THE IMPACT OF OIL SHOCKS ON BRIC MARKETS

DURING UNCERTAIN TIMES

Master's Thesis

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MASTER'S THESIS

Department of Economics

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Anadolu University

Graduate School of Science

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ABSTRACT

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Oil is a crucial input for the economic production process and a financial instrument that can be traded in the financial market. This thesis examines how a sudden decrease in oil prices affects the financial markets of Brazil, Russia, China, and India. The thesis also aims to answer the interesting question of whether uncertain conditions in international financial markets alter such effects on the BRIC financial markets. Using weekly financial data, we estimate the linear and non-linear SVAR models. The results indicate that negative oil price shocks adversely influence the financial markets of BRIC oil exporters (Russia-Brazil) and positively affect the financial markets of BRIC oil importers (China-India). Furthermore, uncertain conditions in international financial markets amplify the effects of such shocks on BRIC markets.

Keywords: Oil shocks, BRIC, Financial markets, Uncertainty, TSVAR

ÖZET

BELİRSİZ DÖNEMLERDE PETROL ŞOKLARININ BRIC PİYASALARI ÜZERİNDEKİ ETKİLERİ

Hasan GÜLOĞLU

İktisat Anabilim Dalı

Anadolu Üniversitesi, Sosyal Bilimler Enstitüsü, Temmuz 2022

Danışman: Prof. Dr. Zekeriya YILDIRIM

Petrol ekonomik üretim süreci için önemli bir girdi ve finansal piyasalarda işlem görebilen bir finansal araçtır. Bu tez, petrol fiyatlarındaki ani düşüşün BRIC'in (Brezilya, Rusya, Hindistan, Çin) finansal piyasalarını nasıl etkilediğini incelemektedir. Ayrıca, tez, BRIC'in finansal piyasaları üzerindeki bu etkileri, uluslararası finans piyasalarındaki belirsiz koşulların değiştirip değiştirmediği konusunda ilginç bir soruyu yanıtlamayı da amaçlamaktadır. Bu çalışmada haftalık finansal veriler kullanılarak, doğrusal ve doğrusal olmayan SVAR modellerini tahmin edilmiştir. Sonuçlar, negatif petrol fiyat şoklarının BRIC petrol ihracatçılarının (Rusya-Brezilya) finansal piyasalarını olumsuz etkilediğini, buna karşın bu şokların BRIC petrol ithalatçılarının (Çin-Hindistan) finansal piyasalarını olumlu etkilediğini göstermektedir. Ayrıca ulaşılan bulgular uluslararası finansal piyasalarda belirsizlik hakim olduğunda söz konusu etkilerin daha derin olacağını ortaya koymaktadır.

Anahtar Sözcükler: Petrol şokları, BRIC, Finansal piyasalar, Belirsizlik, TSVAR.

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Special thanks to my soulmate for her faith in me, every bit of support and endless love.

Last but not least, I would like to thank my parents and my only brother for unwavering support on this adventure.

05/07/2022

STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with "scientific plagiarism detection program" used by Anadolu University, and that "it does not have any plagiarism" whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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Hasan GULOGLU

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SYMBOLS AND ABBREVIATIONS

ADF	: Augmented Dickey Fuller
AIC	: Akaike Information Criterion
BEKK	: Baba, Engle, Kraft, and Kroner
BRIC	: Brazil, Russia, India, and China
BRICS	: Brazil, Russia, India, China, and South Africa
BOP	: Balance of Payment
BOVESPA	: Brazilian Stock Exchange
CBOE	: Chicago Board Options Exchange
CRA	: Contingent Reserve Agreement
CGE	: Computable Generalized Equilibrium
CQ	: Cross Quantilogram
DOLS	: Dynamic Ordinary Least Squares
DSGE	: Dynamic Stochastic General Equilibrium
EDE	: Emerging Developing Europe
EM	: Emerging Markets
EMBI	: Emerging Markets Bond Index
EPU	: Economic Policy Uncertainty
EU	: European Union
FED	: Federal Reserve
FX	: Foreign Exchange
FMOLS	: Fully Modified Ordinary Least Square

GARCH	: Generalized Auto Regressive Conditional Heteroskedasticity
GCC	: Gulf Council Cooperation
GDP	: Gross Domestic Product
GIR	: Generalized Impulse Response
GPR	: Geopolitical Risk
GMM	: Generalized Method of Moment
G-7	: Group of Seven
IMF	: International Money Fund
IRF	: Impulse Response Function
MSCI	: Morgan Stanley Capital Index
MS-VAR	: Markov-Switching Vector Auto Regression
OPEC	: Organization of Petroleum Exporting Countries
OR	: Optimized Rule
PMG	: Pooled Mean Group
R&D	: Research and Development
SLR	: Speed Limit Rule
S&P	: Standard and Poor’s
SVAR	: Structural Vector Auto Regression
SVECM	: Structural Vector Error Correction Model
TAR	: Threshold Auto Regression
TSVAR	: Threshold Structural Vector Auto Regression
TVP	: Time-Varying Parameter
UK	: United Kingdom
US	: United States

USSR	:Union of Soviet Socialist Republics
VAR	: Vector Auto Regression
VARMA	: Vector Auto Regression Moving Average
VXO-(VIX)	: Volatility Index based on S&P 100 (500) Index

INTRODUCTION

Fluctuations in oil prices have consequences for economies all over the world, depending on whether they are oil exporters or importers. While the oil trade supplies huge amounts of revenue for oil-exporting countries, it is the main expenditure item of oil-importing countries. Therefore, a fall in oil prices, for example, is expected to be harmful to the former and beneficial for the latter. Thus, the effects of oil price shocks on macroeconomic aggregates are well-documented. In contrast, evidence of the effects of oil shocks on financial markets is relatively scarce. However, the rapid financialization of oil intensifies the interactions between oil and financial markets, causing researchers to shift their attention toward the oil-financial market link. Moreover, the transmission of oil price fluctuations to local financial markets is driven by international financial uncertainty. For instance, the uncertainty caused by the Covid-19 pandemic that erupted in late 2019-early 2020[1] has created unpredictable environments in global financial markets. Due to lower energy consumption in many fields[2], oil demand and subsequently its prices have decreased. Thus, this recent oil price decline occurs amid uncertain conditions in international financial markets, which is different from past experiences of oil price declines. Motivated by this fact, this thesis investigates how a sharp decline in oil prices influences financial markets during uncertain times.

Following Hamilton (1983), a great number of studies investigated the macroeconomic effects of oil shocks (See, Blanchard & Gali, 2007; Grigoli, Herman, & Swiston, 2017; Kilian, Rebucci, & Spatafora, 2009, and among others). While studies on the oil-financial market nexus have been relatively limited, with the financialization of oil this literature has rapidly grown. Several studies focus on the financial markets of oil-exporting countries (Bjørnland, 2009; Tule, Ndako, & Onipede, 2017; Yildirim & Arifli, 2021) while others focus on oil-importing countries (Lizardo & Mollick, 2010; Park & Ratti, 2008). Studies have also examined the effects on selected oil-exporting and importing countries together (Filis & Chatziantoniou, 2014; Volkov & Yuhn, 2016). However, there is a lack of research on the oil-financial market nexus for Brazil, Russia,

[1]The first case of Covid-19 can be traced back to November 17, 2019; however the WHO (World Health Organization) declared a pandemic on March 11, 2020.(Cucinotta and Vanelli 2020; Roberts, Rossman, and Jarić 2021)

[2]Factors such as curfews, airports closures, working from home, and distance education practices cause lower oil consumption.

India, and China (BRIC), which comprise both oil-exporting and oil-importing countries. The present BRIC literature focuses more on a single component of financial markets (i.e., the stock market) than on financial markets as a whole. For example, Bouoiyour and Selmi (2016) and Ono (2011) focus on the relation between oil shocks and stock prices, while Baghestani, Chazi, and Khallaf (2019) and Bal and Rath (2015) investigate the oil-exchange rate nexus. Unlike these studies, this thesis does not focus on a specific BRIC market, such as the stock market. Instead, it examines the impact of oil shocks on five financial variables: sovereign risk, short-rate, stock price, bond yield, and exchange rate.

Studies investigating how financial markets respond to oil shocks during uncertain times are limited. Yong Jiang, Wang, Ma, and Yang (2021) and Wan and Kao (2015) focus on the role of financial regimes in the transmission of oil shocks to the US stock market. Similarly, Evgenidis (2018) analyzed how oil shocks influence Eurozone output during uncertain and normal times. However, to the best of our knowledge, no study has been conducted on the BRIC nations. Thus, this thesis aims to fill this gap by analyzing the effects of oil price shocks on the BRIC financial markets for uncertain times.

