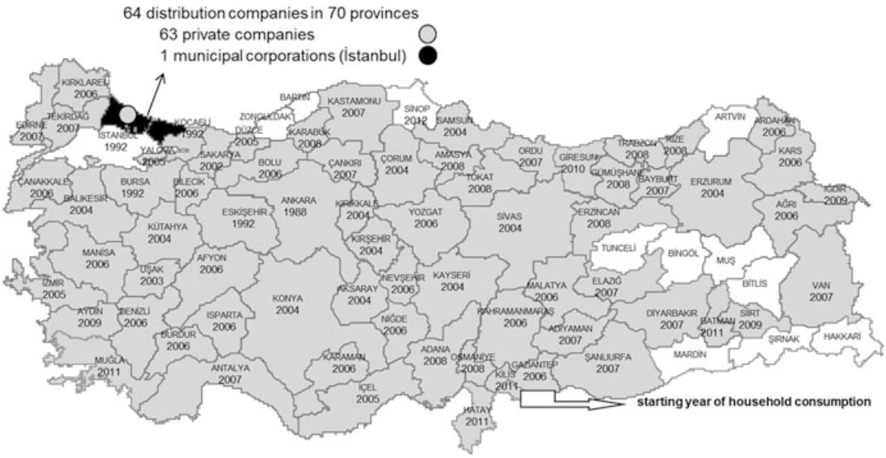

Fig. 9.2 Household natural gas consumption at the beginning of 2013

continued with a license fee following by a zero distribution and connection fee. After 8 years, distribution fee is determined by EMRA, based on the price cap method. Besides this, licenses are granted for 30 years.

Winners of distribution tenders are required to commence construction within 6 months of acquiring a license. In addition, they are required to complete their first gas connections within 18 months. Distribution companies are required to gasify every region in their respective territories in 5 years and they are required to connect every willing potential consumer in their distribution area, if the requested connection is economically and technically feasible. On the other hand, distribution companies are obliged to purchase natural gas from the cheapest two different sources. Their “gas cost” is passed through and the aforementioned rules mean that they can only gain from the distribution fee.

Following the natural gas distribution market structure enacted by the NGML, considerable success has been achieved by private sector investments. The usage of this comfortable public service expanded rapidly. Moreover, due to the aggressive attitude of the firms, tenders were concluded with greatest reductions in the distribution fees for the first 8 years (see Fig. 9.3 and Table 9.1). Consumers, who use gas in regions of the new companies, consume gas around 10 % cheaper than the consumers in regions of the old companies. In this situation, the number of gas users has been increased on a regular basis during the first 8 years (Yardımcı 2010).

At first glance, the above seems like a “success story” for the developing countries. On the other hand, it may easily result as a case study with a label of a “regulatory delusion”. In order to avoid the regulatory failure, social welfare including the service quality and the late consequences of the tariff design should be taken into account carefully by effective regulation.

As mentioned before, new companies shall be able to apply their tender offers as distribution tariffs in the relevant area for 8 years. After this time, the tariff is

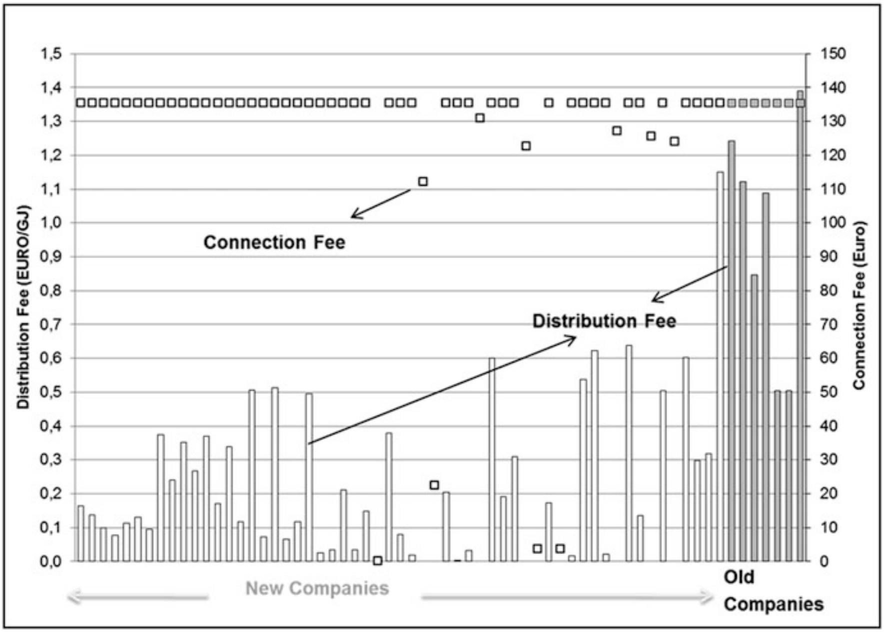

Fig. 9.3 Tender results

determined by EMRA under the price cap regulatory scheme. The legislation, Principles and Procedures of Tariff Calculation for Natural Gas Distribution Companies, ("methodology") includes the details of the tariff design. The service cost (same as OPEX), depreciation and reasonable profitability for investment is taken into account during the tariff setting procedure. The first new company (KAYSERİGAZ) and the second one (GAZNET) have completed the 8 year period at the end of 2011, the next 17 new companies have completed the 8 year period during the year 2012 and the following eight new companies have completed the 8 year period during the year 2013. The new tariffs are valid for the approximately half of the new companies at the moment. The tariff setting processes are ongoing for the other ones.

In the constant tariff period, distribution fees are lower than the marginal costs and this affects the financial viability of the distribution companies. In order to avoid modifications of the tender conditions, it is very important not moving this problematic situation to the end of 8 years by subsidizing the winner companies. Discussions and lawsuits about this subject are ongoing and not directly related to this research, so these are put aside for another future study. Since the distribution fees were very low, it is expected to see efficiency improvements over time. The distribution fee was the same for all consumer groups during the 8 year period, so it is difficult to say that fairness was achieved from a social point of view. On the other hand, it was determined on the basis of the consumption groups by methodology (based on their consumption level) and this application prevented cross-

Table 9.1 Tender results

Distribution companies (March 2012 fees)	Distribution fee (Euro/GJ)	Connection fee (Euro)	New company: N Old company: O	Distribution companies (March 2012 fees)	Distribution fee (Euro/GJ)	Connection fee (Euro)	New company: N Old company: O
1. KAYSERİGAZ	0.163	135	N	33. GÜRGAZ	0.204	135	N
2. GAZNET	0.138	135	N	34. ÇANAKKALEGAZ	0.002	135	N
3. PALEN	0.099	135	N	35. TOROSGAZ	0.032	135	N
4. ÇORDAŞ	0.077	135	N	36. AFYONGAZ	0.000	131	N
5. PALGAZ	0.112	135	N	37. KARSGAZ	0.600	135	N
6. İNGAZ	0.131	135	N	38. ERZİNGAZ	0.191	135	N
7. TRAKYADAŞ	0.095	135	N	39. DOĞANGAZ	0.310	135	N
8. BADAŞ	0.374	135	N	40. TAMDAŞ	0.000	123	N
9. BALGAZ	0.241	135	N	41. OLİMPOS	0.000	4	N
10. SİDAŞ	0.353	135	N	42. OVAGAZ	0.174	135	N
11. ÇİNİGAZ	0.267	135	N	43. ELAZIĞGAZ	0.000	4	N
12. NETGAZ	0.370	135	N	44. KARADENİZ	0.017	135	N
13. ÇORUMGAZ	0.170	135	N	45. GÜMÜŞHANE	0.537	135	N
14. KIRGAZ	0.340	135	N	46. DİYARGAZ	0.623	135	N
15. SAMGAZ	0.118	135	N	47. AKMERCAN	0.021	135	N
16. AKSARAY	0.507	135	N	48. FINDIKGAZ	0.000	127	N
17. DERGAZ	0.073	135	N	49. VANGAZ	0.639	135	N
18. GEMDAŞ	0.514	135	N	50. SELÇUKGAZ	0.135	135	N
19. ARMAGAZ	0.067	135	N	51. ÇUKUROVA	0.000	126	N
20. UDAŞ	0.118	135	N	52. SİİRT	0.505	135	N
21. POLGAZ	0.494	135	N	53. AYDIN	0.000	124	N

22. İZMİRGAZ	0.026	135	N	54. GEPA	0.602	135	N
23. MANİSAGAZ	0.034	135	N	55. DELTA	0.299	135	N
24. KAPADOKYA	0.211	135	N	56. HAVZA	0.319	135	N
25. BEYGAZ	0.034	135	N	57. KIZILCAHAMAM	1.149	135	N
26. KARGAZ	0.148	135	N	58. İGDAŞ	1.242	135	O
27. TRAKYAGAZ	0.000	0	N	59. BAŞKENTGAZ	1.122	135	O
28. SÜRMELİ	0.378	135	N	60. AGDAŞ	0.847	135	O
29. PEGAZ	0.080	135	N	61. İZGAZ	1.087	135	O
30. ARMADAŞ	0.019	135	N	62. ESGAZ	0.505	135	O
31. KENTGAZ	0.000	112	N	63. BURSAGAZ	0.505	135	O
32. GAZDAŞ	0.000	23	N	64. BAHÇEŞEHIR	1.391	135	O

subsidization between consumer groups after 8 years. Last but not least, minimum regulatory intervention was achieved in the fixed tariff period. Reducing the OPEX by minimization of the regulatory intervention is one of the important components of the efficiency improvements and directly affects the social welfare.

As seen in Fig. 9.3 and as mentioned above, private sector investment has been a great success and remarkable reduction was achieved in the distribution fees for the 8 years. On the other hand, the effect of the reduction should be analyzed carefully in order to make a comment on the effectiveness of the regulation and the liberalization process. The 8 years period was like a fixed price contract between the distribution company and the regulatory body, so there was a high powered incentive to reduce operating costs. It is nearly same as with the regular price cap regulation but the prices were not determined by investments, depreciation, and reasonable profitability etcetera, but they were determined during the auction by the companies' decisions. Regular price cap regulation is ongoing after the 8 years, but this time EMRA determines the tariff for a multi-year period. It is important to take into account both the efficiency and service quality in order to design the fair tariff and effective regulation. Although there is a penalty scheme for the inefficient companies, there is not any reward/penalty scheme in the methodology for the service quality in order to encourage the companies for better quality. Some quality requirements[6] are valid for the distribution companies but these are not compatible with the tariff of the company for now.

9.3 Data

9.3.1 Efficiency

During the tariff studies, EMRA requests an information-documentation basis for the tariffs and reviews the financial tables and the other documents of the firms. These data are obtained from EMRA for the analysis of this study. The financial tables are reliable since the companies are inspected. Panel data of the period 2009–2011 is used for the SFA to compare the efficiency levels of the distribution

[6] The Natural Gas Market Law states that in case the distribution company, whose licence term has been expired, requests from the Authority to renew its city distribution licence 1 year before the expiry of the licence term, the Board may grant a second distribution licence by taking into consideration technical and economic power, **service quality** of the company, its **subscribers' satisfaction** and other issues to be determined by the regulations to be issued by the Authority. By the Natural Gas Market Tariffs Regulation, provision of adequate amount of natural gas of **good quality to consumers**, at low cost, and in a safe and reliable manner, and principles of non-discrimination and transparency shall be taken as a basis in preparation of the tariffs. The Natural Gas Distribution and Customer Services Regulation states that a distribution company in the event of an emergency intervention should arrive at the scene within **15 min at the latest**, should keep a **high level of service quality** and should contain **at least two maintenance—repair vehicles** up to 50,000 subscribers. The company should provide a vehicle for each additional 50,000 subscribers.

companies. Each year's efficiency scores and average scores are evaluated for the companies. Each year is taken into consideration separately, since the average of each years' efficiency score is meaningless for the DEA. As mentioned in Sect. 9.2, new tariffs have been determined, starting from the year 2012, for some of the new companies. In order to avoid the effect of the incentivized tariffs, year 2012 and onwards data are not used for this study. 2012–2016 is a transition time period since tariffs are determined by EMRA for the first new companies whereas the last ones continue to apply the lower tariffs that were determined through the bidding procedure. Definitely, the data of the transition time period is valuable for a possible future study that searches the effect of the tariff improvement on the efficiency and/or service quality.

As seen in Fig. 9.2 and Table 9.1, 57 new companies and seven old companies were operating at the beginning of 2012. The characteristic properties of the 57 new companies are very different from the old ones'. The average life is around 5 years for the new companies; on the other hand it is more than 10 years for the old ones. Similar to the maturity; area, number of consumer and the total consumption are smaller in the new ones. The biggest one of the old companies is İGDAŞ, the only remaining state-owned company, and the other five of them were privatized in the last 6–7 years whereas all the new ones are privately owned companies from the beginning of their operation. Moreover, tariffs of the old companies were determined by EMRA during the 2009–2011 period and they are very high comparing to the new companies' tariffs. Due to these important differences, old companies are not taken into consideration for the analyses. A previous study (Ertürk and Türüt-Aşık 2011) about the efficiency analysis of Turkish natural gas distribution companies showed that generally immature and low scale companies were found inefficient. In order to avoid a scale effect on the efficiency/service quality relationship, 25 companies over the 57 new companies are taken into consideration since these 25 companies are relatively mature (operating 6 years or more) and their scales are similar.

In this study, input oriented DEA is preferred for the efficiency analysis, since the distribution companies cannot determine their output level. Due to the relevant legislation, distribution companies are accountable for providing distribution service to all consumers in their defined area. Therefore, in order to achieve an efficiency improvement, the distribution company has to decrease the amount of inputs. Taking into account this fact, it is believed that input oriented DEA models are more suitable to analyze the performance of the Turkish natural gas distribution companies (Ertürk and Türüt-Aşık 2011). For the selection of the input/output variables of the efficiency calculations, EMRA's preferences are taken into consideration. Distinctively, the consumptions of the extraordinary consumers[7] are removed to avoid disruption of the efficiency scores. In order to clarify the

[7] A consumer is counted as an "extraordinary consumer" if the yearly consumption exceeds 10,000,000 m^3. In the rest of the chapter, a consumer who consumes below 10,000,000 m^3 will be referred as an "ordinary consumer".

extraordinary consumers' effect, it may be useful to visualize the efficiency comparison of two companies with an illustrative example. The Company-A which expends 10 units OPEX and serves to ten consumers with 1,000 units distribution/consumption seems pretty much more efficient than the Company-B that expends 10 units OPEX and serves to ten consumers with 10 units distribution/consumption. It is clear that, although their inputs are same, Company-A achieves a higher output than Company-B does. However, this first view may be misleading due to an extraordinary consumer of the Company-A, for example consuming 989 units. In the real world, this can be a customer that consumes natural gas for power generation. Having this kind of consumer is unavoidable by the distribution company and should not affect the company positively or negatively for the efficiency analysis. Assume that we omit this extraordinary consumer's data from the Company-A accounts and count 8 units OPEX, nine ordinary consumers and 11 unit distribution/consumption for the ordinary consumers. In this situation, which company is the most efficient one? Maybe Company-B is better off, since it has 10 units OPEX, ten ordinary consumers and 10 units distribution/consumption. Company-B expends more OPEX and brings out less consumption; from this point of view Company-B is not relatively efficient. On the other hand it serves one more consumer. What should be the effect of this additional consumer? This basic example also reveals us the necessity of using non-parametric or parametric methods for the comparison. It is not possible to make an easy comparison in a complex situation with lots of companies and variables. Methods such as DEA and SFA make this possible for the studies.

In order to avoid the extraordinary consumers' effect, EMRA applied the household consumption/total consumption ratio as an environmental factor alternatively. This environmental factor is removed, since extraordinary consumers' data is not taken into account in this study. The challenging and arguable side of this preference is the difficulties of the allocation procedure. It is easy to remove the extraordinary consumers' data from the number of consumers and total consumption since these data are straightforward for each consumer. On the other hand, allocation assumptions should be used to purify some of the variables such as OPEX.

