Essays on Macroeconomics, Energy Prices and Policies

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Abstract

This dissertation, called *Essays on Macroeconomics, Energy Prices and Policies,* is a series of research papers on links between macroeconomics, energy prices and policies over the last two decades. The thesis consists of the four original chapters. *Chapter One* investigates determinants of global oil prices over the last two decades focusing on the role of industrial production. *Chapter Two* analyzes how oil prices affect macroeconomic indicators and monetary policy of one of the largest non-OPEC[1] oil exporting economy – Russia. *Chapter Three* examines energy security status in Asia and its relationship with real GDP per capita growth. *Chapter Four* assess asymmetry of oil prices pass-through to gasoline prices in Russia and South Korea.

Introduction

Currently, energy is one of the main production inputs of modern economies and among different energy sources oil is the largest energy source globally. Crude oil is useful for various purposes including transportation, heating, electricity and even as a raw material to produce plastics and other products. Worldwide oil accounts for 33% of total primary energy

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[1] As of 2020, Organization of the Petroleum Exporting Countries or OPEC members include Algeria, Angola, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Republic of the Congo, Saudi Arabia, United Arab Emirates, Venezuela (according to https://www.opec.org).

consumption and is followed by natural gas (24%), coal (27%) and other energy sources as of 2019.[2]

The period mainly considered in this thesis was described as "new industrial age" by Hamilton (2013) in contrast to the period of 1973 – 1996 or the "age of OPEC". This thesis was motivated by the fact that since the first oil price shock of 1973, when real oil prices skyrocketed from $19 US per barrel in 1973 to $60 US per barrel in 1974[3] causing adverse effects on energy importers, energy price fluctuations (especially oil) are still of main concern not only for energy importers but also for energy exporting economies. And while for energy importers higher energy import prices mean higher production input costs, for energy exporters higher energy prices and revenues mean higher economic dependency on energy exports and vulnerability to negative energy price shocks. This thesis attempts to examine in depth what factors affected oil prices during the "new industrial age"; what were the consequences of oil price volatility for energy exporters and importers and how oil price movements relate to macroeconomic policies.

These chapters aim to provide theoretical and empirical insights on energy price formations, macroeconomic impacts caused by energy prices volatility, the role of energy security in economic growth and on the pass-through of oil prices.

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[2] British Petroleum (BP) Statistical Review of World Energy 2020, (2020).

[3] Brent prices in real 2019 prices, deflated using the Consumer Price Index for the US. Data from British Petroleum (BP) Statistical Review of World Energy 2020.

Chapter 1 The Role of Industrial Production in Global Oil Price Determination Over the Last Two Decades[4]

Chapter One investigates the recent oil price drivers and compares the role of supply and demand factors in recent oil price formation providing theoretical oil price modelling framework which is followed by empirical analysis. Oil is the major energy source worldwide (Figure 1). Until 1990s the Organization of the Petroleum Exporting Countries (OPEC) played a key role in oil pricing, however, recent rapid economic growth in developing economies has boosted the demand for oil, making oil prices vulnerable to a wider range of factors.

This chapter proposes an alternative methodology of estimating the impact of oil demand on oil price by using a proxy of industrial production index. It also compares the impact of demand from Organisation for Economic Co-operation and Development (OECD)[5], People's Republic of China (PRC) and India.

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[4] Another version of this chapter is published as a working paper: Yoshino, N. and V. Alekhina (2019). Empirical analysis of global oil price determinants at the disaggregated level over the last two decades. ADBI Working Paper 982. Asian Development Bank Institute, Tokyo.

[5] As of, 2020, Organisation for Economic Co-operation and Development or OECD members include Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States (according to https://www.oecd.org).