The heterogeneous characteristics of BRIC make this inquiry interesting. Brazil and Russia are net oil exporters, whereas China and India are net oil importers. Oil prices play a significant role in these countries, as the group includes the second-largest oil exporter (Russia) and the largest oil importer (China). Furthermore, owing to their rapid growth and vast demand in recent decades, the international financial integration of BRIC has accelerated. Both the increased international financial integration and rapid financialization of oil intensify the link between oil and the financial markets of BRIC. These two factors also render them vulnerable to international financial uncertainty. In addition, considering that the financial markets of emerging BRIC economies are not fully developed, oil shocks are expected to have substantial effects on BRIC financial markets, being even stronger under uncertain conditions.

In sum, this study analyzes the effects of negative oil shocks on the financial markets of BRIC economies. This thesis also examines whether uncertain conditions alter the effects of such shocks on BRIC markets. To quantify these effects, we estimate linear and non-linear SVAR models for the period 2002-2019. Our findings demonstrate that negative oil price shocks completely disrupt the financial markets of oil-exporting countries and positively affect those of oil-importing countries. In the oil exporters of

BRIC, negative oil price shocks increase sovereign risk, exchange rate, short-rate, and bond yields, while decreasing stock prices. The reverse is true for the oil importers of BRIC. Furthermore, uncertain conditions in international financial markets magnify the effects of such shocks, regardless of the country's net oil position [oil exporter/oil importer].

The remainder of this thesis is organized into three chapters. Chapter I introduces the structure of the BRIC economy and the relationship between the financial markets of these economies and oil and international financial uncertainty. Chapter II presents the theoretical foundations for oil, financial markets, and uncertainty. Chapter III describes the data and methodology and discusses the results and robustness tests.

CHAPTER ONE

1. BRIC: Financial Markets, Oil, and Uncertainty

This section discusses the main body of the study. It consists of four parts. The first part provides a general overview of BRIC countries. The second part documents the role of oil in these economies. The third part presents a general framework for the integration of BRIC into global financial markets. Finally, the last part documents stylized facts on the observed impact of oil price changes on BRIC financial markets during normal and uncertain times.

1.1. The Overview of BRIC Economies

In 2001, Goldman Sachs economist Jim O'Neill coined the term BRIC to refer to the economies of Brazil, Russia, China, and India (O'Neill, 2001). The country's foreign affairs ministers met for the first time in 2006. As the first BRIC Summit[3], in 2009, an official meeting with the full participation of the countries' leaders took place in Russia. Despite the fact that there is no formal trade or officially established BRIC union like the European Union, this group of countries has the initiative to become an official association. In this regard, the first step towards institutionalization was taken by the establishment of the New Development Bank, which is also called the BRIC Development Bank, supporting the infrastructure investments of member states and reducing their dependence on international organizations such as the World Bank and IMF (Parfinenko, 2020). Similarly, they signed an agreement (Contingent Reserve Agreement) as a precaution for periods of possible liquidity congestion. Consequently, BRIC countries, together with such institutions, are attempting to have a stronger voice in the world economy. [4]

BRIC, which comprises about half of the world's population and one-fourth of its land mass, are among the top 10 countries in this respect (Marr & Reynard, 2010). As shown in Figure 1.1, they occupy an essential place in the world in terms of population and surface area.

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[3]Although South Africa joined the group in 2011, the study will focus on the original four members.

[4] These countries are projected to be among the strongest economies by 2050 (Wilson & Purushothaman, 2006)

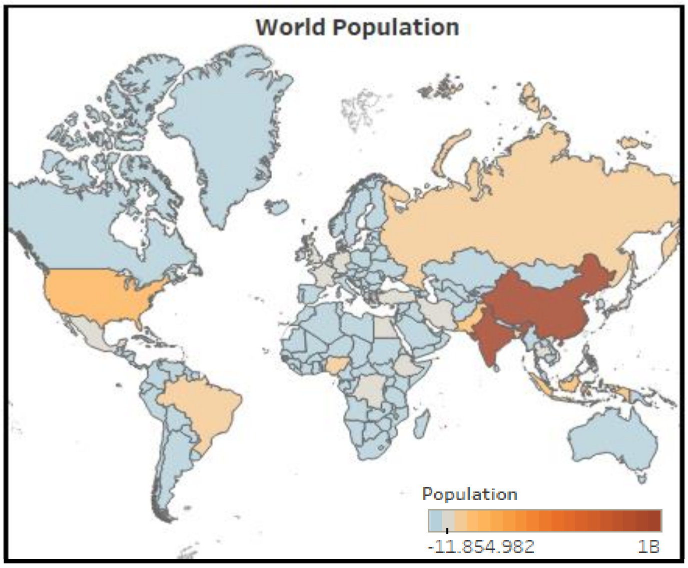

Figure 1.1. *Population and land mass of BRIC countries. (The World Bank, 2020)*

From an economic perspective, BRIC is now a growing player in the world economy. Figure 1.2 clearly shows that the share of BRIC in global GDP exceeds about 30%, slightly surpassing the G-7 countries. With rapid growth in the first decade of the century, their economies have gained significant attention. Thus, they have diverged greatly from other emerging countries through their strong growth performance. While the BRIC countries was hampered by the global economic crisis, they recovered faster than other advanced and developing countries. Even though the individual growth rates of each member have fallen relatively in the second decade of BRIC's emergence, their share is quite high today (see Figure 1.2).

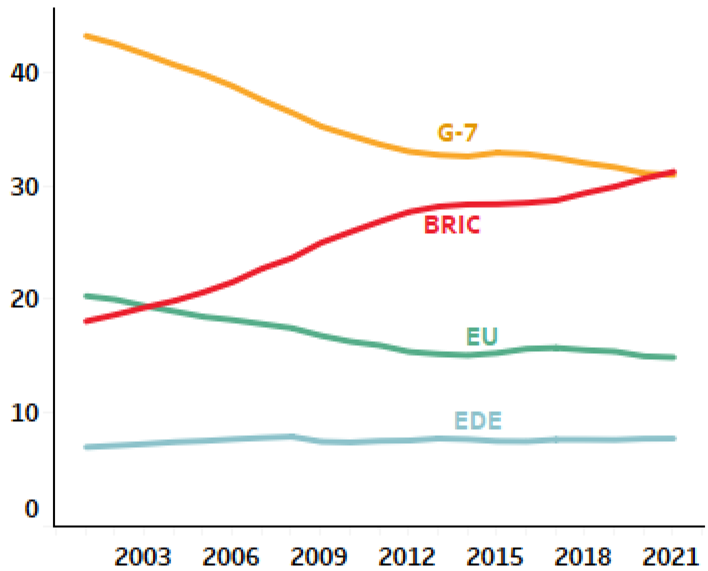

Figure 1.2. *The share of BRIC, G-7, Europe Union, and Emerging Developing Europe in Global GDP (%). (World Economic Outlook, IMF)*

On the trade side, BRIC is a fast-growing player in world trade. Figure 1.3 shows the shares of different groups of countries in world trade. It is evident that while the shares of the G-7 and the EU, formed by developed countries, tends to decrease, the share of BRIC and other emerging markets is constantly increasing. In fact, the BRIC countries surpassed other developing countries in 2012 and outperformed them. Considering that studies have estimated that four of the top seven economies will be BRIC countries by 2050 (Economics, 2013), the steady increase in their share of both global GDP and trade makes this prediction feasible.