Consequently, the selected variables for the efficiency analysis (both for SFA and DEA) are listed below:

- Input; OPEX of the ordinary consumers (TL)
- Outputs; total consumption of the ordinary consumers (m^3), number of ordinary consumers, total length of network (km)
- Environmental factor (as an output); climate (1/Heating Degree Day)

Consumption and the number of consumers are the factors that are used commonly since they highly impact the OPEX. Total length of network is used as an output factor since it affects the maintenance and repair costs a lot. This factor also represents the area of the distribution region. The environmental factor, climate, is accounted for by using the Heating Degree Day (HDD) data of the year 2011 obtained from BOTAŞ. The HDD is a measurement designed to reflect the demand of energy that is needed to heat the spaces. It is counted that there is no need to heat the space, if the average temperature of the day is above 18 °C. For that day the HDD is zero. If the average temperature of the day is less than 18 °C, the HDD of that day equals to the subtraction of the average temperature of the day from 18 °C, i.e. if temperature of the day is 15 °C, the HDD of that day equals to 3. The yearly HDD index is the sum of the all days' HDD's in a year. That's why; a high HDD value means a harsh climate, on the other hand a low HDD value means mild climate. The fraction 1/HDD is used as an environmental output factor to eliminate the disadvantage of the distribution companies that are operating in the regions with a mild climate.

It is known that as the number of variables increases, the efficiency scores tend to increase in DEA models. A rule of thumb is that the sample size should be greater than or equal to three times the sum of the number of inputs and outputs (Pahwa et al. 2003). Therefore, the sample size is appropriate since it is five times the sum of the number of inputs and outputs in this study. The descriptive statistics of the variables are summarized in Table 9.2. The HDD values of the year 2011 are also used for the other years' analyses. Previous data is not recorded by BOTAŞ but it is not a big concern since the climate is not changing a lot in a distribution area during the 3 years period.

9.3.2 Service Quality

As stated above, the EMRA requests detailed service quality data of the distribution companies every year. Although most of them; such as payment points, cash desks, emergency staff, emergency vehicles, call center staff, are inspected by supervisions occasionally, reliability is still the biggest headache of the authority. This especially goes for some of the quality data; such as number of complaints, complaint results, number of outages, duration of outages, and call waiting. It is possible to check the outages by installing new equipment to the metering or to check call waiting by the integration of telecom technology. On the other hand, as indicated above, one of the critical points of effective regulation is minimizing regulation costs.

The yearly service quality data (see Table 9.3a) is requested in 15 subsections by the EMRA. In order to equalize the distribution companies, some normalization factors (see Table 9.3b) are used to obtain service quality ratios (see Table 9.3c). For instance, it is unfair to make a comparison between two companies by looking only the total number of complaints. Likely, the bigger company has more complaints than the smaller one. That's why the data has to be normalized by dividing by the total number of consumers. This percentage is meaningful to make a comparison between the companies and definitely, the company that has a smaller percentage is better off on the basis of the number of complaints. On the other hand, some of the data do not require any normalization for the comparison, such as average time of the complaint solution or waiting times on calls.

Table 9.2 The descriptive statistics of the variables

			Input			Output-1	Output-2	Output-3		Output-4 (environmental factor)
		Total OPEX (Turkish Lira, 2011 value)	OPEX of the ordinary consumers (Turkish Lira, 2011 value)	Total consumption (m^3)	Consumption of the extraordinary consumers (m^3)	Consumption of the ordinary consumers (m^3)	Number of ordinary consumers	Total length of network (km)	HDD	1/HDD
2009	Sum	80,504,690	70,421,939	6,324,652,229	4,228,011,800	2,096,640,430	1,445,850	14,736,268	–	–
	Average	3,220,188	2,816,878	252,986,089	169,120,472	83,865,617	57,834	589,451	2,188	0.000497
	Standard deviation	2,481,498	1,902,868	400,078,612	374,044,139	54,203,096	52,297	388,905	665	0.000156
	Minimum	862,668	803,017	23,587,158	–	18,949,839	13,304	144,223	984	0.000228
	Maximum	9,941,683	7,531,100	2,019,739,639	1,813,818,267	205,921,372	248,749	1,753,502	4,380	0.001017
2010	Sum	84,739,281	73,762,634	7,182,244,439	4,870,450,517	2,311,793,923	1,766,360	17,245,677	–	–
	Average	3,389,571	2,950,505	287,289,778	194,818,021	92,471,757	70,654	689,827	2,188	0.000497
	Standard deviation	2,416,175	1,897,512	474,368,474	431,376,992	65,179,622	61,820	455,637	665	0.000156
	Minimum	450,971	393,495	22,300,861	–	22,300,861	15,424	153,808	984	0.000228
	Maximum	11,200,688	9,352,082	2,405,030,523	2,109,728,058	295,302,465	280,558	1,891,897	4,380	0.001017
2011	Sum	87,062,737	75,265,381	9,367,275,296	6,427,142,370	2,940,132,926	2,170,205	19,788,329	–	–
	Average	3,482,509	3,010,615	374,691,012	257,085,695	117,605,317	86,808	791,533	2,188	0.000497
	Standard deviation	2,420,621	1,959,733	533,034,773	501,144,111	72,887,400	77,040	560,131	665	0.000156
	Minimum	507,533	380,381	51,722,124	–	20,107,962	18,376	158,774	984	0.000228
	Maximum	9,999,558	8,606,283	2,748,607,407	2,497,995,488	258,540,775	312,992	2,566,123	4,380	0.001017
Average of 2009–2011	Sum	84,102,236	73,149,985	7,624,723,988	5,175,201,562	2,449,522,426	1,794,138	17,256,758	–	–
	Average	3,364,089	2,925,999	304,988,960	207,008,062	97,980,897	71,766	690,270	2,188	0.000497
	Standard deviation	2,365,844	1,851,489	467,698,879	433,421,293	62,268,836	63,162	464,470	665	0.000156
	Minimum	657,402	525,631	33,825,486	–	24,332,539	15,701	153,199	984	0.000228
	Maximum	10,037,555	8,460,946	2,391,125,856	2,140,513,938	250,611,919	280,766	1,977,686	4,380	0.001017

Table 9.3 Service quality data, normalization factors, and ratios

Subsections of the service quality data	(a) Service quality data	(b) Normalization factors	(c) Service quality ratios
(I) Connection	Number of accepted connection requests	–	Refusal/acceptance ratio
	Number of rejected connection requests		
(II) Metering	Number of meters that does not record	Total number of meters	(Number of not record + inaccurate meters)/total number of meters
	Number of inaccurate metering		
(III) Complaint reasons	Number of complaints about metering	Total number of consumers	Total number of complaints/ total number of consumers
	Number of complaints about the pressure level		
	Number of complaints about the outage		
	Number of complaints about service companies		
	Number of other complaints		
(IV) Complaint results	Average time of the complaint solution (hours)	–	Average time of the complaint solution (hours)
(V) Bill objections	Number of total bill objections	–	Accepted bill objections / total bill objections
	Number of accepted bill objections		
(VI) Payment points	Number of payment points	Total length of network (meters)	Total length of network/ payment points
(VII) Cash desks	Number of cash desks	Total number of bills	Total number of bills/ number of cash desks
(VIII) Emergency calls	Number of telephone lines for the emergency calls	Total number of consumers	Total number of consumers/ number of telephone lines for the emergency calls
(IX) Emergency staff	Number of emergency staff	Total number of consumers	Total number of consumers/ number of emergency staff
(X) Emergency vehicles	Number of emergency vehicles	Total length of network (meters)	Total length of network/ number of emergency vehicles
(XI) Emergency intervention	Average duration of the emergency intervention (minutes)	–	Average duration of the emergency intervention (minutes)

(continued)

Table 9.3 (continued)

Subsections of the service quality data	(a) Service quality data	(b) Normalization factors	(c) Service quality ratios
(XII) Number of outages	Number of outages due to maintenance	Total number of consumers	Total number of outages/ total number of consumers
	Number of outages due to emergency		
(XIII) Duration of outages	Duration of outages due to maintenance (minutes)	Total number of consumers	Total duration of outages/ total number of consumers
	Duration of outages due to emergency (minutes)		
(XIV) Call center staff	Number of telephone operators	Total number of consumers	Total number of consumers/ number of telephone operators
(XV) Call waiting	Average waiting time on call (seconds)	–	Average waiting time on call (seconds)

The descriptive statistics of the service quality ratios are summarized in Table 9.4. A smaller ratio or number indicates better quality in this table. It is seen that, in the course of time, service quality improvements are achieved in some factors such as; connection, metering and outages. The main common property of these factors is the high dependency on technological progress. That is why this achievement is arguable and should not be presented primarily as a success of the distribution companies, a liberalization process or an effective regulation. In fact, service quality has been decreased regularly from 2009 to 2011 in some factors that highly depend on the efforts of the companies such as; average time of the complaint solution, payment opportunities, number of emergency lines, staff, vehicles and number of call center operators. Main factors and grades are used to score the service quality and the methodology of scoring will be explained in Sect. 9.4.2 in detail.

Table 9.4 The descriptive statistics of the service quality ratios

	2009			2010			2011			2009–2011			
Six main factors	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Grade
Connection and metering													
Refusal/acceptance ratio	1.99 %	0.02 %	9.66 %	1.62 %	0.04 %	34.09 %	0.83 %	0.01 %	40.91 %	1.16 %	0.01 %	40.91 %	5
(Number of not record + inaccurate meters)/total number of meters	0.24 %	0.01 %	2.70 %	0.19 %	0.04 %	1.79 %	0.11 %	0.03 %	0.67 %	0.17 %	0.01 %	2.70 %	5
Complaints and objections													
Total number of complaints/total number of consumers	1.94 %	0.07 %	11.76 %	1.72 %	0.01 %	12.87 %	1.68 %	0.06 %	13.95 %	1.76 %	0.01 %	13.95 %	3.33
Average time of the complaint solution (hours)	24	1	78	25	1	70	28	1	193	29	1	193	3.33
Accepted bill objections/total bill objections	51.17 %	0.00 %	100.00 %	46.59 %	0.00 %	100.00 %	51.78 %	0.00 %	100.00 %	49.86 %	0.00 %	100.00 %	3.33
Payment													
Total length of network/payment points	297,056	144,223	738,543	320,582	153,808	878,153	347,399	156,801	1,013,626	322,907	144,223	1,013,626	5
Total number of bills/number of cash desks	46,845	4,288	139,294	54,148	4,636	142,195	64,012	6,830	174,179	55,689	4,288	174,179	5
Emergency													
Total number of consumers/number of telephone lines for the emergency calls	14,754	2,540	95,026	17,241	3,508	123,807	20,867	3,874	148,360	17,679	2,540	148,360	2.5

(continued)

Table 9.4 (continued)

	2009			2010			2011			2009–2011			
Six main factors	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Grade
Total number of consumers/ number of emergency staff	5,127	1,355	17,768	5,698	2,148	20,040	5,696	2,312	15,650	5,532	1,355	20,040	2.5
Total length of network/number of emergency vehicles	192,213	73,507	584,501	207,105	66,873	613,939	206,015	79,387	494,939	202,259	66,873	613,939	2.5
Average duration of the emergency intervention (minutes)	12	5	17	12	6	18	12	6	16	12	5	18	2.5
Outages													
Total number of outages/total number of consumers	0.14 %	0.00 %	0.62 %	0.12 %	0.01 %	0.48 %	0.08 %	0.00 %	0.38 %	0.10 %	0.00 %	0.62 %	5
Total duration of outages/total number of consumers	0.03516	0.00122	0.15011	0.03221	0.00156	0.10991	0.02930	0.00032	0.16533	0.03162	0.00032	0.16533	5
Call center													
Total number of consumers/ number of telephone operators	27,440	7,993	82,916	27,960	9,577	93,519	30,187	11,559	104,331	28,688	7,993	104,331	5
Average waiting time on call (seconds)	43	15	80	50	15	100	47	15	100	47	15	100	5

9.4 Methodology

9.4.1 Efficiency

Generally, econometric or mathematical programming are using for the efficiency analyses. The parametric methods (the most common one is SFA) are based on econometrics. On the other hand the non-parametric methods are based on mathematical programming.

The stochastic frontier production function was independently proposed at the same period by various researchers (such as, Aigner et al. 1977; Meeusen and Van Den Broeck 1977). The original specification involved a production function specified for cross-sectional data which had an error term that had two components, one to account for random effects and another to account for technical inefficiency. The stochastic frontier production function was proposed by Battese and Coelli (1992) for panel data which has firm effects that are assumed to be distributed as truncated normal random variables. The variables are also permitted to vary systematically with time. After 3 years, the same researchers proposed a model (Battese and Coelli 1995) with the exceptions that allocative efficiency is imposed, the first-order profit maximizing conditions are removed, and panel data is permitted. The computer program FRONT calculates predictions of individual firm technical efficiencies from estimated stochastic production frontiers, and predictions of individual firm cost efficiencies from estimated stochastic cost frontiers (Coelli 1996).

On the other hand, the popular non-parametric model, DEA, produces efficiency scores by comparing the performance of the relevant company with the performance of another company. Two types of efficiency scores, named as technical and scale are taken into consideration commonly. CRS model find TE scores ("crste") under the assumption that all firms are operating at the optimal scale. This model may underestimate the company's pure efficiency by benchmarking it against dissimilar and, presumably, more scale-efficient comparators. To eliminate this shortcoming, restrictions on returns to scale are released. Therefore, we use the VRS model to find the TE scores. ("vrste") while comparing the firms with similar firms. In addition, Scale Efficiency (SE) scores are calculated by crste and vrste scores, with the following formula:

$$\text{scale efficiency} = \text{crste}/\text{vrste} \tag{9.1}$$

In this study, efficiency scores of the companies are calculated by using SFA with the assumptions of the Battese and Coelli (1992). The FRONT programme is used for the SFA tests. Besides this, crste and vrste scores are calculated by using DEA. The DEAP programme is used for the DEA models.

9.4.2 Service Quality

As seen in Table 9.4, service quality ratios are clustered into six main factors, connection and metering, complaints and objections, payment, emergency, outages and call center. Each factor is counted with same importance and ten points are divided equally to the number of the service quality ratios in the factor. Distribution companies are scored according to the comparison of their ratios. Table 9.5 shows the details of the scoring, as an example of the year 2011. The right and left side of the "average ratios" are divided into five parts and company scores are determined by using the segments. As an example, if the average waiting time on call is 20 s for Company-A in 2011, 5.00 points is given to the Company-A since the score is between 15.00 and 21.40. When the average waiting time on call is 47 s (equal to the average time of the all companies), or when there is no data for this factor, Company-A gets 2.50 points. Company-A total points are calculated by adding all the points given to it. The 25 companies are ranked based on their total points. The company that has the most points gets a 100 % service quality score and the company that has the least points gets a 0 % service quality score. The other companies get a service quality score between 0 and 100 based on their total points.

9.5 Findings

As referred to in Sect. 9.3.2 briefly, service quality factors which depend on technology get better each year with a parallel to the technological developments. These kinds of improvements generally mislead the public while they are trying to find the answers of the some key questions such as; does the liberalization process brings better service quality? Is a private company more successful than a state-owned company? Comparing the effort of the state-owned company that is operating before liberalization with the private company that is operating with today's technological opportunities is unfair. Moreover, in this study it is seen that service quality has been decreased regularly year by year in some quality factors that highly depend on the efforts of the companies such as; average time of the complaint solution, payment opportunities, number of emergency lines, staff, vehicles and number of call center operators. Definitely, one of the main reasons for this worsening is the financial viability of the distribution companies. As mentioned in Sect. 9.2, the ambition of the firms during the distribution tenders made the distribution fees lower than the marginal costs during the constant tariff period that is the first 8 years of the new companies. Due to the financial viability, companies not only tried to improve their efficiencies by cutting their costs, but also downgraded quality of some services. Judging the effort of the private companies under this specific condition is unfair. The effectiveness of the service quality regulation should be examined, instead of making an early comment on the comparison of private companies and state-owned companies.