Figure 1. World Primary Energy Consumption by Source, 1970 and 2019
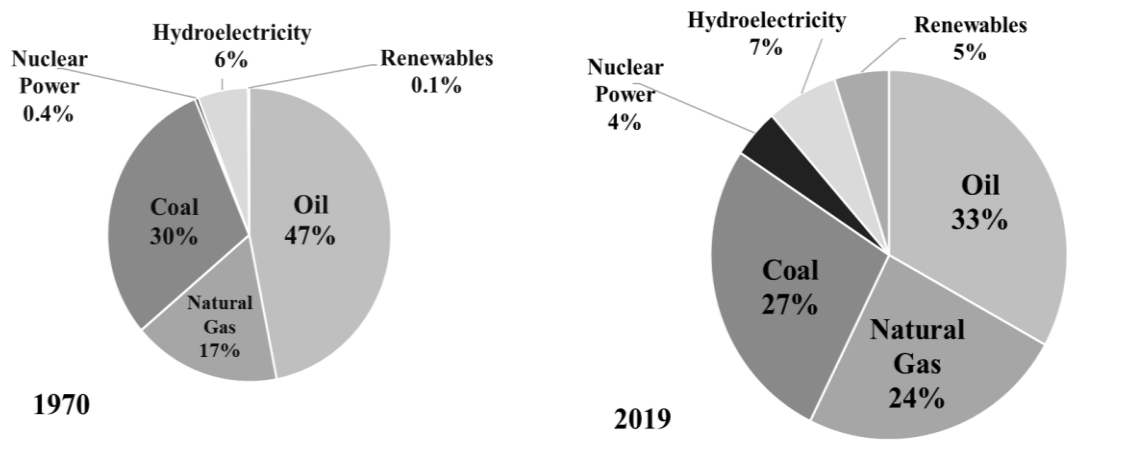
Source: British Petroleum (BP) Statistical Review of World Energy 2020. Note: original data is in exajoules.

The literature on energy price volatility and its impacts on macroeconomy is vast. This chapter of this thesis aims to extend the theory of oil price formation by modeling and estimating oil price drivers over the past 20 years. This study aims to contribute to an unsettled discussion on various factors affecting oil price movements from both – oil supply and demand sides. It was widely discussed in previous literature that up until 1990s oil prices were mostly affected by supply factors, since then, however, the paradigm of the oil market has changed and recently oil prices are influenced by different factors.

To analyze the impact of different factors on oil prices, first, the aggregate demand – aggregate supply model is developed and estimated econometrically during the period of 1999 – 2017. This research attempts to examine the measure of industrial production in the context of global oil demand proxy. Industrial production index refers to the output of industrial establishments and covers various sectors including mining, manufacturing, electricity, gas and others. In order to gauge influence on oil prices from advanced and developing economies oil demand side is disaggregated into demand from OECD, China and India which together account for roughly 70% of total world oil consumption[6].

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[6] As of 2019, according to BP statistics.

Using well established vector error correction model (VECM), this chapter finds that oil demand from OECD's and China measured by industrial production index had positive impact on oil prices in the estimated period, however, India's did not. On the other hand, the impact of oil supply side was almost two times smaller than that of demand from OECD and China. This highlights that indeed over recent decades oil demand side has had more impact on oil prices than oil supply side, which supports previous findings and validity of the method used in this research. This chapter also examines the equilibrium of oil market and comes to conclusion that oil market was in equilibrium during the estimated period. This means that oil prices were adjusting instantly in response to different factors.

Chapter 2 Exogeneity of World Oil Prices to the Russian Federation's Economy and Monetary Policy[7]

Chapter Two focuses on the impact of oil price changes on the economy of one of the largest non-OPEC oil exporting countries – Russian Federation. Production and export of hydrocarbons play a significant role in Russian economy and contributes to it most directly through the government budget. The government highly taxes the extraction and export of natural resources; therefore, oil and gas account for a significant part of the budget revenues (Figure 2).

Figure 2. The Russian Federation's General Account Budget Revenues for FY 2015

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[7] The work discussed in this chapter has been published as: Alekhina, V. and N. Yoshino (2019). Exogeneity of World Oil Prices to the Russian Federation's Economy and Monetary Policy. *Eurasian Economic Review*, 9, 531–555.

Earlier version of this chapter: Alekhina, V. and N. Yoshino (2018). Impact of World Oil Prices on an Energy Exporting Economy Including Monetary Policy. ADBI Working Paper 828. Asian Development Bank Institute, Tokyo.
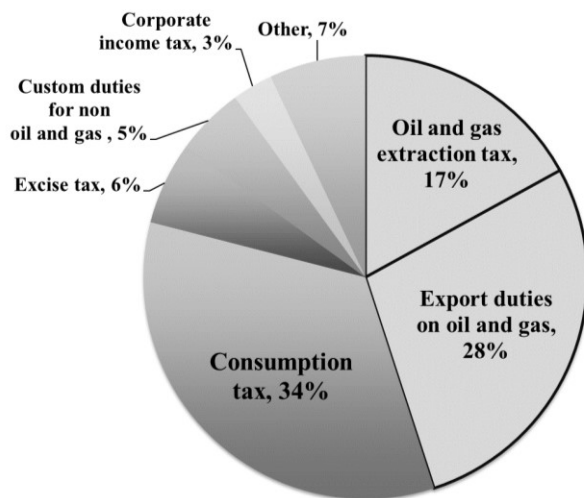
Source: Ministry of Finance of the Russian Federation.