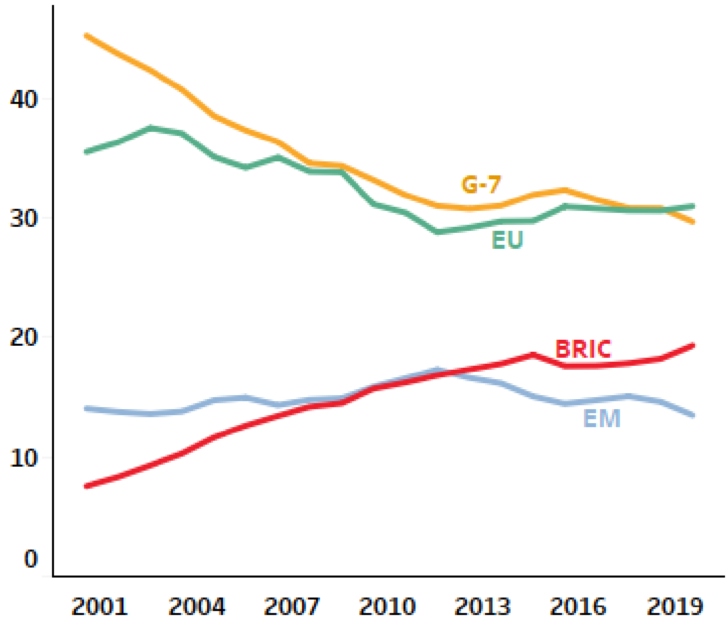

Figure 1.3. *The share of BRIC, G-7, Europe Union, and Emerging Markets in Global Trade (%). (UNCTAD)*

1.1.1. Brazil

Brazil, the first country in BRIC, has the largest economy in South America. Brazil had a strong stance in the 2000s, after struggling with problems such as hyperinflation, debt crises, and unstable currency in the 1990s. Because of the chronically high inflation, the Brazilian economy has experienced high interest rates hindering investments and disrupting the economy for many years (Radulescu, Panait, & Voica, 2014). In 2000, fiscal discipline was established, and an inflation-targeting policy was introduced. After addressing issues such as high inflation and exchange rate instability, Brazil's economy has provided positive signals. With the implementation of structural and financial reforms, exports have increased significantly. Then, their current account surplus strengthened the Brazilian real. This has attracted foreign investors and increased financial inflows. Brazil experienced low inflation and interest rates until the global financial crisis. Moreover, income levels have increased substantially, and there has also been massive development in education and health (Albert, 2014).

At the present time, Brazil may be defined as an export-driven economy. The export share of minerals is quite high, especially because they are rich in natural resources. In addition, after becoming self-sufficient for oil for the first time in 2006, Brazil increased its investment in this field and became a major oil exporter. In fact, during the Great Recession of 2009, the Brazilian economy benefited from oil deposits, which allowed them to recover from the negative effects of the crisis. On the other hand, at the local level, oil companies supported by the government have a significant share in the country’s stock market, BOVESPA. Natural resources, especially oil, play a crucial role in the strong growth performance as they are essential components in the real and financial markets of Brazil’s economy.

1.1.2. Russia

Another member of this group is Russia, a commodity exporter. The country moved to a free-market economy in 1992 after the collapse of the Union of Soviet Socialist Republics (USSR). Russia attempted to get back on track in the 1990s. The Russian economy had an unstable currency with an ever-falling output until the new century. It became a fast-growing country from the early 2000s until the global financial crisis. As the second largest oil exporter in the world, Russia’s financial markets and real economy have always been significantly vulnerable to oil price changes. High (low) oil prices improve (deteriorate) a country’s terms of trade and increase (decrease) foreign currency reserves, thus strengthening (weakening) the economy. Until the global financial crisis, increasing oil prices contributed to strong growth performance. However, when oil prices fell from $129 per barrel to $64 in 2009, the Russian economy experienced a deep recession (Hanson, 2014). Stabilization funds constituting oil revenues helped overcome the crisis with the least damage. In the following years, the state of the economy moved in line with the oil prices.

Although Russia was the first country to industrialize within the BRIC, it is still an emerging market economy. As an oil-exporting country, Russia has chronic structural problems, such as the inability to balance other sectors. Russia has attempted to expand and diversify its economy; however, it has always been a volatile country in the global sense, as it plays a leading role in both political and geological issues. In addition, there are other structural obstacles to the progress of the Russian economy, such as high corruption, lack of law and order, and difficulty in doing business (Mostafa & Mahmood, 2015). As a result, it is not an underdeveloped country; it has remained an emerging market with a high dependence on oil.

1.1.3. China

China follows a different path from the other countries in BRIC. After the death of the Chinese leader Mao, the country made several economic breakthroughs in the 1990s, such as the privatization of state enterprises, the opening of the stock market, and improvements in health and education systems. With cheap labor costs and competitive exchange rates, China's economy broke growth records every year until the global crisis. Industrialization and urbanization have accelerated through strong domestic and foreign investments and high R&D expenditures. The strong domestic demand from the middle class in the country also provides an advantage for China. On the other hand, China's rapid growth and increasing demand for raw materials and energy inputs has also been an opportunity for resource-rich members of the BRIC, such as Russia and Brazil (Marr & Reynard, 2010). As China is the main trade partner of Brazil, the growth cycles of both countries are significantly correlated (Yanqing Jiang & Dai, 2020). Therefore, the presence of China in BRIC is of critical importance in this regard.

China has an important position in the world economy, with the largest share of global GDP. Other economies also benefit from China's increasing import demand and outward investments (Bottelier, 2014). As a competitive economy, the country is still at the top, although its growth rates have recently lost speed compared to the previous decade. China's economy still suffers from a lack of political reforms and democratic institutions, despite its strong structural characteristics such as a high savings rate, strong financial/fiscal structure, and huge stock markets. The country will offer a more reliable economy to the world if it provides reformist developments.

1.1.4. India

The last country in BRIC is India. Similar to the other group members, it experienced major changes in the early 1990s. It provided a transition to a liberal economy and experienced a structural transformation from agricultural life to industrialization. Since the country is the second most populous country, GDP is consumption-driven at a tremendous rate. It is also a labor-rich country because of the majority of the population being young (Marr & Reynard, 2010). However, the country, which is highly dependent on raw materials and energy, meets this need through imports. India ranks in the top 3 among the countries with the most oil importers, along with China and the United States. India's huge oil demand reinforces the growth performance of BRIC oil exporters, namely, Brazil and Russia.

India has become the 3rd largest Asian economy with its development in the industrial field, breakthroughs in creating a world brand, and regulations made to attract foreign investment. Nevertheless, geological issues as well as religious and cultural turmoil in India make it a volatile country. The Indian economy continues to grow predominantly through local production and consumption. This could be improved if they implemented reforms that attracted foreign capital.

The BRIC countries catch their eyes in the global economy with high growth rates in the first place. The fact that each member has its own characteristics ensures heterogeneity within the group. Although Brazil's natural resource richness is at the forefront, Russia has been a net oil exporter for many years. China is notable for its cheap labor and competitive production. On the other hand, India stands out for its strong domestic demand. On the contrary, the common deficiencies of BRIC countries are the prevalence of corruption, the lack of democratic practices, and the abundance of geopolitical issues. If the necessary official regulations can be made in these matters, the BRIC countries will be among the supreme economies in the future.

1.2. The Role of Oil in BRIC

Oil is a primary source of energy worldwide. Thus, the BRIC countries are of great importance. BRIC consists of two types of countries: oil-exporting (Brazil and Russia) and oil-importing (China and India). This structure suggests that the effects of oil prices vary between the two types. However, both BRIC oil exporters and importers are highly dependent on oil, intensifying the effects of oil price changes in both groups. Oil is an important revenue stream for oil exporters, whereas an important cost factor for oil importers. Overall, oil prices exert substantial effects on BRIC, although the direction of these effects varies considerably across the two types of BRIC countries.

1.2.1. The role of oil in the exporters

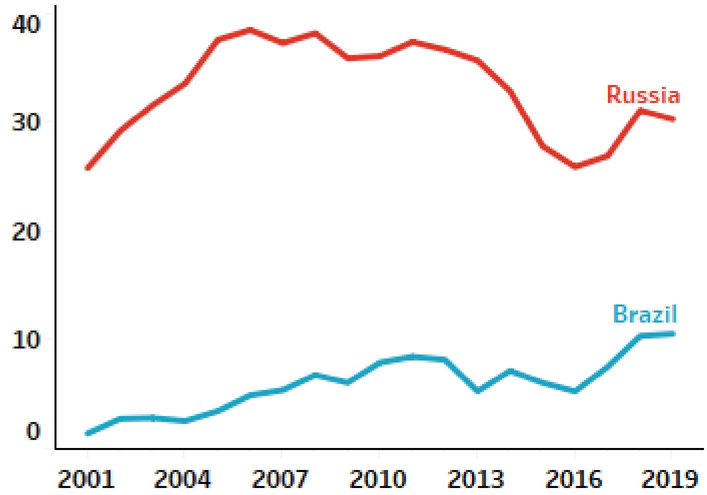

Figure 1.4. *The share of oil in the exports of Russia and Brazil (%). (OEC)*

Figure 1.4 shows the share of oil in Brazil and Russia's exports. This figure reveals that the share of oil in Russia's exports is very high; that is, oil accounts for one-third of the exports. Russia is also the second largest oil-exporting country (see Figure 1.5).