To continue with a relationship between efficiency and service quality, Table 9.6 shows the quality, crste efficiency, vstre efficiency and SFA efficiency scores of the

Table 9.5 Scoring methodology, as an example of the year 2011

	Ave.	Min.	Max.	Grade	Max. points					Ave. points					Min. points
Connection and metering					5.00	4.50	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00
Refusal/ acceptance ratio	0.83 %	0.01 %	40.91 %	5	0.01 %	0.17 %	0.34 %	0.50 %	0.66 %	0.83 %	8.85 %	16.86 %	24.88 %	32.89 %	40.91 %
(Number of not record + inaccurate meters)/total number of meters	0.11 %	0.03 %	0.67 %	5	0.03 %	0.05 %	0.06 %	0.08 %	0.09 %	0.11 %	0.22 %	0.33 %	0.45 %	0.56 %	0.67 %
Complaints and objections					3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0.33	0.00
Total number of complaints/total number of consumers	1.68 %	0.06 %	13.95 %	3.33	0.06 %	0.39 %	0.71 %	1.03 %	1.36 %	1.68 %	4.14 %	6.59 %	9.05 %	11.50 %	13.95 %
Average time of the complaint solution (hours)	28	1	193	3.33	0.50	6.01	11.51	17.02	22.52	28.03	61.02	94.02	127.01	160.01	193.00
Accepted bill objections/total bill objections	51.78 %	0.00 %	100.00 %	3.33	0.00 %	10.36 %	20.71 %	31.07 %	41.43 %	51.78 %	61.43 %	71.07 %	80.71 %	90.36 %	100.00 %
Payment					5.00	4.50	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00
Total length of network/ payment points	347,399	156,801	1,013,626	5	156,801	194,921	233,040	271,160	309,279	347,399	480,644	613,890	747,135	880,381	1,013,626
Total number of bills/number of cash desks	64,012	6,830	174,179	5	6,830	18,266	29,703	41,139	52,575	64,012	86,045	108,078	130,112	152,145	174,179
Emergency					2.50	2.25	2.00	1.75	1.50	1.25	1.00	0.75	0.50	0.25	0.00
Total number of consumers/ number of telephone lines for the emergency calls	20,867	3,874	148,360	2.5	3,874	7,273	10,672	14,070	17,469	20,867	46,366	71,864	97,363	122,861	148,360

(continued)

Table 9.5 (continued)

	Ave.	Min.	Max.	Grade	Max. points					Ave. points					Min. points
Total number of consumers/ number of emergency staff	5,696	2,312	15,650	2.5	2,312	2,989	3,666	4,342	5,019	5,696	7,687	9,677	11,668	13,659	15,650
Total length of network/number of emergency vehicles	206,015	79,387	494,939	2.5	79,387	104,713	130,038	155,364	180,690	206,015	263,800	321,585	379,370	437,154	494,939
Average duration of the emergency intervention (minutes)	12	6	16	2.5	6.00	7.13	8.25	9.38	10.50	11.63	12.44	13.26	14.07	14.89	15.70
Outages					5.00	4.50	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00
Total number of outages/total number of consumers	0.08 %	0.00 %	0.38 %	5	0.00 %	0.02 %	0.03 %	0.05 %	0.06 %	0.08 %	0.14 %	0.20 %	0.26 %	0.32 %	0.38 %
Total duration of outages/total number of consumers	0.02930	0.00032	0.16533	5	0.00032	0.00612	0.01191	0.01771	0.02350	0.02930	0.05650	0.08371	0.11092	0.13813	0.16533
Call center					5.00	4.50	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00
Total number of consumers/ number of telephone operators	30,187	11,559	104,331	5	11,559	15,285	19,010	22,736	26,461	30,187	45,016	59,844	74,673	89,502	104,331
Average waiting time on call (seconds)	47	15	100	5	15.00	21.40	27.80	34.20	40.60	47.00	57.60	68.20	78.80	89.40	100.00

year 2011. Since it is the best year in respect to maturity of the companies before the new tariff period starting from the year 2012, the results are evaluated in detail for 2011. Only a summary of the results will be given for the other years. A higher percentage means better efficiency or quality in Table 9.6.

According to the results;

- Company 7 is the leading one and Companies 11, 8, 17 and 2 have high service quality scores. Company 23 is the last one and Companies 24, 15, 10 and 1 have low service quality scores.
- Companies 19 and 23 are the leading ones and Companies 6, 10, 3 have high crste efficiency scores. Company 20 is the last one and Companies 4, 8, 13, 9 and 12 have low crste efficiency scores.
- Companies 2, 5, 10, 19, 23, 24 and 25 are the leading ones based on vrste efficiency scores. Company 4 is the last one and Companies 20, 12, 13, 21 and 11 have low scores vrste efficiency scores.
- Company 6 is the leading one and Companies 19, 22, 21, 1 and 24 have high SFA efficiency scores. Company 8 is the worst one and Companies 2, 4, 11, 13 and 15 have low SFA efficiency scores.

According to Fig. 9.4a, b, not only the crste scores but also the vrste scores support the hypothesis that "*efficient Turkish natural gas distribution companies reduce the service quality whereas inefficient ones increase the service quality*". On the other hand this relationship cannot be seen between the service quality and the SFA efficiency scores (see Fig. 9.4c). Parallel with these figures, correlation between crste efficiency score and quality score is calculated as −29 %, correlation between vrste efficiency score and quality score is calculated as −34 %, correlation between SFA efficiency score and quality score is calculated as 0 %.

Figure 9.5 shows the comparison of efficiency scores. According to Fig. 9.5a, b, the efficiency scores are generally consistent with the different techniques. The consistency is higher between crste and SFA than the vrste and SFA. The correlation between crste efficiency score and SFA efficiency score is calculated as 51 %, the correlation between vrste efficiency score and SFA efficiency score is calculated as 19 %. Table 9.7 shows the all years' results separately and the whole period. Negative correlation is also found in the whole period between the service quality and the SFA efficiency scores and this result also supports the hypothesis of "*efficient Turkish natural gas distribution companies reduce the service quality whereas inefficient ones increase the service quality*".

Finally in order to explore a reward/penalty scheme, efficiency scores are evaluated by using the service quality variable as an output (see Table 9.8). In this case, based on the vrste, five new companies (Company 3, 6, 7, 8, 11) become efficient and the efficiency scores of the companies that have the good quality scores (more than the average is counted as good) tend to increase by adding service quality scores as a variable. On the one hand, it is clearly seen in Fig. 9.6 that the efficiency scores tend to hike due to the increase of the number of variables. Efficiency scores with quality variables may be taken into account by the regulators

Table 9.6 Efficiency and service quality scores of the year 2011

Company ID[a]	Quality score	crste efficiency score	vrste efficiency score	SFA efficiency score
1	21 %	63 %	74 %	73 %
2	75 %	56 %	100 %	54 %
3	59 %	73 %	90 %	66 %
4	50 %	27 %	28 %	54 %
5	38 %	60 %	100 %	64 %
6	67 %	80 %	80 %	97 %
7	100 %	45 %	68 %	65 %
8	88 %	30 %	71 %	50 %
9	68 %	37 %	49 %	63 %
10	5 %	74 %	100 %	58 %
11	93 %	43 %	43 %	55 %
12	67 %	37 %	37 %	63 %
13	34 %	34 %	40 %	56 %
14	56 %	55 %	63 %	67 %
15	3 %	50 %	64 %	56 %
16	57 %	49 %	77 %	58 %
17	77 %	46 %	53 %	67 %
18	63 %	44 %	51 %	68 %
19	61 %	100 %	100 %	92 %
20	48 %	21 %	29 %	59 %
21	34 %	38 %	42 %	78 %
22	47 %	59 %	61 %	83 %
23	0 %	100 %	100 %	59 %
24	2 %	57 %	100 %	72 %
25	14 %	41 %	100 %	63 %
Mean	**0.49**	**0.53**	**0.69**	**0.66**
Standard deviation	**0.29**	**0.20**	**0.25**	**0.12**
Minimum	**0.00**	**0.21**	**0.28**	**0.50**
Maximum	**1.00**	**1.00**	**1.00**	**0.97**

[a]Company ID's are appointed randomly

during the OPEX efficiency analysis. On the other hand, sample size should be balanced with the sum of the number of inputs and outputs in order to avoid misleading efficiency results. Moreover, the costs of quality and the gain of the company from efficiency should be analyzed to suggest a better reward/penalty scheme of the tariff design. Besides that, the regulator should try to find a better solution by using a hybrid system as a regulatory scheme considering the particular conditions of the market.

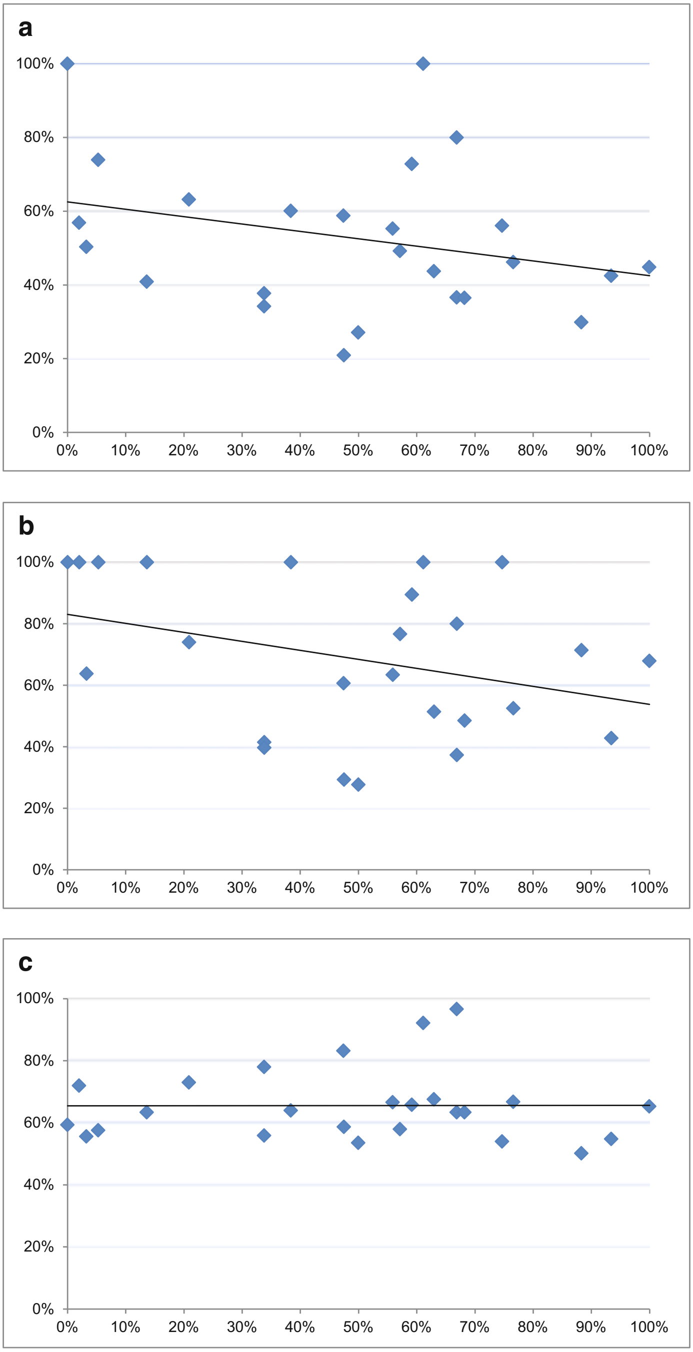

Fig. 9.4 Comparison of efficiency and service quality scores of the year 2011. (**a**) Quality score vs efficiency score (crste)—2011. (**b**) Quality score vs efficiency score (vrste)—2011. (**c**) Quality score vs efficiency score (SFA)—2011

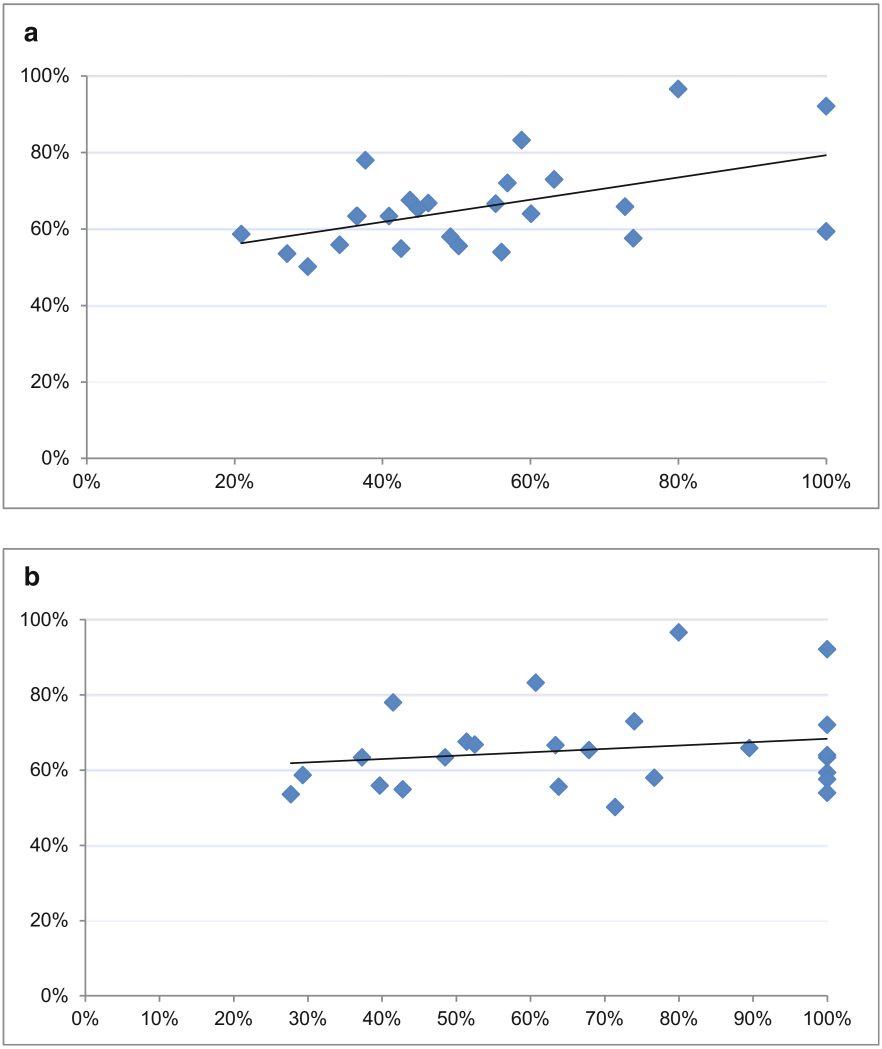

Fig. 9.5 Comparison of efficiency scores of the year 2011. (**a**) Efficiency score (crste) vs efficiency score (SFA)—2011. (**b**) Efficiency score (vrste) vs efficiency score (SFA)—2011

Table 9.7 Correlations of scores

Correlations	2009 (%)	2010 (%)	2011 (%)	2009–2011 (%)
Quality score (%) vs efficiency score (%) crste	−23	−5	−29	NA
Quality score (%) vs efficiency score (%) vrste	−8	−13	−34	NA
Quality score (%) vs efficiency score (%) SFA	−11	5	0	−12
Efficiency score (%) crste vs efficiency score (%) SFA	3	45	51	NA
Efficiency score (%) vrste vs efficiency score (%) SFA	5	10	19	NA

Table 9.8 Efficiency scores with the service quality variable

Company ID	Efficiency scores without quality variable		Service quality scores	Efficiency scores with quality variable	
	crste	vrste		crste	vrste
1	0.63	0.74	0.21	0.63	0.74
2	0.56	1.00	0.75	0.79	1.00
3	0.73	0.90	0.59	0.84	1.00
4	0.27	0.28	0.50	0.41	0.43
5	0.60	1.00	0.38	0.60	1.00
6	0.80	0.80	0.67	0.83	1.00
7	0.45	0.68	1.00	0.70	1.00
8	0.30	0.71	0.88	0.67	1.00
9	0.37	0.49	0.68	0.48	0.71
10	0.74	1.00	0.05	0.74	1.00
11	0.43	0.43	0.93	1.00	1.00
12	0.37	0.37	0.67	0.59	0.62
13	0.34	0.40	0.34	0.47	0.50
14	0.55	0.63	0.56	0.67	0.77
15	0.50	0.64	0.03	0.50	0.64
16	0.49	0.77	0.57	0.73	0.87
17	0.46	0.53	0.77	0.62	0.79
18	0.44	0.51	0.63	0.64	0.68
19	1.00	1.00	0.61	1.00	1.00
20	0.21	0.29	0.48	0.23	0.33
21	0.38	0.42	0.34	0.38	0.42
22	0.59	0.61	0.47	0.62	0.65
23	1.00	1.00	0.00	1.00	1.00
24	0.57	1.00	0.02	0.57	1.00
25	0.41	1.00	0.14	0.41	1.00
Average	**0.53**	**0.67**	**0.51**	**0.65**	**0.80**
Standard deviation	**0.21**	**0.25**	**0.29**	**0.20**	**0.22**
Minimum	**0.21**	**0.28**	**0.00**	**0.23**	**0.33**
Maximum	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