This study investigates the interrelationship between the Russian Federation's gross domestic product (GDP), consumer price index (CPI) inflation rate, Ruble/US Dollar exchange rate, interest rate and world oil prices using a vector autoregression (VAR) approach. The results suggest that the impact of the oil price fluctuations on the country's GDP, CPI inflation rate, interest rate, and exchange rate was more significant between 2000 and 2016 than between 1993 and 1999. The reason for this might be growing dependence of the economy on oil export revenues. The sharp increase of the world oil prices in late 1990s benefited Russia's economy and helped it to recover from 1998 financial crisis, on the other hand, made the economy vulnerable to oil price fluctuations.

To examine the monetary policy rule for the Russian Federation, the modified Taylor equation that includes oil price gap is estimated. The evidence suggests that the oil price gap significantly affected the post-global financial crisis monetary policy of the Russian Federation (2008-2016). This highlights a reluctance of monetary authorities to take action when oil price growth rate is high (2000-2008) but a willingness to adjust monetary policy when oil price growth rates are low or negative (2008-2016). It can be concluded that it is crucially important for the economies highly depended on oil export to diversify the range of their revenues from too much reliance on oil export into other types of revenues.

Chapter 3 The Role of Energy Security in Economic Growth in Asia: Quantitative Analysis and Policy Options[8]

Chapter Three focuses on energy security and expands the scope of the analysis to 20 Asian economies, among which there are both – net energy exporters and net energy importers. This chapter assesses energy security in Asia and was motivated by the fact that rapid economic growth in Asia during recent decades has boosted energy consumption and contributed to higher energy prices. Currently Asia and Pacific region is the main consumer of the primary energy using more than 40% of all global energy per year. It was found that energy consumption in the region significantly exceeds its energy production what makes the region highly dependent on imported fossil fuels. In addition, that makes local energy prices higher than in other regions. In addition, in its energy mix Asia is still heavily relying on coal, what raises environmental concerns in the region.

Energy and environmental security issues in Asia have been under radar recently with a number of studies investigating on Asia's progress in these directions. The novelty of this research is that it not only assesses Asia's position in energy and environmental security but moves forward and integrates energy and environmental security framework into economic growth analysis. The literature on the optimal policy mix aimed to improve energy security is limited since it remains questionable how compatible energy security and economic growth objectives are. Therefore, the goal of this exercise was to contribute to the discussion on this topic and analyze several energy security indicators in terms of their relationship with real GDP per capita growth.

The main results of this research support the hypothesis that energy security is an important factor of GDP per capita growth in Asia. Rapidly expanding energy demand boosted by population growth and improvement of living standards in Asia has made it vulnerable to

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[8] The work presented in this chapter has been published as: Alekhina, V. (2020). The Role of Energy Security in Economic Growth in Asia: Quantitative Analysis and Policy Options. *Singapore Economic Review,* 66-02, 545-567.

energy security risks. One way to reduce energy import reliance is to diversify the energy basket and to increase the renewable energy share in the total energy basket. While careful consideration of country-specific energy policies and their complementarity with macroeconomic objectives would still be necessary, a number of policies to improve energy security status in Asia is discussed in this chapter.

Chapter 4 Asymmetric Pass-Through of Oil Price to Gasoline Price: Case Study of Russian Federation and South Korea

Chapter Four is an insight on pass-through of oil prices to price of the main product of oil refinery – gasoline. Understanding gasoline prices is of interest due to a number of reasons. Gasoline spending, for instance, constitutes a portion of an average household's total spending, moreover, the price elasticity of gasoline demand is rather low as the degree for substitution with other products still remains rather limited.

The relationship between crude oil price and retail gasoline price seems straightforward since motor gasoline is obtained directly from crude oil refining. However, it was observed and shown in previous literature that oil prices pass-through to gasoline prices asymmetrically[9]. In other words, gasoline prices respond to increases and decreases in oil prices with different magnitude. In addition, adjusting pattern of gasoline prices varies. Bacon (1991) first described this phenomenon as "rockets and feathers effect" because gasoline prices "rise like a rocket", but "fall like a feather". It was then found that an increase of oil price was followed by a rapid gasoline price adjustment with an initial delay, while a decrease of costs was followed by sooner yet smaller series of price adjustments. Therefore, this adjustment pattern was named "rockets and feathers".