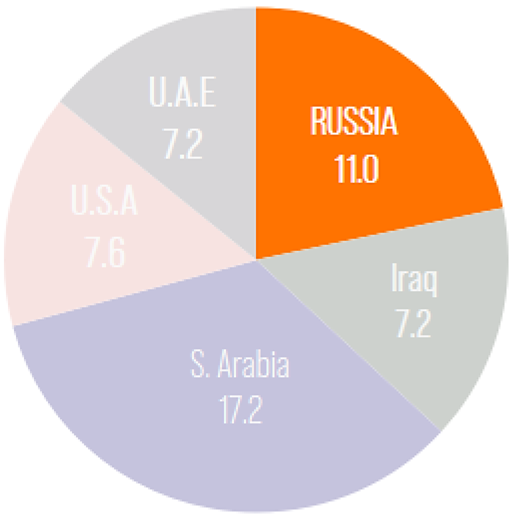

Figure 1.5. *Global oil export share by country (%). (Statista, 2020)*

In Russia, oil is a source of large amounts of government revenue and foreign currency reserves (Sadorsky, 2001). Thus, high oil prices stimulate the Russian economy, whereas low oil prices cause the economy to lose its growth power (Rautava, 2004). Thus, changes in oil prices influence the economy through revenue and reserves. Oil-driven export revenue fluctuations shift all the dynamics of the economy. In an oil-exporting economy such as Russia, the export of petroleum-based products is more attractive than that of non-oil tradable goods, decreasing the importance of non-oil sectors, thereby resulting in a non-diversified export structure. Owing to this lack of export diversification, the Russian economy is more vulnerable to oil price fluctuations than any other country. If the price of this energy source fluctuates, then the Russian economy fluctuates in accordance with oil price changes, as a natural result. Figure 1.6 provides important evidence to support this argument. This figure indicates that Russia's growth path is closely linked to oil prices: each oil downturn (surge) is followed by a sharp decline (increase) in growth. Overall, these figures highlight the crucial role of oil in Russian business cycles (Pönkä & Zheng, 2019).

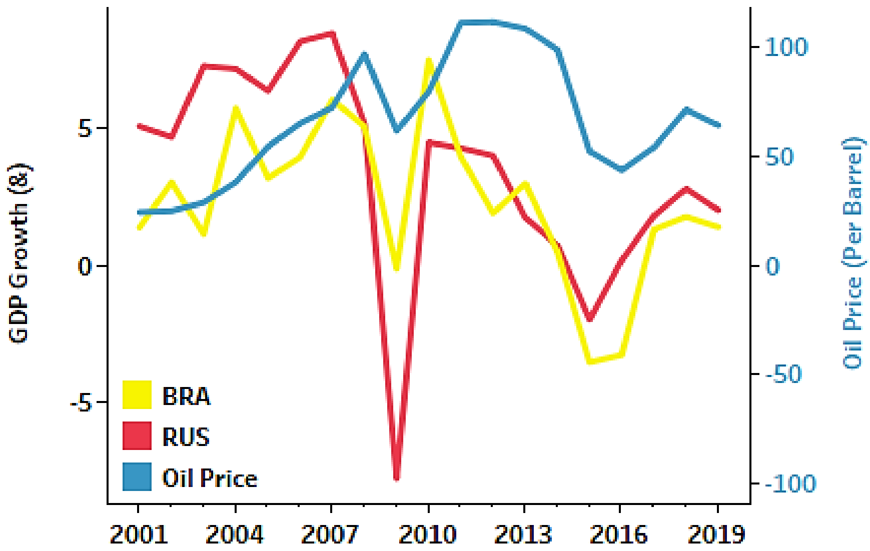

Figure 1.6. *The GDP growth of Russia & Brazil and Oil Prices (The correlation between growth and oil prices is -0,09 and 0,25 for Russia and Brazil, respectively.) (The World Bank & DataStream)*

By contrast, the share of oil in Brazil's exports was lower than that of the Russian economy. However, the oil share has increased since the emergence BRIC in 2001. In domestic markets, Brazil has increased its investments in large-scale exploration to bring the energy sector to the forefront (Kumar, 2016). The Brazilian economy, which has been self-sufficient in oil since 2006, has focused on oil exports, creating a large source of revenue for the country. As oil exports have the power to change the revenue stream in the economy, fluctuations in oil prices have a direct impact on real and financial markets.

Figure 1.6 clearly indicates that the Brazilian economy fluctuates with the price of oil: an increase in the oil prices positively affects the economic growth by heightening Brazil's earnings (Ferreira, Pereira, & Silva, 2020; Mo, Chen, Nie, & Jiang, 2019). Similar to Russia, Brazilian exports have remained undiversified. There have been efforts to reduce the dependence on oil in exports, but the Brazilian economy is still sensitive to oil prices.

Brazil and Russia are oil exporters. Oil is a gold pot for these economies. Fluctuations in oil prices alter the dynamics of the two economies through government revenues and foreign currency reserves. Thus, the oil-producing economies of BRIC, especially Russia, are highly vulnerable to oil price movements because of limited diversification in their exports. Overall, a fundamental characteristic of the two economies, notably Russia, is the large dependency on one sector, namely oil.

1.2.2. The role of oil in the importers

The country with the largest GDP has a massive energy demand. From this perspective, China is a catalyst for the demand in this group. Most of this demand is met within the BRIC region, especially in Brazil (Yanqing Jiang & Dai, 2020). Thus, China's oil demand positively affects the economies of its foreign trade partners[5].

For China, oil, one of the necessary inputs for production, is an essential energy source. Thus, price is an important driver of China's production costs. An increase in oil prices increases production costs, causing inflation and discouraging producers from production. On the contrary, if oil prices decrease, the production cost decreases, and the economy strengthens with growing production. Figure 1.7 shows that the share of oil in the country's imports is increasing. These observations suggest that oil is a crucial determinant of production costs, stressing the importance of oil in China's business and financial cycles.

[5]The fact that the largest trading partner is China also demonstrates the significance of oil in the group. Brazil's share of oil exports to China increased from 4.62% in 2001 to 63.8% in 2019. (https://oec.world/en/visualize/tree_map/hs92/export/bra/show/52709/2019/)

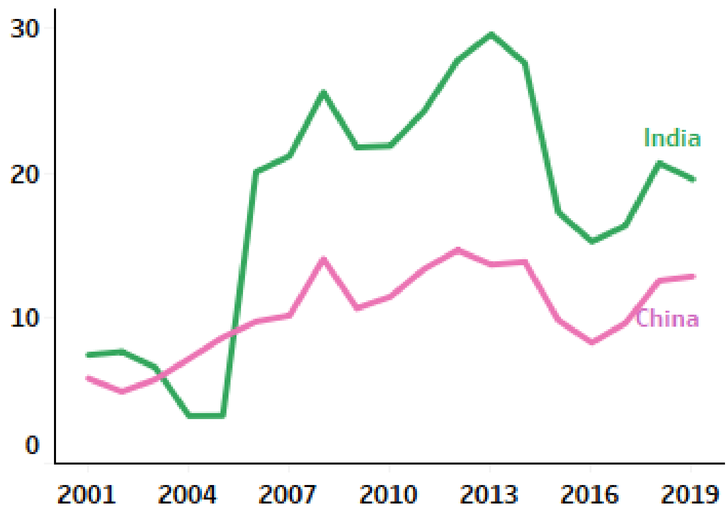

Figure 1.7. *The share of Oil in the Import of China and India. (%)* (OEC)

Oil constitutes one-fifth of India's imports, which is one of the group's oil-importing countries (see Figure 1.7). The expansion of India's oil imports has been astonishing. Although oil was not meaningful in the early 2000s, it gained great importance with increasing industrialization and urbanization. Oil consumption is almost indispensable for India since it is one of the main components enabling industrialization (Dash, Sethi, & Bal, 2018; Nasir, Naidoo, Shahbaz, & Amoo, 2018).