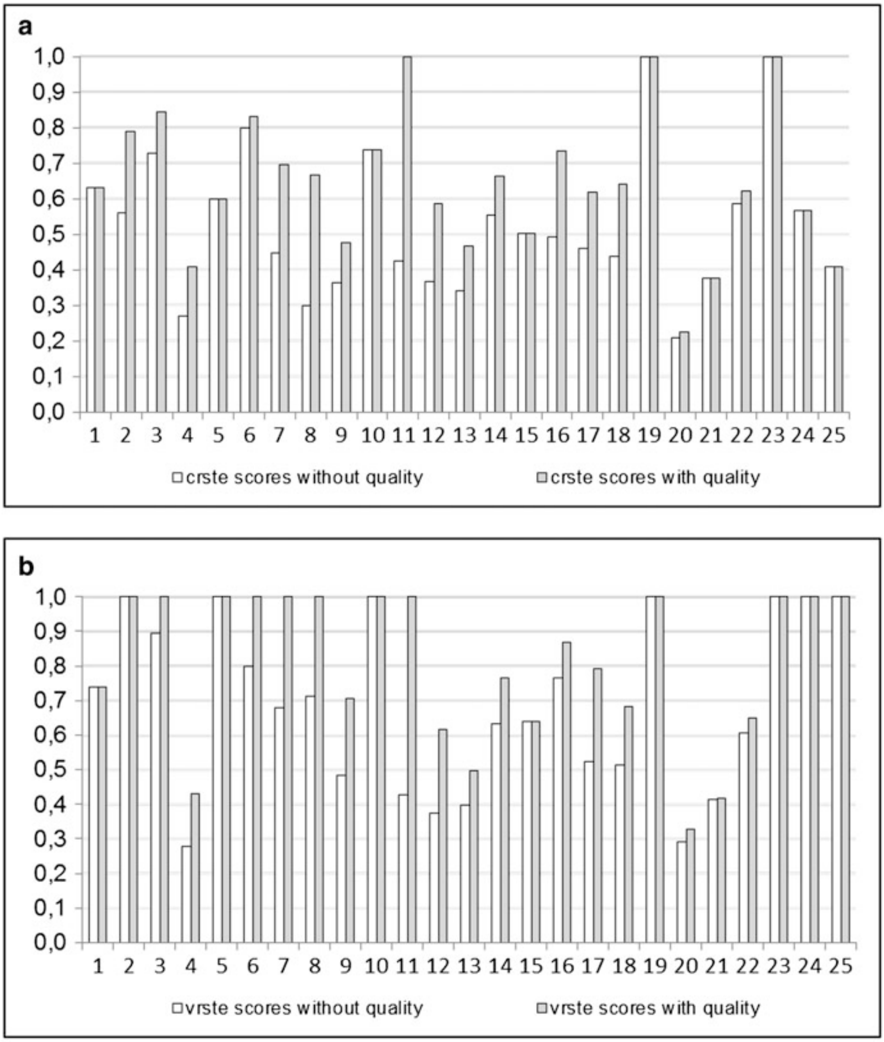

Fig. 9.6 Comparison of efficiency scores with and without the service quality variable. (**a**) vrste scores with and without quality. (**b**) crste scores with and without quality

Conclusion

In parallel with the structural energy market reform in Europe, Turkey has been working on the liberalization of its natural gas market since 2001. Unbundling the market activities and regulating the natural monopoly ones, such as distribution, are the key elements of the process. In this respect, the Turkish regulatory authority, EMRA, determines the tariff of the distribution companies by using a price cap method.

Definitely, efficiency and service quality improvements are the main indicators of the effective regulation which creates the social welfare. Under the price cap regulation, utilities have the opportunity to gain higher profits by cost reductions and efficient management, so this incentive regulation improves efficiency and reduces costs. However, there is not any reward/penalty scheme for the service quality in common usage and the companies are not willing to increase the service quality in this type of regulation. The main advantage is achieving a rapid price drop through an efficiency improvement. This accomplishment is much more important for the developing countries that are also trying to open their state-owned monopoly markets to competition. Generally, the early outcomes are shown as an evidence for success of the liberalization process and presented as an effective regulation to the public. Side effects, such as service quality, and the late consequences of the tariff design are ignored by the regulators.

Costs reductions and service quality improvements are the most important indicators of the effectiveness of the distribution companies and the regulatory body. However, studies on the relationship between the efficiency and the service quality are too limited in the literature. In this study, which is the first effort on the Turkish natural gas distribution companies, we analyzed the efficiency and the service quality performances of the 25 private distribution companies. The findings should also be of interest to regulators in other developing countries which are also at the early stage of their natural gas market regulation. The companies' efficiency scores are evaluated both by non-parametric and parametric methods, DEA and SFA respectively. The same distribution companies are ranked by the service quality scores that are obtained from the service quality data.

The private companies are to operate in a determined distribution region by competitive auctions after the market law enacted. Due to the aggressive attitude of the firms during the auctions, tenders were concluded with greatest reductions in the distribution fees, even lower than the marginal costs, for the constant tariff period of the first 8 years. Literally, this affected the financial viability of the distribution companies and created potential complications. Since the distribution fees were very low, it is expected to see efficiency improvements over time. However, the effect of the reduction should be analyzed carefully in order to make a comment on the effectiveness of the regulation and the liberalization process.

According to the results, service quality factors which depend on technology get better each year with parallel to the technological developments. These kinds of improvements generally mislead the public. Comparing the effort of the state-owned company that is operating before the liberalization progress with the private company that is operating with today's technological opportunities is unfair. Moreover, in this study it is seen that service quality has been decreased regularly year by year in some quality factors that highly depend on the efforts of the companies. Due to the financial viability, companies not only tried to improve their efficiencies by cutting their costs but also downgraded quality of some services. Having said this, judging the effort of the private companies under this specific condition is also unfair. The effectiveness of the service quality regulation should be examined instead of making an early comment on the comparison of private companies and state-owned companies.

The results also show that efficient Turkish natural gas distribution companies reduce—whereas inefficient ones increase—the service quality. These results reveal that a reward/penalty scheme is vital for an effective regulation. Considering the service quality scores for the efficiency analysis is an alternative for the reward/penalty scheme. The costs of quality and the gain of the company from the efficiency should be analyzed to suggest a better reward/penalty scheme of the tariff design. Besides that, the regulator should try to find a better solution by using a hybrid system as a regulatory scheme, considering the particular conditions of the market. Additionally, we should always keep in our minds that, more quality means more cost. Nevertheless consumers' preferences have to be in the account book, since they pay these costs.

In further studies, effectiveness of the companies may be measured with more data and variables. 2012–2016 is a special time period for the Turkey case, since tariffs are determined by EMRA for the first new companies whereas the last ones continue to apply the lower tariffs that were determined through the bidding procedure during this transition time period. Definitely, the data of the transition time period is valuable for a possible future study that searches the effect of the tariff improvement on the efficiency and/or service quality. Data analysis of the distribution companies that operate in other countries may also be an important step for a comprehensive analysis.

References

Aigner DJ, Lovell CAK, Schmidt P (1977) Formulation and estimation of stochastic frontier production function models. J Econ 6:21–37

Ajodhia V, Hakvoort R (2005) Economic regulation of quality in electricity distribution networks. Util Policy 13:211–221

Bağdadioğlu N, Waddam Price CM, Weyman-Jones TG (1996) Efficiency and ownership in electricity distribution: a non-parametric model of the Turkish experience. Energy Econ 18:1–23

Bağdadioğlu N, Waddam Price CM, Weyman-Jones TG (2007) Measuring potential gains from mergers among electricity distribution companies in Turkey using a non-parametric model. Energy J 28:83–110

Battese GE, Coelli TJ (1992) Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India. J Prod Anal 3:153–169

Battese GE, Coelli TJ (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data. Empir Econ 20:325–332

Baumol WJ (1977) On the proper cost tests for natural monopoly in a multiproduct industry. Am Econ Rev 67:809–822

Bernard JT, Bolduc D, Hardy A (1998) The marginal cost of natural gas distribution pipelines: the case of Societé en Commandite Gaz Métropolitain, Quebec. Dissertation, Université Laval

Brown RE, Burke J (2000) Managing the risk of performance based rates. IEEE Trans Power Syst 15:893–898

Carrington R, Coelli T, Groom E (2002) International benchmarking for monopoly price regulation: the case of Australian gas distribution. J Regul Econ 21:191–216
Coelli TJ (1996) A guide to FRONTIER Version 4.1: a computer program for stochastic frontier production and cost function estimation. Mimeo, Department of Econometrics, University of New England, Armidale, pp 1–33
Erbertta F, Rappuoli L (2008) Optimal scale in the Italian gas distribution industry using data envelopment analysis. J Omega 36:325–336
Ertürk M, Türüt-Aşık S (2011) Efficiency analysis of Turkish natural gas distribution companies by using data envelopment analysis method. Energy Policy 39:1426–1438
Fabbri P, Fraquelli G, Giandrone R (2000) Costs, technology and ownership of gas distribution in Italy. Manag Decis Econ 21:71–81
Farsi M, Filippini M, Greene W (2006) Application of panel data models in benchmarking analysis of the electricity distribution sector. Ann Public Coop Econ 77:271–290. doi:10.1111/j.1467-8292.2006.00306.x
Fumagalli E, Black JW, Vogelsang I, Ilic M (2004) Quality of service provision in electric power distribution systems through reliability insurance. IEEE Trans Power Syst 19:1286–1293. doi:10.1109/TPWRS.2004.831294
Gomez T, Rivier J (2000) Distribution and power quality regulation under electricity competition. A comparative study. IEEE, Orlando, pp 462–468. doi:0-7803-6499-6/00/S10.00
Granderson G (2000) Regulation, open-access transportation and productive efficiency. Rev Ind Organ 16:251–266
Granderson G, Linvill C (1999) Parametric and nonparametric approaches to benchmarking the regulated firm. J Prod Anal 12:211–231
Hollas DR, Stansell SR (1988) Regulation, interfirm rivalry and the economic efficiency of natural gas distribution facilities. Q Rev Econ Bus 28:21–37
Hollas DR, Macleod KR, Stansell SR (2002) A data envelopment analysis of gas utilities' efficiency. J Econ Finance 26:123–137
Jamison MA (2007) Regulation: price cap and revenue cap. Enc Energy Eng Technol 3:1245–1251
Kim TY, Lee JD (1996) Cost analysis of gas distribution industry with spatial variables. J Energy Dev 20:247–267
Kiss A, Lesi M, Sugar A, Szolnoki P (2006) Price regulation and tariffs. Energy Regulators Regional Association, Budapest
Meeusen W, Van Den Broeck J (1977) Efficiency estimation from Cobb-Douglas production functions with composed error. Int Econ Rev 18:435–444
Mohammadnezhad-Shourkaei H, Fotuhi-Firuzabad M (2010) Impact of penalty-reward mechanism on the performance of electric distribution systems and regulator budget. IET Gener Transm Distrib 4:770–779
Pahwa A, Feng X, Lubkemann D (2003) Performance evaluation of electric distribution utilities based on data envelopment analysis. IEEE Trans Power Syst 18:400–405
Rossi M (2001) Technical change and efficiency measures: the post-privatization in the gas distribution sector in Argentina. Energy Econ 23:295–304
Sheshinski E (1976) Price, quality and quantity regulation in monopoly situations. Economica 43:127–137
Simab M, Haghifam MR (2012) Quality performance based regulation through designing reward and penalty scheme for electric distribution companies. Int J Electr Power Energy Syst 43:539–545
Simab M, Alvehag K, Soder L, Haghifam MR (2012) Designing reward and penalty scheme in performance-based regulation for electric distribution companies. IET Gener Transm Distrib 6:893–901
Spence AM (1975) Monopoly, quality and regulation. Bell J Econ 16:417–429
Tanure JEPDS, Tahan CMV, Lima JWM (2006) Establishing quality performance of distribution companies based on yardstick regulation. IEEE Trans Power Syst 21:1148–1153

Xu N, Wen F, Huang M, Dong Z (2007) Optimal parameter setting of performance based regulation with reward and penalty. In: 2007 I.E. congress on evolutionary computation, pp 2740–2744

Yardımcı O (2010). Petrol fiyatlarının doğal gaz fiyatları üzerindeki etkisi ve Türkiye için öneriler (The effect of oil prices on natural gas prices and suggestions for Turkey). Dissertation, Energy Market Regulatory Authority

10 Deregulation in Electricity Markets: The Interplay of Political Stability and Fossil Fuel Prices

John L. Simpson

Abstract

Electricity markets are perceived to be monopolistic or oligopolistic in nature, whether government or private sector owned. Prices, therefore, are subject to government (political) interference and/or monopoly pricing as well as economic factors, such as the supply cost of fossil and other fuels. Greater interest is now being shown by international energy economists, regulators, policy makers and practitioners as to whether or not country electricity markets are becoming more globalised with pricing subject to economic factors, such as global fossil fuel prices. This chapter examines a representative sample of larger OECD country and transitional/developing country electricity markets in a dynamic model. In the long-term in the cointegrated markets, economic and financial forces of energy prices and fossil fuel prices interact with political forces indicating the degree of political stability and level of government interference to produce stability in the electricity markets. No such stability occurs in the long-term for the remainder of the markets where it might be suggested that government interference may yet be distorting the electricity markets concerned thus producing relatively less degrees of electricity market liberalisation. With regard to the short-term dynamics the only countries where the electricity markets are endogenous when all variables interact in each market on a 1 month lag are Hong Kong and Canada. Only in the cases of China, New Zealand and Malaysia are electricity prices significantly exogenous.

Keywords

Domestic • Economic • Electricity • Energy • Government • Interference • Political

J.L. Simpson (✉)
Financial Economics Consultants, Perth, WA, Australia
e-mail: simmojl@iinet.net.au

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_10

10.1 Introduction

The concept of electricity liberalisation or deregulation is based on the premise that, historically, electricity supply has been a natural monopoly and, as such, it has required costly regulation to enforce competition. As noted in Simpson et al. (2012) the British model is the standard in OECD countries. This model began in the late 1980s with the privatisation and de-integration of the electricity industry where a system of competition was established to auction spare capacity through a central system. Anecdotally, such a system benefits large industrial consumers, but the benefits to domestic consumers are questionable when electricity supply through a public monopoly is compared to that through a regulated private monopoly. Whichever the case, monopoly pricing through market power is expected to inflate electricity prices. The evidence shows that despite deregulation attempts in the UK the markets are neither long-term nor short-term efficient. Financial health indicators are endogenous when all variables in the specified model interact ion a 1 month lag.

The motivation for this chapter is to further a model and methodology to test the relative importance of economic and political factors in the electricity pricing in a sample of developed and developing economies. The chapter is an extension of the work based on Simpson (2013) positing that dynamic multivariate time series analysis of various economic and political data can provide a greater understanding of the mechanics of electricity pricing. An indication of the extent of deregulation of such markets can also be provided. That is, if overseas and domestic economic factors dominate electricity pricing for a particular country then that country has succeeded in the partial deregulation of its electricity market because domestic political factors (including government/political interference) are less important. Such economic forces are expected to be driven by prices in global fossil fuel prices with global energy prices still dominated by oil, coal and natural gas prices. If the reverse is true, then there is less deregulation (less liberalisation) with electricity prices being largely driven by government/political interference in either a private or a public monopolistic environment. According to Simpson (2013), an important step is to firstly demonstrate the strong connection between global energy stock markets and fossil fuel prices with oil treated as the dominating fossil fuel energy source. The study in this chapter controls for the influence on electricity prices of domestic and international economic factors (measuring the extent of electricity market deregulation and liberalisation) and domestic political factors (measuring the extent of regulation). A vector error correction model is specified to investigate long-run equilibrium relationships and short-term exogeneity in monthly time series data to demonstrate the feasibility of the methodology as a measure of the degree of market liberalisation.