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[9] Pass-through is considered as a degree of downstream (gasoline) price changes caused by upstream price (oil) fluctuation. Asymmetric pass-through is when downstream (gasoline) prices respond differently to increases and decreases in upstream (oil) prices.

While fluctuations in oil prices have been widely covered in the literature, its pass-through to gasoline prices and the asymmetry of pass-through has received less attention. To fill the gap, this research estimates and compares pass-through of oil prices to retail gasoline prices. The novelty of research method described in this chapter is that in addition to oil-retail gasoline prices pass-through, it proposes the measure of net retail gasoline prices (adjusted for taxes and non-oil costs) and compares both – oil prices pass-through to retail gasoline prices and to net retail gasoline prices. This comparison allows, first, to better understand on which stage of retail gasoline price formation there is a presence of asymmetry. Second, to figure out what could be possible future policies on smoothing the asymmetry of oil-gasoline pass-through.

This approach allows to better understand which stage of retail gasoline price formation causes the asymmetry of oil-gasoline price pass-through. For quantitative analysis, South Korea and Russia, which both have adopted market-based pricing systems for fuels, are considered based on data availability. For empirical analysis nonlinear autoregressive distributed lags (NARDL)[10] model was adopted and estimated using monthly data (2000-2018).

The evidence obtained captures the signs of asymmetry of oil prices transmission to gasoline prices for both countries but of different magnitudes. In case of Russia there is notable asymmetry of oil-gasoline price pass-through. One reason could be that in Russia gasoline retailers are vertically integrated into oil producing companies. When oil prices decline, price of gasoline increase to compensate losses from oil price drop. One reason could be that in Russia gasoline retailers are vertically integrated into oil producing companies. When oil prices decline, price of gasoline increase to compensate losses from oil price drop.

The method proposed and the results obtained in this study are potentially useful for energy policymakers, consumers and commodity investors. This study is motivated by the necessity to improve fuel prices monitoring and the competitiveness of the fuel market. It also contributes

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[10] NARDL model is relatively recently developed technique (Shin et al. 2011) that builds on error-correction model (ECM) (Engel and Granger 1978, Johansen 1988). It allows to examine short- and long-run asymmetric responses by deriving positive and negative partial sums decompositions of independent variable and to quantify the responses of downstream prices to upstream prices shocks.

to methods of fuel price forecasting, developing energy outlooks and designing wholesale and retail energy market's rules and policies.

Preventing from monopolization and excessive concentration of power in certain sectors or companies, ensuring market competitiveness and efficient price monitoring should allow developing fairer price mechanism on retail energy marker. Collecting and analyzing data for retail fuel price components, developing this method even further and comparing experience of retail fuel price formations is an interesting niche for future research and will be useful for drawing associated energy policies and forecasts.

Concluding Remarks

It is worth noting that data analysis underlying this thesis was done before the outbreak of COVID-19 pandemic[11], which triggered an oil price collapse in 2020, as countries have introduced strict lockdown measures and the demand for oil has dropped. The mix of demand and supply factors have contributed to the recent collapse of oil prices, making economies dependent on oil and petroleum products export revenues suffer from significant revenue shortfalls in addition to severe negative effects of COVID-19 crisis.

On the other hand, for energy import depended economies, lockdown posed significant risks of imported energy supply chain disruptions. COVID-19 crisis once again highlighted the importance of strengthening of the energy security policies in some countries, while shifting away from extensive reliance on energy export revenues in others.

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[11] According to the World Health Organization (WHO), COVID-19 is the infectious disease caused by the coronavirus, SARS-CoV-2, which is a respiratory pathogen. The new virus became known by the WHO on 31 December 2019. The WHO announced a Public Health Emergency of International Concern on 30 January 2020, and a pandemic on 11 March 2020 (WHO 2020, last accessed on 27 October 2020 https://www.who.int/emergencies/diseases/novel-coronavirus-2019).

Possibly, one of the biggest global issues ahead is the climate crisis. Climate change creates an urgency for countries to diversify their energy mixes and increase the share of "green energy" in total energy use. In combination with COVID-19 crisis, green recovery and cleaner energy use are now at the forefront of countries' recovery agendas implying a possibility of a swifter transitions to low-carbon economies. It is left for future studies to analyze how this transition, especially growing deployment of renewable energy, will affect fossil fuel prices and energy policies.