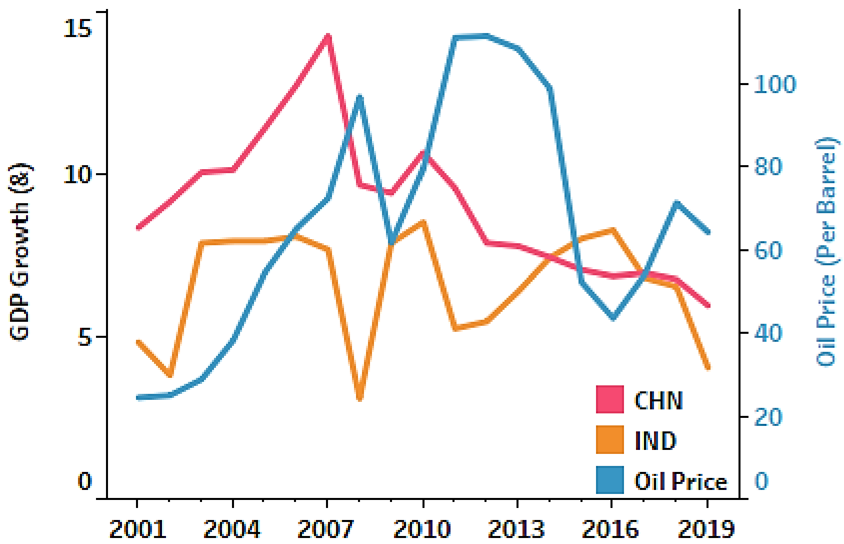

Figure 1.8. *The GDP growth of China & India and Oil Prices (The correlation between growth and oil prices is -0,03 and -0,16 for China and India, respectively.) (The World Bank & DataStream)*

In the economy, oil is both an energy source that triggers production and an input cost. Thus, oil price volatility has significant implications. Figure 1.8 depicts oil price decreases have a positive effect on the country's GDP, while negative effects occur when prices surge (Sadath & Acharya, 2018). The exploitation of oil in production, the biggest catalyst for GDP growth, affects the economy, depending on the direction of oil price changes. An oil price slump (rise) boosts (shrinks) GDP by reducing (surging) costs and increasing (decreasing) production.

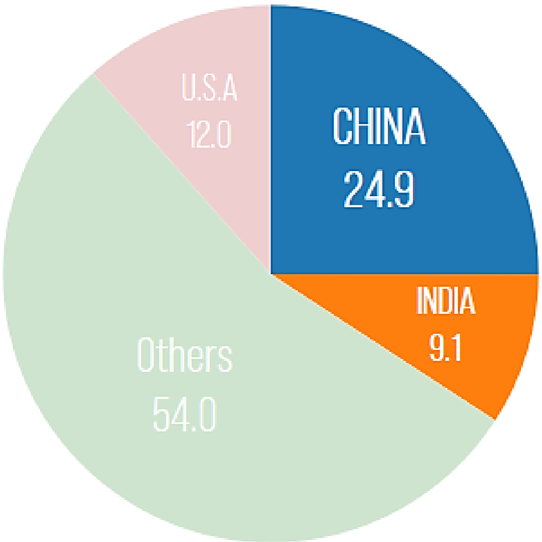

Figure 1.9. *Global oil import share by country (%). (Daniel Workman, 2020)*[6]

China and India are the oil importers of BRIC. The share of oil imports in both the economies is spectacular. The dependence on oil is greater than in other countries since their oil imports account for 36% of the world's total (See Figure 1.9). Strong domestic demand and rapid industrialization have increased the need for oil. However, this makes both economies susceptible to oil price shocks. Such shocks change the fundamental dynamics of economies through disruption of expenditure-income balance as well as shaking in production. To avoid negative effects, China has attempted to switch to different resources, such as coal, but this seems unlikely for India. Diversification efforts aside, these two huge economies, which desire to continue to produce and grow, continue to need oil and remain affected by oil price shocks.

1.3. The Global Financial Integration of BRIC

All four BRIC countries transitioned to open economies in the 1990s. After solving their economic problems, these countries have attracted the attention of global markets in the 21st century. Measures to eliminate physical boundaries in the world have accelerated the integration of all economies. BRIC countries have attracted global market investors

[6]It is available on https://www.worldstopexports.com/crude-oil-imports-by-country/.

because of their rapid growth and demand for commodities owing to their growing population. In particular, their rapid recovery from the 2009 global crisis compared to other countries has further increased this interest even more (C. Jiang & Yao, 2017). The presence of deeper problems in other emerging markets has reinforced investors' focus on BRIC. With high savings and investment rates, China and India have outperformed their rivals and made BRIC more tempting (Chorafas, 2014). After BRIC gained attention, foreign investors directed their investments toward these countries. Figure 1.10 shows the portion of government bonds issued in the local currency held by foreign investors. In particular, after 2008, the share of foreign investors increased significantly in all BRIC countries. Following 2016, foreign holdings exhibited a decreasing trend in Brazil, Russia, and India, but there was a sharp rising trend in China during the same period.

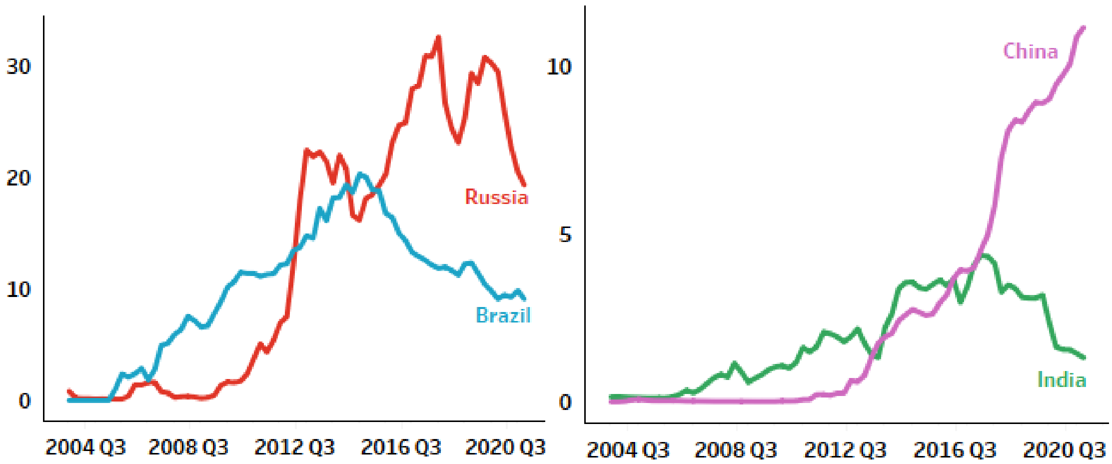

Figure 1.10. *The Foreign Holdings of Local Currency Central Government Debt Securities (%)*
(Arslanalp & Tsuda, 2014)

Until the mid-2010s, the positive grades from credit rating agencies (S&P, Moody's, and Fitch)[7] made BRIC an investment center. Investors who realized possible gains in financial markets moved to BRIC countries. They managed to attract investors from all over the world as popular investment destinations. Global financial integration has rapidly increased during these times.

Another indicator of financial integration is the foreign ownership and investment restriction index published in the World Economic Freedom Report. The index ranges from 1 to 7. It ranks foreign ownership in companies and the presence of regulations that

[7]https://tradingeconomics.com/country-list/rating

prevent global capital flow. An index value approaching 7 indicates excess foreign ownership and the absence of regulations that prevent the flow of global capital (Chittedi, 2014).

Table 1.1. *The Foreign Ownership/Investment Restrictions Index (World Economic Freedom Report-2019)*

	2000	***2005***	***2010***	***2015***	***2017***
BRAZIL	7,56	6,16	5,99	5,23	5,20
RUSSIA	5,71	4,82	4,23	4,07	4,12
INDIA	4,05	7,40	6,13	5,86	5,84
CHINA	4,66	6,71	6,35	5,76	5,89

The index values for BRIC are shown in Table 1.1. The figures for each country are more than the average of four. The excessive values in the early 2000s fluctuated after the global crisis. Recently, the index value was quite high in all BRIC countries (with the exception of Russia), suggesting that foreign ownership of companies in BRIC countries is strong, and the barriers to capital are quite low. BRIC economies appear to attract capital from foreign investors.

Due to the large presence of foreign investors, BRIC financial markets are highly vulnerable to global shocks such as oil prices and international financial uncertainty shocks. For instance, negative sentiments in global financial markets sharply decrease international investors' risk appetite, cause capital outflows from BRIC, and consequently, throw their financial markets into turmoil. Even though heightened global financial integration makes economies more vulnerable to global shocks through capital flows movements, BRIC economies have maintained a policy of liberalizing financial markets (Zouhair, Lanouar, & Ajmi, 2014).[8] Global integration facilitates the inflow of capital into these countries and supports their economic growth.

[8]Several studies in the literature also show that BRIC is affected by financial turmoil in other countries. For example, Fink and Schüler (2015) and Nicolăescu (2013) show that financial stress in the U.S. has changed the dynamics of the BRIC economies. In addition, Gilenko and Fedorova (2014) find that there is an increasing spillover effect from US, Japanese, and German stock markets to BRICs. The spread of risks and volatility of other countries indicates that the global financial integration of BRIC has been increasing day by day.