This is important because the research in this chapter maintains that economic factors that affect electricity prices are incorporated in to energy stock market prices, which are largely driven by fossil fuel prices and these in turn are dominated by oil prices. These relationships are shown in graphical representation in Simpson and Mon Abraham (2013). Simpson and Mon Abraham (2013) tracked the powerful

US energy stock market sector as another example of how energy sectors in domestic stock markets relate strongly to the global energy market as reflected in oil prices. Similar structural breaks in the data are demonstrated showing a coincident gradual buildup in prices, leading to a more rapid build-up prior to the global financial crisis, a rapid fall in prices at the time of the crisis and then a partial recovery to the end of the study period.

This introduction is followed by a section on the data, model and methodology. Then there is a section on preliminary analysis of the data; then a section on results followed by a section on a discussion of those results and finally a section for the conclusion.

10.2 The Data, Model and Methodology

The study from Simpson (2013) specifies a Vector Error Correction Model (VECM) of country electricity markets against country energy stock market sectors and proxies for a country's relative economic and financial strength and political stability. All data are extracted as at the end of each month. The study period to 2011 is deemed in order for the purposes of this book as the global financial recovery continues at a slow pace up to the time of writing in February 2014.

The variables for this study are electricity prices, energy stock market sector price indices and financial, economic and political risk ratings. End of month data for electricity prices are extracted from Bloomberg's and that for energy stock market sectors from DataStream for the period December 1999 to December 2011. Electricity prices in each country reflect the prices paid by domestic users. Energy sector indices represent listed companies in each country in the businesses of production and distribution of energy in the predominant forms of oil, gas and coal. The global prices of fossil fuels are major drivers of energy stock market sectors.

The components of country risk data are used to proxy economic and financial health and political stability and are taken from the International Country Risk Guide (2013). These are end of month data and include economic and financial risk (as a basic indicator of a country's ability to perform its external obligations and thus an indicator of relative economic and financial strength) and political risk (as a basic indicator of a country's willingness to perform its external obligations and thus an indicator of a country's relative political stability and political will). Economic and financial risk ratings are objectively measured based on balance of payments current account and capital account data respectively. Political risk ratings are subjectively quantified based on the surveyed opinions of risk experts. The higher the ratings in each case the lower the risk. In other words the higher the ratings, the stronger the requisite implementation of macro and micro-economic and political reforms necessary for an efficient deregulated market.

Electricity and energy price data are converted to logarithms as a form of data standardisation. Structural break tests provided by Quandt (1988) and Andrews (1993) reveal a break at the beginning of the global financial crisis, but testing the model over two periods in unlagged data does not reveal enough evidence to suggest that the basic conclusions of the study should alter between the period up to the break, after the break and over the full period. The full period is therefore studied without any loss of degrees of freedom and it thus includes the rapid fall in energy prices during the global financial crisis from 2008. The countries selected for investigation are those that have both electricity and energy market sector prices as well as country risk ratings components simultaneously reported over the full period of the study.

The model reported based on Simpson (2013) is as follows:

$$EL_{i_t} = \alpha_{i_t} + \beta_1(EL_{i_{t-n}}) + \beta_2(EM)_{i_t} + \beta_3(EM_{i_{t-n}}) + \beta_4(CR_{i_t}) + \beta_5(CR_{i_{t-n}}) + e_{i_t} \tag{10.1}$$

where:

EL_{i_t} is the electricity price in country i at time t.

EM_{i_t} is the energy sector stock market index in country i at time t. This variable represents global economic factors, such as global fossil fuel prices impacting country energy market prices.

α_{i_t} is the regression intercept reflecting current commencement prices or base electricity market prices and electricity market conditions for country i at time t.

CR_{i_t} and $CR_{i_{t-n}}$ are vectors of country risk ratings in country i at times t and $t - n$, representing separate components of country risk in economic risk, financial risk and political risk.

e_{i_t} is the residual of the regression for country i at time t representing the contribution to the variance of country electricity prices from factors other than risk factors and energy sector prices in country i.

n denotes the optimal lag determined by lag exclusion tests and information criteria.

As noted in Simpson (2013), the vector autoregressive (VAR) model in level series is initially specified and VAR based tests for optimal lags and cointegration are undertaken. If the VAR is stable, and if the optimal lag is determined and cointegration (Johansen 1988) is proven, the VAR is re-specified into a vector error correction model (VECM). The optimal lag in all country models is 1 month as determined from the VAR information criteria. The VECM is re-tested for cointegration and the variables tested for exogeneity. Granger block exogeneity (causality) tests (Granger 1988) are deemed inappropriate with monthly data, where it is felt that the optimal lag in daily data may only be 1 or 2 days in markets that are reasonably information efficient. Daily data is not available for risk ratings so the study becomes one in monthly data for all variables and evidence thus supports a 1 month optimal lag in each case. For evidence of exogeneity the study reverts to the error correction terms (ECTs) of the VECM. The VECM ECTs are examined to assess the speed of each model towards equilibrium and thus the true endogenous variable. The magnitude of the adjusted R square values in the VECM, to the extent that their rankings coincide with the rankings of the magnitude of the significant t statistics for the endogenously treated variables, also confirms endogeneity.

10.3 Preliminary Analysis

Table 10.1 shows the basic descriptive statistics in means and standard deviations of electricity prices in each country in the sample as well as in world emerging and developed economies. Descriptive statistics of the energy stock market sectors are unnecessary as these prices, to the extent that the indices represent oil and gas production, wholesaling and retailing companies, are deemed to reflect the global prices of fossil fuels. Table 10.1 shows that the mean electricity prices for developed economies are substantially higher than those for emerging economies and that the volatility of these prices (total price risk) is greater for developed economies compared to developing economies. In the sample of countries it is clear that the developed economies have higher mean electricity prices reflecting a greater degree of economic development and higher per capita incomes and living standards. All markets except Canada have a high degree of total pricing risk as reflected in the standard deviation of electricity prices.

In the preliminary analysis some of the markets are discussed in terms of their institutional background and these may be read in conjunction with the main results of the study. In the largest OECD country studied, the US, the reliance on fossil

Table 10.1 Descriptive statistics during the sample period

Country	Mean of electricity prices/ mean of composite risk ratings	Standard deviation of electricity prices/ standard deviation of composite risk ratings
Brazil	34.94/68.73	8.56/3.89
Argentina	9.67/68.37	4.39/6.76
Thailand	4.42/71.40	1.79/3.45
China	37.47/76.27	16.15/2.17
Hong Kong	558.13/83.31	187.19/2.15
Canada	535.89/84.47	103.68/1.64
USA	304.70/76.92	64.84/2.76
UK	733.46/80.03	284.13/3.83
New Zealand	1,069.56/79.31	612.24/1.67
Chile	4.11/78.20	1.69/2.74
Philippines	14.11/69.56	9.42/1.49
Emerging economies[a]	186.69	101.41
Developed economies[a]	619.29	177.70

Note: All electricity prices are converted to USD at current exchange rates as at December 2012. The higher the mean risk rating the lower the risk and the greater the levels of economic health, financial health and political stability

[a]These rows reflect only the means and standard deviations of electricity prices

fuels in mainly coal and gas for power generation is well documented. The electricity sector includes a large number and array of stakeholders providing generation, transmission and distribution services to industrial and domestic consumers across the country. The market segments are regulated by different public institutions with some functional overlaps. The US government sets general policy through the Department of Energy, but there are other public institutions that set policy for example in environmental impact and consumer protection. Economic regulation in distribution is a state government responsibility (US Electricity 2013). The US is a very large electricity market and economy and the regulatory environment is favourable with electricity pricing less likely to be interfered with by government. It remains likely that US electricity prices will continue to show a stronger relationship with energy sector prices over the long-term than many other countries. In addition, the regulatory environment has promoted competition and fairer pricing than in many other countries (Simpson et al. 2012). The results of this study, it is posited, show evidence of the degree of market liberalisation, but may also show evidence of market efficiency.

In the smallest OECD country studied, New Zealand, electricity power transmission national grid is owned by the State owned enterprise, Transpower New Zealand Ltd. Seventy percent of energy supply is provided internally by renewables (hydropower, geothermal and wind) and while this makes New Zealand a low carbon dioxide emitter it is not a highly energy efficient country when comparing economic output to consumption (New Zealand Electricity 2013). New Zealand, though a developed country, is a comparatively small electricity market and economy. In terms of the results reported in this paper it is probable that long-term equilibrium relationships may be demonstrated between risk ratings and energy sector prices, but the relationships may be less robust than in the US because of the dominance of internal renewables supplies (less influenced by global supply costs of fossil fuels) and also because of the probable influence of a state owned monopoly on electricity pricing.

Latin American countries are developing economies. The Argentina electricity market is taken an example where the electricity price is expected to possess a lower relationship with the energy sector price because 54 % of energy sources are internally generated in thermal systems and 41 % are also internally supply from hydropower. Whilst the electricity market is one of the most deregulated and competitive in Latin America the government agency, the Energy Secretariat has the power of veto over CAMMESA (the administrator of the wholesale market) and can alter the functioning of the market in electricity generation, transmission and distribution. The Argentina electricity market is small compared to that in the EMU, China, and the United States. In addition the effect of the potential for government interference (through the Energy Secretariat) on electricity demand and pricing is likely to be of greater importance in terms of explanatory power of electricity pricing over all periods of the study. The evidence of this study shows that this market is efficient in the long-term but not in the short-term where economic health is endogenous when all variables in that model interact on a 1 month lag.

An example of China as a large Asian transitional economy is examined. In 1996 China's Electric Power Law was implemented in order to develop the electricity industry and protect consumers and investors. It aimed to regulate the generation, distribution and consumption of electricity. In 2002 the State Power Corporations monopoly was dismantled and 11 smaller corporations were established. The State Power Corporation had previously owned 46 % of electricity generation and 90 % of electricity of supply assets. Ongoing reforms are dealing with the separation of power plants from power supply networks, privatisation of a significant amount of stated owned property, the encouragement of competition and the revamping of pricing mechanisms. In relation to energy supply, 78 % of power is generated from coal fired plants and around 15 % is hydropower. China is a very large electricity market and economy but is still developing in terms of macro and micro economic reforms. It is still likely that there exists, in lagged data, a weaker relationship between electricity and energy sectors. The evidence in this study shows that the Chinese market is efficient in the long-term but not in the short-term where economic health is endogenous when all variables in the model interact on a 1 month lag.

Another Asian developing economy, Malaysia, is also investigated. Due to a strong surge in demand for electricity, the Malaysian government divested Tenaga Nasional (the owner of the national grid) in 1992 and awarded independent power producers (IPPs) licences to build plant and sell electricity to Tenaga for transmission and distribution. The licences were awarded without tender quite possibly to friends of the government and large profits were made at Tenaga's expense. Malaysia's electricity market is also small compared to those in, for example, the EMU, China and the United States. Whilst fossil fuels dominate over renewables (such as hydropower) in energy supply, the relationship between electricity prices and the energy market sector prices is expected to be lower over all periods of the study due to the probability of instances of corruption and government indirect interference in electricity pricing (Simpson et al. 2012). The evidence reported later in this study shows that Malaysian markets are neither long-term nor short-term efficient. Financial health indicators are endogenous when all variables in the model interact on a 1 month lag.

Table 10.1 shows the means and standard deviation of the electricity prices and the composite country risk ratings for each of the countries in the sample. In composite risk ratings the higher the mean score the lower the risk and therefore the greater the levels of economic sand financial health and political stability.

The results in Table 10.1 show that the developed countries have generally lower levels of country risk (That is, composite ratings that reflect higher levels of economic and financial health and greater levels of political stability). It is interesting to note that Chile ranks with developed economies and their levels of country risk are lower than those of the United States. The volatility of these ratings (total country risk) is substantially less than the volatility in electricity markets because the ratings are not reported daily and quite often country risk ratings do not change from 1 month to the next depending upon the degree of economic and financial health as well as on the degree of political stability (and the degree of government interference in markets). In preliminary analysis therefore, according to risk ratings it may be observed that electricity market prices and country economic, financial and political indicators are related and this might reflect a greater degree of liberalisation of developed country electricity markets. However, in preliminary analysis, basic hypothesis testing has not been undertaken as level series in financial economic analysis suffer from non-stationarity and in addition there are invariably problems with serial correlation and heteroscedasticity in the errors of the level series relationships producing spurious regression results. It is clear that the analysis needs to go further to examine these relationships in dynamic models where there is greater reliability in the parameters of the relationships between the variables.

Table 10.2 shows the preliminary analysis of unit root tests. Columns 2–4 show the results of unit root testing where the Phillips–Perron test was used and deemed appropriate in the light of structural breaks in the data. The columns show non-stationary level series and stationary first differenced series as well as stationary error terms of the relationship between the first differenced variables.

These results are important to show that the study is first dealing with integrated non-stationary processes so that testing can then be undertaken for cointegration.

10.4 Results

The results for cointegration and exogeneity testing are displayed in Table 10.3. Columns 2–5 deal with long-term equilibrium relationships. Column 1 refers to the country. Column 2 shows the results of the VAR stability condition tests for unit roots. Column 3 shows the VAR optimal lag based on the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike (AC), Schwartz (SC) and Hannan-Quinn (HQ) information criteria. Column 4 shows the results of the VECM based cointegration tests and the number of cointegrating equations, according to Trace and Maximum Eigenvalue test statistics and reports the assumptions of the model for the electricity prices models (e.g. linear trend with no intercept). Column 5 shows the true endogenous variable in a model where all specified variables interact on the optimal lag of 1 month, as determined by the magnitude of the model's ECT which is reported if the relative t statistic is significant up to the 10 % level. Column 5 also shows the value of the t statistic and the adjusted R square value. The ECT shows the speed of the model towards equilibrium and it assumed that the model with a significant ECT of greatest magnitude indicates the model with the best fit. Column 6 of Table 10.3 deals with short-term dynamics and endogeneity. Column 6 of Table 10.3 therefore confirms true exogeneity of the remaining variables in the model and provides the significant t statistic in order of magnitude. The t statistics of other exogenous variables are not shown if they are not significant up to the 10 % level.

Table 10.2 Unit root tests for variables in the electricity sector regression

(1) Country	(2) Level series Electricity prices/energy prices/economic risk/financial risk/political risk ratings	(3) First differences Electricity prices/energy prices/economic risk/ financial risk/political risk ratings	(4) Level series errors/first difference errors
US	−0.8680/−1.9872/−1.9611/ −3.4228**/−2.6066***	−13.4085*/−14.0531*/ −10,9170*/−13.4901*/ −10.1817*	−2.4208/ −14.0799*
United Kingdom	−1.6819/−1.7931/−1.1494/ −3.5626*/−1.2463	−10.2342*/−11.7988*/ −12.0463*/−12.7013*/ −11.2945*	−3.1882**/ −10.8761*
New Zealand	−1.5430/−1.0465/−1.5992/ −1.2168/−1.6815	−14.6080*/−11.2341*/ −11.9152*/13.4656*/ −11.0352*	−4.2540*/ 15.8022*
Canada	−1.5825/−0.9732/−1.5350/ −3.3874**/−2.5930***	−12.4555*/−11.1717*/ −12.0040*/−10.9507*/ −10.9464*	−4.4017*/ −12.3831*
Argentina	−1.1720/−1.6431./−1.9403/ −1.0626/−2.1912	−10.6962*/−13.4024*/ −11.9900*/−10.7319*/ −10.3913*	−3.0425**/ −10.4717*
(1)	(2)	(3)	(4)
Brazil	−0.9848/−1.3868/−2.2272/ −1.3075/−2.9407***	−11.9355*/−10.1528*/ −11.8128*/−12.0568*/ −10.4354*	−2.9087**/ −11.1788*
Chile	−2.1007/−3.1821**/ −2.4235***/−2.4935***/ −2.3032	−10.3167*/−12.3048*/ −11.9217*/−11.6506*/ −10.6547*	−2.5708***/ −10.9099*
Malaysia	−3.5343*/−1.8177/ −3.4691**/2.5936***/ −2.1180	−12.4423*/−12.1194*/ −11.9546*/−11.8336*/ −9.9805*	−3.6176*/ −12.8633*
Thailand	−2.2981/−2.3244/ −2.8728***/−1.6051/ −1.0018	−11.5357*/−11.1031*/ −13.5672*/−15.0264*/ −12.1274*	−4.1480*/ −16.6929*
Hong Kong	−2.0088/−1.4155/ −2.7470***/−0.9575/ −2.4881	−12.7367*/−14.4561*/ −11.9077*/−11.9489*/ −10.8198*	−4.7513*/ −23.8708*
China	−1.2102/−0.2559/ −2.4200***/−1.6719/ −1.3619	−11.9721*/−11.8605*/ −13.6928*/−12.0401*/ −13.1094*	−4.0236*/ −14.8411*
The Philippines	−1.4489/−0.4620/ −3.2906**/−0.9482/−2.4339	−11.2770*/−12.1369*/ −13.2597*/−12.3693*/ −11.3951*	−1.7499/ −11.4507*

Note: Phillips and Perron (PP) unit root tests are utilised
Critical values for PP tests are at 1 %, −3.4768; at 5 %, −2.8818; at 10 %, −2.5777
*Significance levels are at 1 %; **significance levels are at 5 %; ***significance levels are at 10 %

Table 10.3 Results for models of country electricity pricing

(1) Country	(2) VAR stability condition check	(3) Optimal lag in months from VAR criteria (information criteria used)	(4) Cointegrating equations from VECM tests (tests used/ assumptions)	(5) Unlagged endogenous variable (t statistic/adjusted R square value) These statistics are reported if the ECT is significant at the 10 % level	(6) Lagged exogenous variables (t statistic)
Argentina	Stable	1 (according to LR, FPE, AC, SC, HQ)	1 (according to trace and maximum eigenvalues/data trend linear with intercept**)	Economic risk (−3.0496**/ 0.0390*)	No significant exogeneity A –ve link of electricity and energy with economic risk
Brazil	Stable	1 (according to LR, FPE, AC, SC, HQ)	None (according to trace and maximum eigenvalue statistics)	Economic risk (−3.3705**/ 0.0392*)	No significant exogeneity A −ve link with energy. A +ve link with electricity
Chile	Stable	1 (according to FPE, AC, SC and HQ)	1 (according to trace and maximum eigenvalue statistics/linear assumption with trend)	Energy prices (+3.3046**/ 0.1771*)	Political risk (+4.8394*) A +ve link with electricity market
China	Stable	1 (according to FPE, AC, SC and HQ)	1 (according to trace and maximum eigenvalue statistics/assumptions of no trend and no intercept)	Economic risk (−3.6730**/ 0.0648*)	Electricity market (+1.8528**) and the energy market (−1.3799***)
US	Stable	1 (according to FPE, Ac, SC and HQ)	1 (according to maximum eigenvalue statistic/ assumptions of no intercept and no trend)	Financial risk (+4.7169*/ 0.1453**)	Energy market (+1.6673**) Political risk (−1.6938**)
(1) UK	(2) Stable	(3) 1 (according to FPE, AC, SC, HQ)	(4) None (according to trace and maximum eigenvalue statistics)	(5) Financial risk (+4.3826*/ 0.1001*)	(6) Political risk (+1.5730***) A −ve link with the electricity market
New Zealand	Stable	1 (according to FPE, AC, SC, HQ)	1 (according to trace and maximum eigenvalue statistics/assumptions of a linear relationship with intercept and trend)	Financial risk (−3.3666**/ 0.0574*)	Electricity prices (+2.0196**) A –ve link with energy market

Malaysia	Stable	1 (according to FPE, AC, SC, and HQ)	None (according to trace and maximum eigenvalue statistics)	Financial risk (+3.6896**/ 0.0955*)	Electricity market (+1.5532***) A –ve link with energy prices
The Philippines	Unstable	1(according to FPE, AC, SC and HQ)	1 (according to trace and maximum eigenvalue statistics/assumptions are that relationship is linear with a trend and an intercept)	Financial risk (−3.5959**/ 0.0839*)	Political risk (+1.6120***) Electricity market Energy markets show –ve link
Thailand	Stable	1 (according to LR, FPE, AC, SC and HQ)	1 (according to trace and maximum eigenvalue statistic/ quadratic assumption with intercept and trend)	Political risk (−3.3450**/ 0.0520*)	All other variables not statistically significant at the 10 % level. A +ve link with electricity market and a –ve link with energy sector
Hong Kong	Stable	1 (according to SC and HQ) 2 (according to LR, FPE and AC)	None (according to trace and maximum eigenvalue statistics)	Electricity market (−5.0081*/ 0.1369*)	Lagged electricity market (+2.0324**) Energy market (−1.4581***)
(1) Canada	(2) Stable	(3) 1 (according to FPE, AC, SC and HQ)	(4) 1 (according to trace test statistic only/linear assumption and an intercept with no trend)	(5) Electricity market (−3.0133**/0.0905**)	(6) Political risk (−1.9776***) A +ve link with lagged electricity market and a –ve link with energy market

*Significance levels are at 1 %; **significance levels are at 5 %; ***significance levels are at 10 %

10.5 Discussion of Results

Table 10.2 provides strong evidence that the processes in each country are integrated and non-stationary and this clears the way for testing for cointegration and exogeneity. Table 10.3 shows the results of testing for cointegration and exogeneity. Evidence of cointegration means that the data in each country model have similar stochastic trends and together achieve equilibrium in the longer term. This means that in the long-term the markets are efficient and rational expectations are that the independent variables in the models will consistently either under or over-predict the prices in the electricity markets. This means that these markets provide evidence that they have achieved a degree of deregulation and liberalisation in the longer term. Adjusted R square values and t statistics of the VECM equation will indicate the degree of such liberalisation. Where political factors dominate it is posited that there remains a significant component of government pricing interference despite cointegration. The short-term dynamics of each country model is also examined by analyzing the magnitude of the ECTs and the significance of t statistics in each case. In the short-term it may be that the electricity market is not endogenous and that the markets may demonstrate little efficiency due to changes in government policies that affect pricing.

Table 10.3 Column 2 shows that all VARs except the Philippines are stable according to the VAR stability condition check. Table 10.3 Column 3 shows that the optimal lag according to information criteria is 1 month in each case. Monthly data only were available for this study and realistically, in markets which are at least weak-form efficient the true optimal lag would be in the order of 1–3 days. Table 10.3 Column 4 shows that cointegration exists in each country electricity market except those of Brazil, the UK, Hong Kong and Malaysia.

In the long-term the extent of liberalisation of each market is indicated by whether or not there is evidence of cointegration and if cointegration exists, the magnitude of the ECT will show the relative speed of each model towards stability. This may also be an indication of relative market efficiency. Where the ECT is significant at the 10 % level the adjusted R square values and significant t statistics are reported. The adjusted R square value for cointegrated relationships will indicate the degree of liberalisation of the market. The t statistic indicates each models true endogenous variable when all variables are cointegrated and interact within a single system on a 1 month lag. According to the adjusted R square value of cointegrated relationships for each country it is evident that the countries with the most deregulated markets in the long-term are Chile (17.71 %), the US (14.53 %), Canada (9.05 %), the Philippines (8.39 %), China (6.48 %), New Zealand (5.74 %), Thailand (5.20 %) and Argentina (3.90 %).

With regard to the short-term dynamics the concern is what the short-term forces that bring about the long-term equilibria are for each model. That is, whether or not in each system where all variables interact on a 1 month lag, the electricity market is as specified (that is, endogenous). This is decided by the magnitude of the ECTs and the relevant t statistics for each country model. Only in the cases of Hong Kong and Canada are electricity markets endogenous in the short-term. The relevant and significant t statistics (see Table 10.3) based on the magnitude of the ECTs are −5.0081 and −3.0133 respectively. With respect to the true endogenous variables for the other country models it appears that in Argentina, Brazil and China the endogenous variables are economic in nature reflecting the degree of economic health of these countries where the significant t statistics are −3.0496, −3.3705 and −3.6730 respectively. In Chile energy prices are endogenous with a significant t statistic of 3.3046. In the US, the UK, New Zealand and Malaysia it appears that the endogenous variable is financial in nature with financial risk as an indicator of the financial strength of the country (with significant t statistics of 4.7169, 4.3826, −3.3666 and −3.5959 respectively. In Thailand political risk is the endogenous variable representing the degree of political stability in that country with a significant t statistic of −3.3450.

The study now deals with exogeneity. In Hong Kong the electricity market is mainly influenced by the lagged electricity market and the energy market, which are thus exogenous (t statistics at 2.0324 and −1.4581 respectively). In Canada the electricity market is influenced mainly by political risk (as a measure of political stability) with a t statistic at −1.9776. In Argentina, Brazil and China economic risk (economic health) is partly driven by electricity prices. These are not significant in Argentina and Brazil, but in China the main (significant) exogenous variable is electricity prices with a t statistic of 1.8528. In Chile energy prices are mainly influenced by political stability (t statistic at 4.8394). In the US financial health is driven or influenced mainly by political stability and the energy market (t statistics at −1.6938 and 1.6673 respectively. The electricity market is also exogenous, but is not statistically significant. In the UK financial health is mainly influenced by political stability with a t statistic of 1.5730. Electricity prices are not statistical significant as one of the other exogenous variables. In New Zealand financial health is primarily influenced by electricity prices with a t statistic of 2.0196. This may describe a relationship where a large amount of electricity is not generated from fossil fuels in New Zealand. In Malaysia, financial health is mainly influenced by the electricity market with a t statistic of 1.5532. In Thailand political stability is mainly influenced collectively by the other variables in the model which are not individually significant, but include electricity prices.

Conclusion

In unlagged preliminary analysis of level series data it would appear that developed electricity markets, with low levels of country risk and greater economic and financial health and greater political stability, would have the greater level of liberalisation and perhaps exhibit a greater degree of efficiency. However there are problems with such basic analysis and the analysis needs to go further to examine these relationships in dynamic models.

The study shows differing results for each country electricity market in the short-term and long-term. By the criteria of this study, there appears a greater degree of liberalisation and possibly greater market efficiency in the following markets based on the order of strength of explanatory power and cointegration evidence for Chile, the US, Canada, the Philippines, China, New Zealand, Thailand and Argentina. In the long-term in the cointegrated markets it appears that economic and financial forces of energy prices and fossil fuel prices interact with political forces indicating the degree of political stability and level of government interference to produce stability in the electricity markets. No such stability occurs in the long-term for the remainder of the markets where it might be suggested that government interference may yet be distorting the electricity markets concerned in the longer-term and thus producing relatively less degrees of electricity market liberalisation.

With regard to the short-term dynamics the only countries where the electricity markets are endogenous when all variables interact in each market on a 1 month lag are Hong Kong and Canada. When true endogeneity and exogeneity is examined (using the guide of the magnitude of the ECTs that show the magnitude of significant t statistics) the results show a mixture of endogeneity in economic health (Argentina, Brazil and China), financial health (US, UK, New Zealand and Malaysia), energy prices (Chile) and political stability (Thailand). In each of the markets (except Hong Kong and Canada) electricity prices are exogenous, but only in the cases of China, New Zealand and Malaysia are electricity prices significantly exogenous. It is clear that in the short-term the markets of Hong Kong and Canada may demonstrate a greater degree of deregulation than the other markets due to the fact that true endogeneity lies with the electricity markets in those two cases, because in each of those cases the markets are driven by an interaction of lagged and unlagged economic and financial factors (reflecting fossil fuel prices) as well as lagged electricity prices and lagged and unlagged political factors.

Overall it cannot be said from the foregoing evidence that developed economies exhibit greater efficiency than developing and transitional economies. However, by the criteria of the study, it may be said that the countries studied possess varying degrees of government interference in their markets and thus are at varying degrees of progress in market liberalisation and that this does not seem to be contingent on whether or not the countries are developed or developing economies. A weakness of the study is that a longer time period for study would be useful, but this is more a limitation of the study with many countries only recently reporting electricity market prices. In addition, greater information may be provided with an analysis of the institutional structure of the electricity markets in countries such as Chile, Brazil, Thailand, Hong Kong and Canada. It is beyond the scope of this chapter to individual analyse the market environment for each country electricity market, however, the methodology is promulgated as a valid idea for further research and testing of electricity markets in terms of their degrees of liberalisation and deregulation. However, an alternative methodology would be to examine electricity prices only as a function of country energy stock market prices as they reflect the global prices of fossil fuels in the main. The explanatory power of such models will reflect market factors and thus show the level of market liberalisation directly with the residual of each relationship indicating idiosyncratic factors such as government interference and political stability. As in this chapter the results would then, in any future research, be necessarily compared to the electricity market and institutional environment in each case to be able to then arrive at policy implications and recommendations.

References

Andrews DWK (1993) Tests for parameter instability with unknown change points. Econometrica 61(4):821–856

US Electricity (2013) http://www.eia.gov/electricity

Granger CWJ (1988) Some recent developments in a concept of causality. J Econ 39:199–211

International Country Risk Guide (2013), Political Risk Services Group, Country Risk Ratings, www.icrg.com

Johansen S (1988) Statistical analysis of cointegration vectors. J Econ Dyn Control 12:231–254

New Zealand Electricity (2013) http://www.ea.gov.nz/

Quandt RE (1988) The econometrics of disequilibrium. Blackwell, Oxford

Simpson JL (2013) The dynamic interaction of economic, financial and political indicators, energy stock market sectors and electricity markets. Curtin University Working papers, June 2013, pp 1–14

Simpson JL, Mon Abraham S (2013) Financial, convergence or decoupling in electricity and energy markets? A dynamic study of OECD, Latin American and Asian Countries. Int J Econ Finance 4(12):1–14

Simpson JL, Buyukkara G, Mon Abraham S (2012) A contemporaneous model of electricity market interaction with energy stock market sectors. Electr J 25(6):98–109

Country Versus Global Influences on Future Spot Natural Gas Prices: Evidence of Deregulation from America and Britain

11

John L. Simpson and Abdul Alsameen

Abstract
This chapter revisits the importance of domestic versus global economic factors in explaining future spot gas prices in the domestic natural gas markets of the US and the UK, which arguably are the two leading major Western economies engaged in ongoing market reform. The chapter is based on Simpson (J Energy Markets 3(1), 2011) with a significant rewrite around an update of data, analysis and conclusions. The study, involving a comparison of progress in each economy towards natural gas market liberalization, should be interesting for policy makers globally. Assuming that market liberalization will in due course produce economic welfare benefits, the study posits that the relative importance of these factors is one indicator of the extent of natural gas market deregulation in each market. Updating the Simpson (J Energy Markets 3(1), 2011) study, lagged daily oil and gas data from 3rd January 2000 to 28th July 2014 are analyzed and a proven structural break is introduced to control for time varying relationships as affected by the global financial crisis. Global oil futures prices together with domestic gas futures prices are not shown to be very strong predictors of future domestic spot gas prices, thus indicating some progress in US and UK domestic gas market deregulation. However cointegration and Granger causality studies show that there is some distance to go in market liberalization for both the US and the UK. It is up to further research to explain why this is the case in terms of policy actions taken.

J.L. Simpson (✉)
Financial Economics Consultants, Perth, WA, Australia
e-mail: simmojl@iinet.net.au

A. Alsameen
Curtin University, Perth, WA, Australia
e-mail: a.alsameen@gmail.com

A. Dorsman et al. (eds.), *Energy Technology and Valuation Issues*,
DOI 10.1007/978-3-319-13746-9_11

Keywords
Cointegration • De-coupling • Deregulation • Futures • Gas prices • Oil prices • Vector autoregressive models

11.1 Introduction

Futures and forward markets in any commodity reflect market expectations based on forecasted macro-economic conditions, where global rather than domestic factors will dominate if the market is globally integrated. Oil markets (though in the past they have been distorted by OPEC cartel behavior) are more globally integrated than gas markets as oil remains the most prolific of global energy sources. The gas markets by comparison are smaller (but, growing as a cleaner source of energy becomes increasingly recognized) and appear more influenced by domestic factors (in the absence of a global natural gas price) including seasonality and storage. Any historical nexus between oil and gas prices should be eroded over time as gas markets start to stand alone with "gas on gas" competition.