1.4. Uncertainty, Oil Price Shocks and BRIC's Financial Markets

The previous section explains the integration of BRIC's financial markets into global markets. It has also been stated that oil has a great significance in these economies. Thus, this section attempts to demonstrate the role of uncertainty in global markets. Oil price shocks are expected to have a greater effect in uncertain periods. Supporting evidence for this expectation is documented in Figure 1.11, which is one of the most important charts of the study.

International financial uncertainty conditions have deep and lasting effects especially for emerging markets (Belke, Dreger, & Dubova, 2019; Das, Kannadhasan, & Bhattacharyya, 2019). This affects individuals' and institutions' decision-making mechanisms. Investors switch to a wait-and-see policy and start fleeing to safe havens to maintain their earnings. In an uncertain environment, where most decisions are postponed, economic activity ultimately declines (Hailemariam, Smyth, & Zhang, 2019). On the financial side of an economy, uncertainty conditions have effects on the components of financial markets such as exchange rate (Mueller, Tahbaz-Salehi, & Vedolin, 2017), interest rates (Wu, Yao, Chen, & Jeon, 2020), stock prices (Dakhlaoui & Aloui, 2016), and bond markets (Gilchrist, Sim, & Zakrajšek, 2014). Moreover, since BRIC comprises emerging markets, they are considered more vulnerable to international financial uncertainty than advanced countries. Thus, the effects of oil shocks on BRIC financial markets are deepened by uncertain conditions.

For a deeper preview, the first row in Figure 1.11 shows a volatility index with oil prices, highlighting periods of uncertainty with a band.[9] Subsequently, sovereign risks, bond yields, exchange rates, stock prices, and short-term interest rates are presented. The figure is separately demonstrated for oil exporters (Russia-Brazil) and importers (China-India).

[9]The uncertain times are represented by UT.

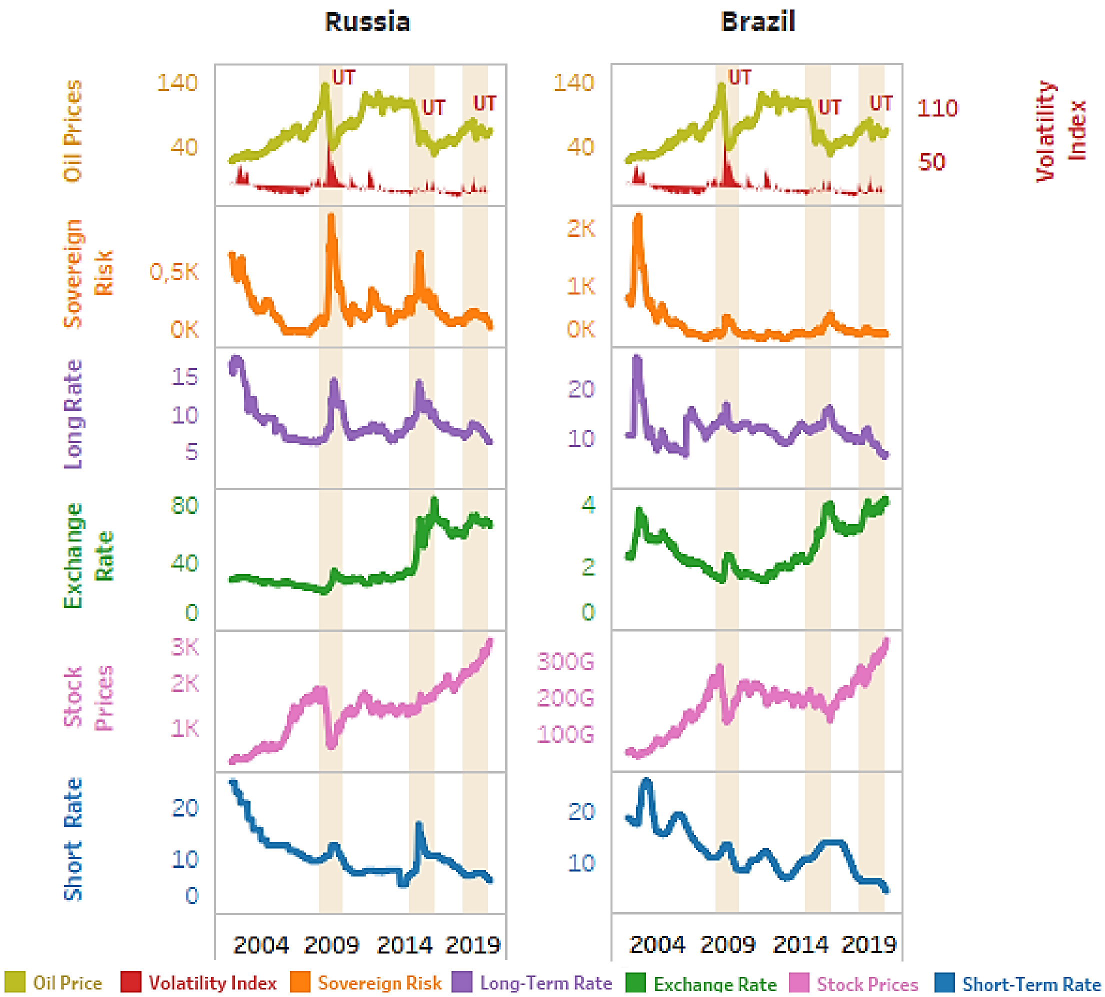

Figure 1.11. *The Stylized Facts of BRIC Countries*

(*Notes:* Sovereign risk is measured by the country level EMBI Spread, long rate is measured by the 3-year government bond yields, exchange rate is represented by bilateral US dollar exchange rate, stock prices are proxied by Morgan Stanley Capital International (MSCI), and short-rate is measured by policy rate.)

At first glance, Figure 1.11 clearly shows that negative oil price shocks affect the financial markets of oil in BRIC. These shocks raise sovereign risks, bond yields, short-term rates, depreciate exchange rates, and reduce stock prices in BRIC oil exporters. However, for oil importers, China and India, the opposite is true. Oil price declines create a positive mood in the financial markets of these economies. In addition, during periods of international financial uncertainty, highlighted by the shaded band, the effects are much stronger. Overall, stronger effects of oil price shocks on BRIC markets are observed, while uncertainty prevails in the international financial market.

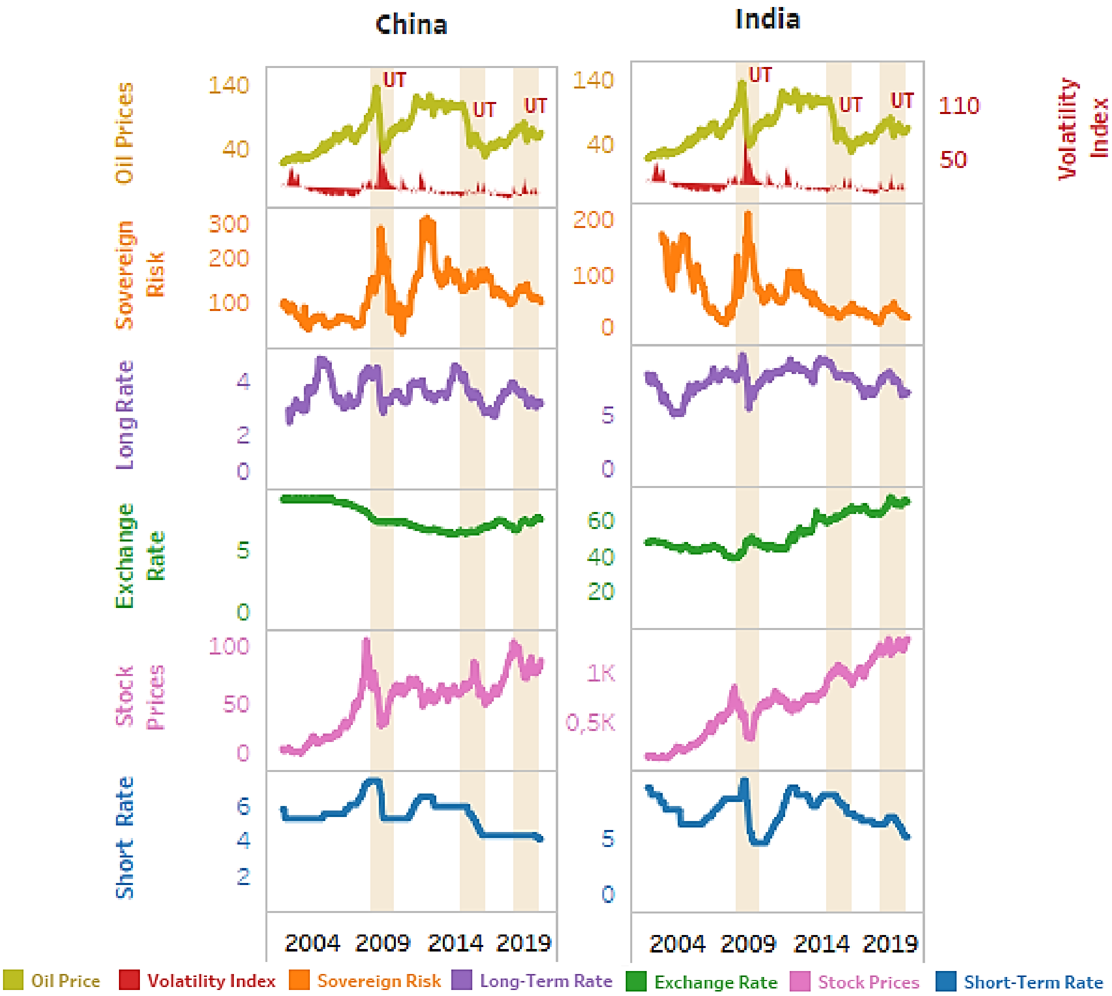

Figure 1.11.(Continue) *The Stylized Facts of BRIC Countries*

(*Notes:* Sovereign risk is measured by the country level EMBI Spread, long rate is measured by the 3-year government bond yields, exchange rate is represented by bilateral US dollar exchange rate, stock prices are proxied by Morgan Stanley Capital International (MSCI), and short-rate is measured by policy rate.)

In sum, negative oil shocks adversely affect the financial markets of BRIC oil exporters, while positively affecting those of oil importers. However, considering the uncertain international financial conditions, the impact of oil price shocks is expected to be deeper and more permanent. Therefore, in the next sections, the theoretical background is first presented, and then the impact of oil price shocks on the financial markets of BRIC countries during uncertain times is investigated.

CHAPTER TWO

2. OIL PRICE SHOCKS, FINANCIAL MARKETS AND UNCERTAINTY

This chapter aims to reveal the theoretical relationships among oil, uncertainty, and financial markets. It comprises four sections. The first section explains the importance of oil concisely. The second section focuses on the determinants of oil prices. The third section explains the oil-financial market nexus. The last section explores how oil price shocks affect financial markets under uncertain conditions.

2.1. The Significance of Oil: A Brief Explanation

Oil is an energy source used in the production of a typical economy. It has a place in many economic fields, including manufacturing, transportation, residency, and agriculture. Since it is extracted from the ground, some countries can produce it from their soil; others have to import it from outside. Thus, countries can be classified into two groups: oil exporters and oil importers. Oil is a means of income for exporters and a cost factor for importers. Therefore, changes in oil prices have significant effects on both types of economies. These effects depend crucially on two factors: the direction of oil price changes (negative or positive) and the type of economy (exporter or importer).

2.2. The Determination of Oil Price

There are a great deal of factors that affect oil prices (EIA, 2022). Figure 2.1 summarizes these factors concisely. Fundamentally, the dynamics of supply and demand are the main factors that determine the price of oil, as well as throughout the economy. When demand increases or supply decreases, price rises, and vice versa. Oil producing countries constitute the supply of oil. Thus, the Organization of Petroleum Exporting Countries (OPEC) may affect oil prices (EIA, 2021) through production decisions. In addition, because of new oil discoveries, such as shale oil[10], an increase in the oil supply implies a downward fluctuation in its price.

[10]The type of oil, which is extracted from the rock fragments thanks to advanced technology, has had an impact on oil prices (Belu Mănescu & Nuño, 2015).

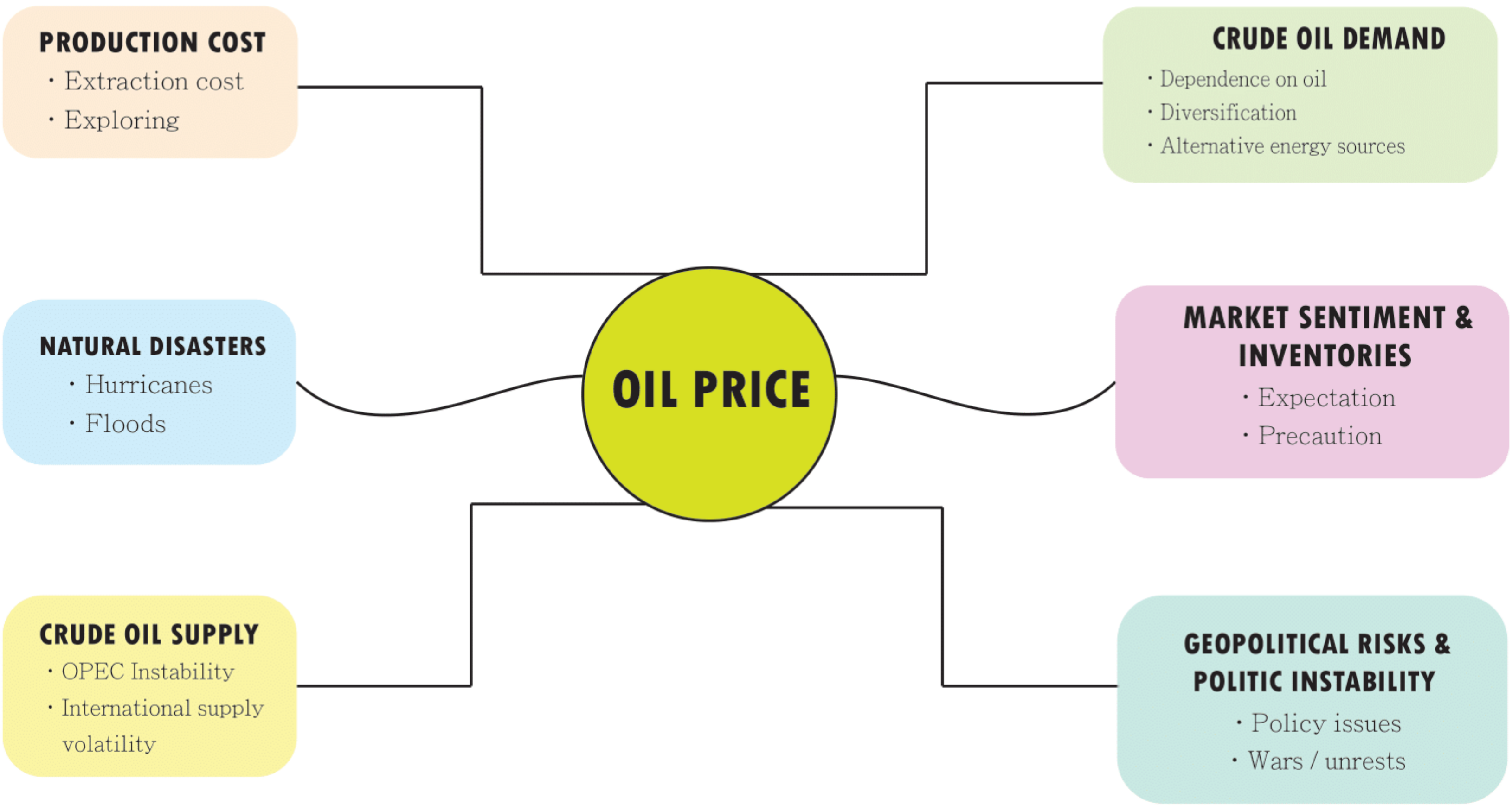

Figure 2.1. *The Determination of Oil Price*

On the demand side, surging or diminishing oil consumption affects oil prices, depending on the state of the economy. Another issue affecting oil demand and price is the transition to renewable energy sources. Replacing alternative energy sources with oil could lead to a decrease in the demand for oil[11].

Political and geopolitical tensions are other factors that influence oil prices. Especially in the Middle East, where oil-producing countries are mostly located (Jaffe & Elass, 2015), tensions such as threats of war, civil unrest, and international disputes substantially influence oil prices. Other causes due to geographic location are natural disasters. Extreme natural events, floods, and hurricanes affect oil production and, accordingly, price.[12]

The cost of producing a barrel of oil (extraction, drilling, and pumping) is also a determinant of oil prices. With technological breakthroughs, lower production costs have led to increased production and decreased oil prices. Similarly, as technological tools improve, exploration costs persistently decrease, and it becomes easier to extract unconventional oil types (shale oil). The addition of new oil discoveries to the supply contributes to decreasing prices.