Simpson (2011) notes that deregulation in the USA began in 1984 with a separation of natural gas supply from interstate pipeline transportation, deregulated natural gas production and the wholesale market, and competition was introduced in interstate pipeline transportation. In the UK in 1986, the British government privatized British Gas and further reforms required the unbundling of supply and transportation and the releasing of some gas supplies to competitors. Institutional and market reforms in the USA and the UK have encouraged "gas on gas" competition. Welfare benefits to consumers are said to emerge with such reform as reflected in a fall in the price of gas.

At the outset, however, it must be said that any high co-movement in gas and oil prices (for example, in Europe generally) is not surprising given that there are many oil market suppliers and few gas market suppliers. In addition, in the US, the large growth of unconventional oil and gas resources will substantially change global markets (even if the increased production is not exported) and there are now differences emerging in, for example, Brent oil price and other global oil price indices. Perhaps changes in the effect of increased US unconventional oil and gas production will be reflected in the extended data period for this study compared to the Simpson (2011) study.

In deregulated gas markets, the Law of One Price should encourage competition. According to theories of market liberalization with application to domestic gas markets, global oil and domestic gas prices should de-couple and evidence of this is emerging in the major energy markets of the US and the UK. Assuming liberalization produces economic benefits, the question is which market has made greater progress in that endeavour. This should be of interest to deregulation policy makers globally, when further questions may be asked as to why one country has made greater progress in market liberalization than others. The following section contains a review of relevant literature. This is followed by a section on the model and data, a section on the data and then a section on the findings followed by a section on a discussion of the findings in relation to the literature and finally there is a section for the conclusion.

11.2 Literature

In the Simpson (2011) study, several authors have been cited in relation to evidence of deregulation and the connection between oil and gas prices. For example (as revisited by Asche 2000), prices of homogenous goods from different producers and suppliers should move together in an integrated market. Price differentials should only indicate differences in transportation costs and quality in that product. This is the case in theory for many commodities. However, in reality there are sound reasons why domestic gas prices in the US differ substantially from those in the UK. These reasons relate to the fact that, more recently, US unconventional gas (shale gas) has substantially increased in production for the domestic market. In addition the US is prevented by law to export that commodity (as well as unconventional oil).

Simpson (2011) also notes the connection between natural gas and oil markets, the degree of integration and the corresponding volatility and similarity of volatility of these markets and cites several authors. For example, Krichene (2002), using a supply and demand model, examines world markets for crude oil and natural gas and finds that both markets became highly volatile following the oil shock of 1973. The elasticity estimates assists in the explanation of the market power of oil producers. Price volatility responding to shocks supports demand price and income elasticities found in energy studies. Ewing et al. (2002) investigates time varying volatility in oil and gas markets across markets and find that common patterns of volatility emerge that might be of interest to financial market participants.

Adelman and Watkins (2005) find a degree of stochastic similarity of movement in oil and gas reserve prices for the period 1982–2003 in the USA using market transaction data. They find that both oil and gas current values rose after 2000 with oil rising sharper than gas in 2003. Serlitis and Rangel-Ruiz (2004) explore common features in North American energy markets in shared trends and cycles between oil and gas markets. The study examines Henry Hub Gas prices and WTI crude oil prices and finds de-coupling of oil and gas prices as a result of deregulation in the USA.

The evidence on market de-coupling is mixed. Silverstovs et al. (2005) investigate the degree of integration of natural gas markets in Europe, North America and Japan in the period early 1990s to 2004 using a principal components and a cointegration approach where oil and gas markets interact. They find high levels of gas market integration within Europe, between Europe and Japan as well as within the North American market.

Mazighi (2005) notes that the UK's National Balancing Point (NBP) gas price is significantly related to oil prices. There is also evidence of a statistically significant relationship between oil and gas prices and industrial stock prices. In testing the long-term behaviour of the UK National Balancing Point (NBP) gas prices he also finds a relationship between the changes in the volume of manufactured production using regression analysis. As oil is used as a source of industrial power it follows that there is a relationship between industrial stock prices as well as alternative energy prices. Mazighi (2005) finds that more than 80 % of gas price changes in the US market were not driven by their fundamental values. In other words other factors such as, oil price changes need to be considered to account for gas price changes. However, Mazighi (2005) suggests that, in the long-term and in accordance with economic theory, the evolution of prices of natural gas and any other homogenous commodity is guided by supply and demand.

Asche (2006) also examines whether or not de-coupling of natural gas prices from prices of other energy commodities (such as oil and electricity) had taken place in the liberalized UK and in the regulated continental gas markets after the Interconnector had integrated these markets after 1998. Asche finds that monthly price data from 1995 to 1998 indicated a highly integrated market where wholesale demand appeared to be for energy generally, rather than specifically for oil or gas.

By 2003 the UK gas market was highly liberalized, according to Panagiotidis and Rutledge (2007), who investigate the relationship between UK wholesale gas prices and Brent oil prices over the period 1996–2003 to test whether or not orthodox liberalization theory applied and whether or not oil and gas prices had de-coupled. Using cointegration techniques and tests of exogeneity of oil prices through impulse response functions, their findings generally do not support the assumption of de-coupling of prices in the relatively highly liberalized UK market. The results may at least indicate that progress in deregulation had been made.

However, studies of the connection between oil and gas markets have suffered because of the modelling of spot prices only, when a growing body of evidence impresses the need to take into account gas price expectations embodied in futures prices and thus prices that include forecasts of global macro-economic indicators as well as country seasonality and storage factors.

One of the early studies to examine the relationship of monthly spot to futures prices for natural gas in the USA was Herbert (1993). According to this study, accurate forecasts of spot gas prices could be obtained by regressing the spot price for a delivery month on the futures contract price for the same month. Whilst the general conclusion is that the gas market was inefficient, it is clear that deregulation in USA gas markets (which commenced in the USA in 1984 with a separation of natural gas supply from interstate pipeline transportation), is having an effect with gas price expectations strongly affecting gas prices.

A later joint study by Herbert and Kreil (1996) finds in USA gas markets, which was addressed in part by the establishment of a second futures market. They note that there is an active unregulated derivatives market in which options and swaps were traded. Herbert and Kreil feel that the market changes enable better responses to changes in market conditions, but that there are still concerns relating to the allocation of pipeline space. Prices for gas and transport are not transparent and some industry practices impede further progress in liberalization. They acknowledge, however that the USA market is large and diverse and that the regulatory authorities are at least trying to craft rules to improve business behaviour and performance.

Root and Lien (2003) use hedge ratios (which determine the effectiveness of a hedge) and examined the relationship between futures and spot prices. Model specification is important and the study investigates the appropriateness of using a threshold cointegrated model of the natural gas markets as the basis for hedging and forecasting. They conclude that whilst the threshold model is appropriate for longer-term futures contract length it does not offer much improvement in hedging or forecasting efficiency. For example, Modjtahedi and Movassagh (2005) find spot and futures gas prices are non-stationary with trends due to positive drifts in the random walk components of the prices. They find that market forecast errors are stationary and that futures prices are less than expected future spot prices (implying futures prices are backward dated). They also find that the bias in futures prices is time varying and that futures have statistically significant market timing ability.

Wong-Parodi et al. (2006) compare the accuracy of forecasts for natural gas prices as reported by the Energy Information Administration's short-term energy outlook and the futures market for the period 1998–2004. They find that on average the Henry Hub is a better predictor of natural gas prices than the short-term energy outlook. Economic modellers are also advised to compare the accuracy of their models to the futures market.

Mu (2007), Marzo and Zagaglia (2008) and Geman and Ohana (2009) examine how weather shocks impact asset price dynamics in the US natural gas futures market revealing a significant weather effect on the conditional mean and volatility of gas futures returns. Marzo and Zagaglia (2008) model the joint movements of daily returns on 1 month futures for crude oil and natural gas using a multivariate GARCH[1] with dynamic conditional correlations and elliptical distributions. They find that the conditional correlation between the futures prices of natural gas and crude oil had risen over the receding 5 years, but the correlation is low on average over most of the sample suggesting that futures markets do not have an established history of pricing natural gas as a function of oil market developments. Geman and Ohana (2009) remind their readers that it is central in the theory of storage, that there is a role for inventory in explaining the shape of the forward curve and spot price volatility in commodity markets. They find that the negative relationship between price volatility and inventory is globally significant for crude oil and the negative correlation applies only during periods of scarcity and increases during winter months for natural gas.

Overall, the forgoing studies are useful in providing information and empirical evidence relating to the changing relationship of oil and gas spot and futures price volatility and the de-coupling progress and integration of gas markets over a period of deregulation particularly in the USA and the UK. However, this chapter does not delve into detailed analysis of specific deregulation policies in each country.

[1] Generalized Autoregressive Conditional Heteroscedasticity model.

11.3 The Model and Method

In the Simpson (2011) study, a comparison of USA and UK gas markets is provided that takes into account the relationship between domestic future spot gas prices and domestic gas futures as well as global oil futures prices, in order to capture the impact of country specific and global influences respectively. Based on evidence of the cited studies of the connection between oil and gas prices and taking into account cited evidence of gas futures price interaction a lagged model is proposed in the Simpson (2011) study. Optimally lagged level series data are examined initially in a vector autoregressive (VAR) model and then in a vector error correction model (VECM) for each of USA and UK markets in order to run tests of long-term equilibrium relationships and to test for short-run dynamics and exogeneity. Based on the above the above-mentioned evidence the following basic model, in its functional form, with the series logarithmically transformed, is proposed for testing.

$$P_{gfs_t} = f\left(P_{gf}, P_{of}\right) \tag{11.1}$$

where P_{gfs}, P_{gf} and P_{of} represent level series prices of future spot gas, gas futures and oil futures at time t.

A dynamic model introduces optimal lags based on information criteria as the main part of the analysis.

11.4 The Data

Simpson (2011) study examined daily price data from 4th February 2003 to 30th November 2009. The study has been updated in this chapter to examine data from 3rd January 2000 to the 28th July 2014 and to include a study of three periods (a period prior to the global financial crisis, a period after that crisis and the full period). The price data are obtained from the DataStream database. The spot gas price in the USA is the Henry Hub (HH) gas price, with a base date of 1/11/1993. The HH is an index in $/MMBTU. The delivery point is a pipeline interchange near Erath, Louisiana, where a number of interstate and intrastate pipelines interconnect through a header system operated by the Sabine Pipe Line. It is also the standard delivery point for the NYMEX natural gas futures contract in the US. It is considered a representative indicator of US gas prices.

The spot gas price in the UK is the National Balancing Point (NBP) gas prices UK or London. The base date is 2/4/2003. The NBP is a virtual trading location for the sale and purchase and exchange of UK natural gas. It is the pricing and delivery point for the Intercontinental Exchange (ICE) natural gas futures contract. It is the most liquid gas trading point in Europe and is a major influence on the price that domestic consumers pay for their gas at home. Gas at the NBP trades in pence per therm. It is similar in concept to the Henry Hub in the United States, but differs in that it is not an actual physical location.[2] The NBP is considered to be a sound proxy for UK gas prices.

To obtain the future spot gas prices, spot gas prices (HH and NBP gas prices) are brought forward by 6 calendar months to coincide with the commencements of the sample period for both gas futures and oil futures. Specifically 6 months of domestic spot gas price data from 3rd January 2000 are deleted thus removing 6 calendar months of data from the domestic spot gas price data sets so that spot gas price data may be brought forward by the above period to coincide with the commencement of the gas futures price data on the 3rd January 2000. The full data set of prices now runs from 3rd January 2000 to 28th July 2014.

The proxy for the UK gas futures price is the ICE London or UK natural gas futures prices for 6 months. It is a Reuter's continuation series, which gives the data for 6 months forward. It has a base date of 31/01/1997. The proxy for the USA gas futures price is the NYMEX natural gas futures prices for 6 months with a base date of 01/03/1995, which is 6 month forward rate. It starts at the sixth nearest contract month, which forms the first values for the continuous series until the first business day of the nearest contract month when, at this point, the next contract month is taken. These gas futures prices are considered representative of UK and US gas futures markets respectively.

The proxy for the global oil futures prices applicable to the USA and the UK are provided in the NYMEX light Sweet Crude Oil futures index and the Brent Crude Oil futures index. The price calculation method for each index is near month change at the beginning of the first of the month. Each is a continuous series and a perpetual series of oil futures prices starting at the nearest contract month until either the contract reaches its expiry date or until the first business day of the actual contract month. At this point the next contract month is taken.

It is noted initially in Simpson (2011) that these prices are highly positively correlated and both therefore represent the global crude oil futures market prices. The global nature of oil price futures is also demonstrated by the similarity of movement between those prices and a global economic indicator in the global stock market index. In addition, the co-movement of gas futures prices in the US and the UK is illustrated and evidence is provided that the gas futures markets in both countries do not track global economic indicators and their respective peaks and troughs probably indicate that domestic macro-economic and other domestic factors in seasonality and storage are the major influences on these prices.

As mentioned above, the Simpson (2011) study investigated data from 2003 to 2009 and did not examine structural breaks and therefore did not control for time varying relationships. For the study in this current chapter the data are tested for structural breaks and a clear structural break at 3rd September 2007 is identified in the US data using Andrews Quandt tests. All F statistics for the maximum

[2] Note: The USA is the larger of the two natural gas markets, estimated at more than 660 billion cubic metres compared to 100 billion cubic metres in the UK in 2007.

Table 11.1 Descriptive statistics of future spot gas and gas futures prices in the US and UK

	HHSP	NBP	HHFP	NBPFP
Mean	5.090	38.865	5.173	40.059
Median	4.480	33.340	4.600	35.780
Maximum	18.480	116.300	18.480	116.300
Minimum	1.690	11.280	1.690	11.280
Standard Deviation	2.286	19.324	2.237	18.889
Skewness	1.308	0.516	1.343	0.455
Kurtosis	5.273	2.369	5.479	2.369
Jarque–Bera	1,836.156	223.942	2,043.710	187.724
Probability	0.000	0.000	0.000	0.000
Observations	3,671	3,671	3,671	3,671

Note: HHSP and HHFP are the future spot gas and gas futures prices in the US. NBP and NBFP are the future spot gas and gas futures prices in the UK

likelihood ratio, the maximum Wald test statistic, the average likelihood ratio and the average Wald test statistic are significant at the 1 % level.[3] It is surmised that the structural break in the US data relates to the commencement of the global financial crisis. A Chow structural break test was undertaken on the UK data with the above date of the US structural break tested. Again, the findings are that this structural break also applies to the UK data set as indicated by the F statistics for the likelihood ratio and the Wald test significant at the 1 % level.[4]

Table 11.1 shows the descriptive statistics for the variables over the full period of the study.

The means for the US future spot and gas futures prices are lower than those for the UK thus indicating the different bases of measurement and the different bases for the original commencement of collection of data for each. The Jarque–Bera statistic (Jarque and Bera 1987) indicates the data are not normally distributed having problems with skewness and kurtosis. The standard deviations for each variable are not higher than the mean values for each and thus the variables are not highly volatile. The standard deviations for the US future spot and gas futures prices are quite similar as are those for the UK future spot and gas futures in the UK.

Figures 11.1 and 11.2 show the behavior of global oil prices for the two sub-periods of the study.

This enables the study to examine data for both the US and the UK for a period from 3rd January 2000 to 3rd September 2007; from 3rd September 2007 to 28th July 2014 and for the full period from 3rd January 2000 to 28th July 2014.

[3] Values of F test statistics are 929.028, 2,787.082, 375.970 and 1,127.909 respectively.

[4] Values of test statistics are 343.457 and 359.727 respectively.

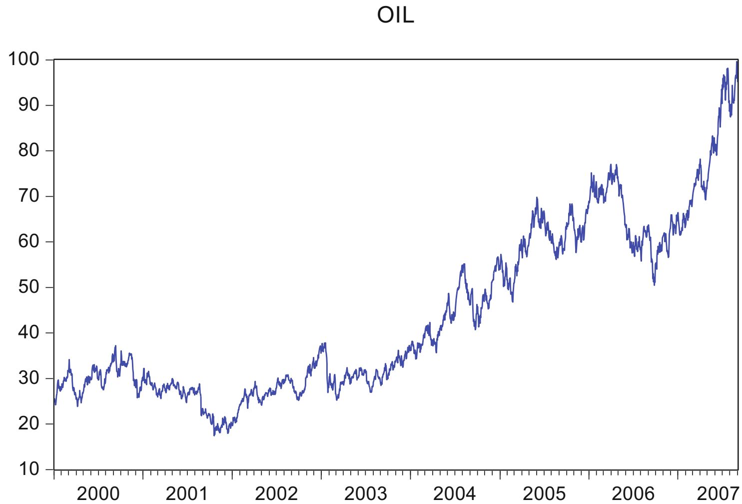

Fig. 11.1 Oil prices for the first study period 3rd January 2000–3rd September 2007

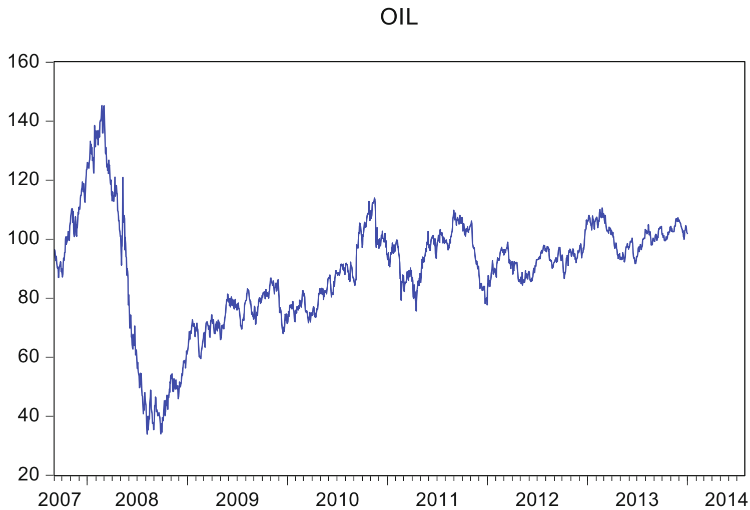

Fig. 11.2 Oil prices for the second study period from 3rd September 2007–28th July 2014

11.5 Findings

Simpson (2011) analysis commences by testing the level series of each price index, the first differenced series and the respective errors of these relationships for each country and each period under study for unit roots. These tests are now in this study

Table 11.2 Unit root tests results

Variables	Model with intercept		Model with intercept and trend	
	Levels	First differences	Levels	First differences
HHS	−3.7424	−63.7864*	−3.7599	−63.7884*
HHF	−3.7932	−62.6035*	−3.8735	−62.6069*
Errors	−4.8345	−63.2485*	−5.0443	−63.2408*
NBPS	−3.0192	−61.4234*	−4.1189	−61.4184*
NBPF	−2.9991	−60.4284*	−4.0349	−60.4220*
Errors	−4.2583	−60.2084*	−4.3125	−60.1993*
WTI crude oil	−1.3940	−62.9492*	−3.0560	−62.9403*

Note: HHSP is the Henry hub future spot gas price in US and HHF is the Henry hub futures gas price. NBPS is the national balancing point future spot gas price in UK and NBPF is the national balancing point futures gas price. WTI is the futures oil price. The Phillips–Perron critical values at the 1, 5 and 10 % levels of significance were referred to. The stationarity statistics of errors for both US and UK models are included
*Significance at the 1 % level

updated to cover the expanded period of the study and Phillips–Perron tests (Phillips and Perron 1988) are added to the study as such tests are more suitable than Augmented Dickey-Fuller (1981) tests when structural breaks are considered. Table 11.2 reports the results of the unit root tests.

The results of the unit root tests on variables in the expanded data confirm the Simpson (2011) results and also enable a conclusion that, in each case for each country, the processes are integrated and non-stationary and this in turn enables a move to the main analysis. Each VAR model is specified in level series for each of the USA and UK future spot natural gas markets. The models were initially tested for stability over the full period of the study for both US and UK markets using stability condition tests. The findings are that the VAR models are stable, with no root lying outside the relative unit root circles.

That is, as expanded in Simpson (2011), all level series are specified in a vector autoregressive (VAR) model and if I(1) variables are found to be cointegrated the VAR is re-specified into a vector error correction model (VECM) and tests run for cointegration (Johansen 1988) and causality (Granger 1988) after verifying the optimal lag order (VAR based lag order tests using information criteria are conducted to ascribe an optimal lag for cointegration and causality tests in the VECM). The results for the lag order, cointegration and causality tests are shown in Table 11.3.

Table 11.3 reports the results when the future spot gas prices are treated endogenously in each country. The first point to note is that both US and UK domestic gas markets are informationally efficient to a reasonable degree with the path to long-run equilibrium commencing after 1 day over each period studied.

Greater domestic gas market liberalization (that is, more gas on gas competition in each domestic gas market and a greater degree of decoupling of domestic gas markets with global oil markets) means less market reliance on global oil prices. Therefore, evidence of cointegration is evidence of less of a degree of decoupling of

Table 11.3 Results: optimal lags and cointegration and causality tests for future spot gas price relationships

Model	Number of cointegrating relationships according to trace and/or eigen-value tests	Optimal lag order in days	Granger causality
First period from 3rd January 2000–3rd September 2007 US	2**	1	There is no evidence dual or one way Granger causality running between any of the variables***
First period from 3rd January 2000–3rd September 2007 UK	1**	1	The future spot gas price Granger causes the oil futures price (Chi Square value 4.515**)
Second period from 3rd September 2007–28th July 2014 US	3**	1	Oil futures Granger causes the future spot gas price (Chi Square value 4.155**) Oil futures Granger causes gas futures (Chi Square value 3 621 at 10 % level of significance)
Second period from 3rd September 2007–28th July 2014 UK	3**	1	There is no evidence dual causality between any of the variables***
Full period from 3rd January 2000–28th July 2014 US	1**	1	There is no evidence of dual or one way Granger causality running between any of the variables***
Full period from 3rd January 2000–28th July 2014 UK	2**	1	There is no evidence of dual causality between any of the variables***

Note: The future spot gas prices in the US and the UK respectively are treated endogenously as specified. The Johansen cointegration tests take the assumption that there is a linear deterministic trend in the data with an intercept. Optimal lags are decided based on the majority significance of the likelihood ratio, the final prediction error, the Akaike, Schwarz and Hannan-Quinn information criteria. The number of cointegrating equations is based on both maximum eigenvalues and trace statistics. In the number of cointegrating relationships, no asterisk means no significance
**Significance at the 5 % level; ***significance at the 10 % level

domestic gas markets with global oil markets and thus less domestic gas market liberalization. That is, it represents evidence that all domestic gas and global oil price variables interacting together in each domestic gas market model, exhibit similar stochastic trends and together achieve stability in the long-term. In the short-term, if there is no evidence of dual or one-way causality between the oil and gas variables in each model, this represents evidence of short-term decoupling and liberalization.

In the first period studied there is slightly stronger cointegration evidence in the US gas market than in the UK market, implying that the US market is less liberalized in the long-term. In the short-term, the UK domestic gas market is less liberalized than the US because of evidence of Granger causality between the domestic future spot gas price and the global oil futures price. The increase in global oil prices up to the time of the start of the global financial crisis appears to have had a greater longer-term effect on the US gas market in impeding gas market liberalization than in the UK market, but this is not the case in the short-term.

In the second period, there is similar cointegration evidence in the UK and the US markets, implying that in the long-term, over the period following the global financial crisis and the subsequent fall in global oil prices, the liberalization of each market was curtailed. In the short-term the US market shows less liberalization than the UK market with evidence of Granger causality running between global oil futures markets and future spot gas prices and global oil futures markets and domestic gas futures prices respectively.

Considering the full period of study, there is one long-term equilibrium (cointegrating) relationship between the variables in the US model at the 5 % level of significance. There is no evidence of dual or one-way Granger causality running between that variable and gas futures US and oil futures. This adds to evidence of de-coupling (deregulation) in US natural gas markets in the short-term where oil prices are not playing a significant role in the determination of future spot gas and gas futures prices.

In the case of the UK domestic gas market, there are two long-term equilibrium (cointegrating) relationships between the variables at the 5 % level of significance. Again, there is no evidence of dual causality between oil futures and the future spot gas price UK at the 10 % level of significance. However, slightly stronger cointegration evidence exists in the UK model implying that in the full period and in the longer-term there is a lesser degree of gas market liberalization in the UK than in the US, even though there is no evidence of oil futures price causality or reverse causality at the 10 % level of significance.

Thus, over the full period the cointegration relationships are slightly stronger in the UK market than the US market, implying that over the long-term there is slightly less liberalization of the UK domestic gas market compared to that in the US. In the short-term it appears that both markets do exhibit a degree of market liberalization to the extent that there is no evidence of Granger causality between any of the variables in each model.

11.6 Discussion

Whilst this study represents a different form of analysis to many previous researchers in that it examines domestic future spot gas prices (by bringing forward 6 months of daily spot prices) against domestic gas futures prices (6 months contracts) and global oil futures prices (6 months contracts), support is generally provided for researchers who find no strong evidence of oil and gas price decoupling and therefore no strong evidence of gas market liberalization in the US and UK and other countries.

As such, the findings of Krichene (2002), Ewing et al. (2002), Serlitis and Rangel-Ruiz (2004), Adelman and Watkins (2005), Mazighi (2005), Asche (2006), Panagiotidis and Rutledge (2007) and Marzo and Zagaglia (2008) are generally supported, using the cases of the US and the UK. The evidence of Silverstovs et al. (2005) is generally not supported in the cases of the US and the UK. However, it may be said that support for a lack of decoupling of US and UK markets, is provided, in this study in this chapter, in long-term cointegration evidence.

In the short-term, exogeneity tests generally allude to a lack of causality between global oil and domestic gas, implying a breaking of the nexus between oil and gas prices and a form of short-term decoupling and thus liberalization. It was only in a few cases in the first and second periods studied, where, in both domestic gas markets, there was a causal link between global oil and domestic gas, thus implying a lack of short-term decoupling.

The importance of the examination of gas futures prices rather than spot prices (for example, Herbert and Kreil 1996; Root and Lien 2003; Modjtahedi and Movassagh 2005 and Wong-Parodi et al. 2006) is recognized in the study in this chapter, along with the need to consider domestic gas futures prices as price expectations based on domestic factors that importantly include seasonality and storage (for example, Mu 2007; Marzo and Zagaglia 2008 and Geman and Ohana 2009).

Conclusion

In this chapter, Simpson (2011) study is updated to include a longer period of study and a proven structural break in order to study time varying relationships that existed prior to and after the global financial crisis. Prior to the crisis there was a strengthening in global oil prices. After the crisis there was an immediate and strong downward movement in oil prices followed by a recovery (as shown in Figs. 11.1 and 11.2). The results of this updated study differ, although not substantially, from the Simpson (2011) study, however generally stronger evidence is provided of the lack of decoupling in each domestic gas market. Any changes in results from the longer study period are likely to reflect a greater effect of the growth of supply of unconventional oil and gas in the US market.

It needs to be recognized that there are differing gas supply circumstances in the US. Unconventional gas production in the US has increased enormously in recent years. This is also true of US unconventional oil but these increased sources of supply are only for consumption in the domestic market. It is quite likely to produce an effect of divergent gas prices between the US and the UK. It may well be affecting global oil prices as differences in the Brent oil and other global oil indices are emerging. It may also be that in Europe and the UK, whilst there are many sources of oil supply, there are few sources of gas supply and this made lead in the UK to a stronger connection between domestic gas and global oil prices.

In the cases of both the US and the UK markets over all periods of the study, there is no evidence to support the notion that gas and oil futures prices are good predictors of future spot gas prices. This may represent evidence overall, of progress in the process of domestic gas market liberalization in the US and the UK. Overall the evidence suggests that progress in deregulation over the long-term and short-term is slightly greater in the US domestic gas market than in the UK market.

The evidence of cointegration in this updated study implies there is some way to go in both markets in the long-term to decouple domestic gas prices from global oil prices. Also in the short-term, evidence of Granger causality running between future spot gas and oil futures price and domestic gas futures prices in the first and second periods indicates that more needs to be done in the deregulation of domestic gas markets in both the US and the UK.

Liberalization of domestic gas markets means removing the nexus between domestic gas prices and global oil prices to achieve gas on gas competition. Progress has been made at different times under different global and domestic economic conditions in the US and in the UK, but it cannot be said that such a nexus has been removed in either market. Nevertheless, it is posited that the study may be regarded by policy makers as a useful starting point for analysis with future research to include a relaxation of assumptions and an attempt to explain in a policy sense, the reasons why one market may exhibit greater liberalization than another.

References

Adelman MA, Watkins GC (2005) US oil and natural gas reserve prices, 1982–2003. Energy Econ 27(4):553–571

Asche F (2000) European market integration for gas? Volume flexibility and political risk. CESifo Working paper, Number 358, November 2000

Asche F (2006) The UK market for natural gas, oil and electricity: are the prices de-coupled? Energy J 27(2):27–40

Dickey DA, Fuller WA (1981) Likelihood ratio statistics for autoregressive time series within a unit root. Econometrica 49:1022–1057

Ewing BT, Malik F, Ozfidan O (2002) Volatility transmission in the oil and natural gas markets. Energy Econ 24(6):525–538

Geman H, Ohana S (2009) Forward curves, scarcity and price volatility in oil and natural gas markets. Energy Econ 31(4):576–585

Granger CWJ (1988) Some recent developments in a concept of causality. J Econ 39:199–211

Herbert JH (1993) The relation of monthly spot to futures prices for natural gas. Energy 18 (11):1119–1124

Herbert JH, Kreil E (1996) US natural gas markets: how efficient are they? Energy Policy 24 (1):1–5

Jarque CM, Bera AK (1987) A test for normality of observations and regression residuals. Int Stat Rev 55:163–172

Johansen S (1988) Statistical analysis of cointegration vectors. J Econ Dyn Control 12:231–254

Krichene N (2002) World crude oil and natural gas: a demand and supply model. Energy Econ 24 (6):557–576

Marzo M, Zagaglia P (2008) A note on the conditional correlation between energy prices: evidence from future markets. Energy Econ 30(5):2454–2458

Mazighi, AEH (2005) Henry hub and national balancing point prices: what will be the international gas price reference. Organization of Petroleum Exporting Countries, Research paper, September 2005

Modjtahedi B, Movassagh N (2005) Natural gas futures: bias, predictive performance, and the theory of storage. Energy Econ 27(4):617–637

Mu X (2007) Weather, storage and natural gas price dynamics: fundamentals and volatility. Energy Econ 29(1):46–63

Panagiotidis T, Rutledge E (2007) Oil and gas markets in the UK: evidence from a cointegration approach. Energy Econ 29(2):329–347

Phillips PCB, Perron P (1988) Testing for a unit root in a times series regression. Biometrika 75:335–346

Root HR, Lien D (2003) Can modelling the natural gas futures market as a threshold cointegrated system improve hedging and forecasting performance. Int Rev Financ Anal 12(2):117–133 [2nd Quarter]

Serlitis A, Rangel-Ruiz R (2004) Testing for common features in North American energy markets. Energy Econ 26(3):401–414

Silverstovs B, L'Hegaret G, Neumann A, von Hirschhausen C (2005) International market integration for natural gas? A cointegration analysis of prices in Europe, North America and Japan. Energy Econ 27(4):603–615

Simpson JL (2011) Future spot gas prices in the US and the UK: are the movements more influenced by country or global price expectations. J Energy Markets 3(1):3–16

Wong-Parodi G, Dale L, Lekov A (2006) Comparing price forecast accuracy of natural gas models and futures markets. Energy Policy 34(18):4115–4122