Finally, market expectations affect oil price. Economies increase the amount of oil in their inventory if they foresee oil price volatility. They may also choose to hold massive quantities of oil for precautionary purposes.[13] Thus, future prospects put pressure on oil price.

2.3. The Oil Price Shocks[14] and Financial Markets

Oil is involved in all dynamics of the economy; thus, it has the power to affect financial markets. Oil implies income or expense, depending on whether a country produces it. Income and expense imbalances change the company and its associated profitability in a micro sense. In macro terms, such imbalances alter the current account position and the exchange rate. Simultaneously, since an oil price shock entails risk, it

[11]In particular, it is expected that moving to the use of eco-friendly energy and reducing the dependence on oil will be more critical in the future (Pickl, 2019).
[12]For the impact of hurricanes on oil, in and around the U.S, see Faouzi, Kiefer, and Sean (2018) and Kumins and Bamberger (2005).
[13]This decision is made by comparing the cost of keeping it in inventory with the expectation of future oil prices.
[14]Shocks may be negative or positive in accordance with direction of changes. However, this study concentrates the effects of negative oil price shocks.

disturbs the decision-making mechanism of investors. As investors' risk aversion increases, they abstain from making decisions on investment instruments such as stocks, bonds, or interest.

2.3.1 Financialization of Oil

Oil is generally associated with both production and energy. However, oil is an important asset traded in financial markets. Oil derivatives (futures and options) have become widespread in financial markets, significantly accelerating the financialization of oil. (Tudor & Anghel, 2021). In addition, oil might be a means for investors to differentiate their portfolios, especially as a hedge against inflation and a weak US dollar (Fattouh, 2012).

Figure 2.2 demonstrates the share of future commodity contracts on the Dow-Jones stock exchange. The energy sector has an overall share of one-third, half of which originates from oil. Oil has emerged as a financial asset with a large share in both the energy sector and the total commodity market. The volatility in oil prices, thus, is attributed to the existence of speculative behavior in financial markets (Ma, Ji, & Pan, 2019).[15] In addition, this type of behavior makes it difficult to predict spot and future prices. This generates uncertainty regarding the formation of prices (Fattouh & Mahadeva, 2012).

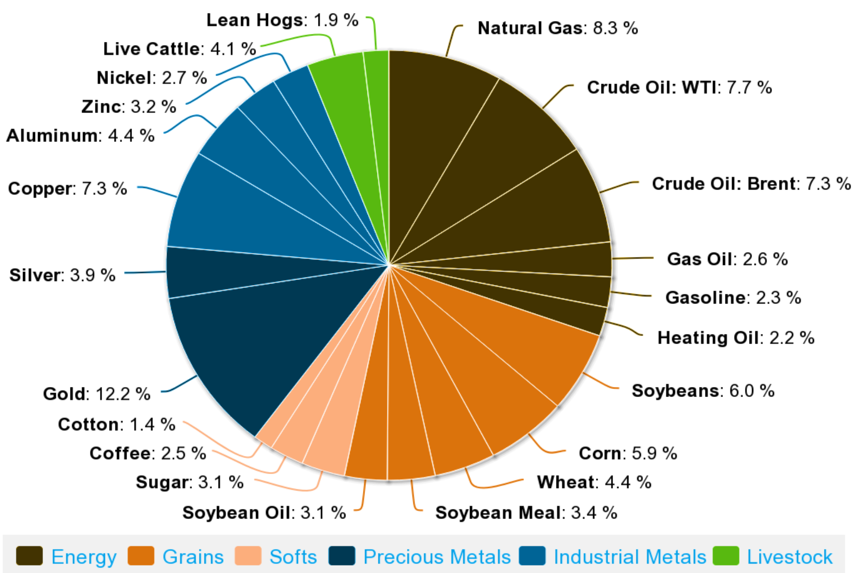

Figure 2.2. *Composition of Bloomberg L.P. Commodity Index. (Bloomberg, EIA, 2019)*

[15]See also Baruník and Kočenda (2019) for connectedness among currencies and oil.

The financialization of oil substantially intensifies the dynamics between oil and financial markets. With numerous investors taking an active role in the oil market, the spillover of oil price shocks strengthens with herd behavior (Brunetti, Buyuksahin, & Harris, 2013). Overall, with the rapid financialization of oil, changes in oil prices are expected to have more powerful effects on the financial markets of economies, especially oil-exporting economies through strong financial effects. Figure 2.3 illustrates the theoretical effects of oil shocks on the financial markets of oil exporters and importers. The following sections explain the theoretical links between oil and financial markets.

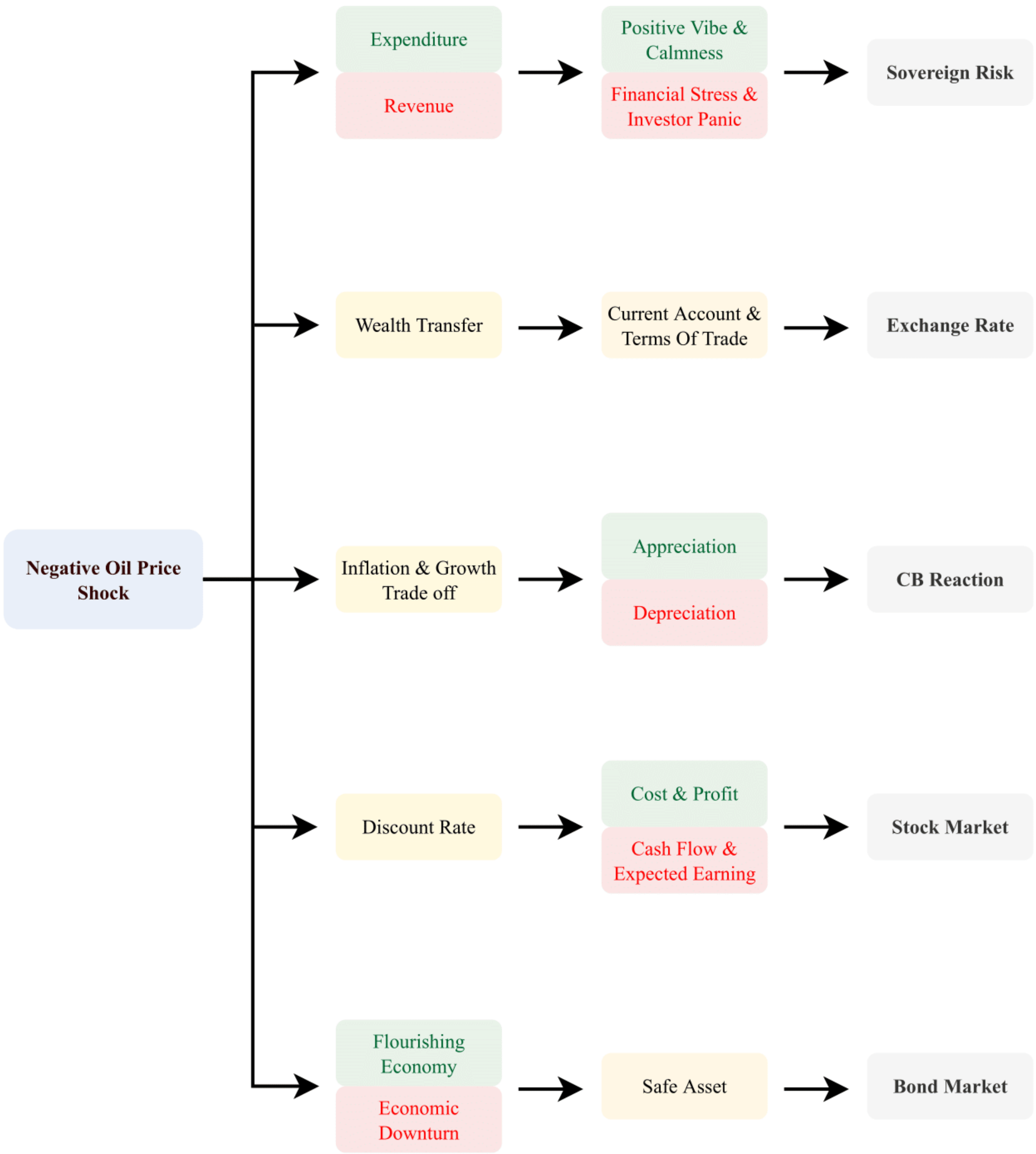

Figure 2.3. *The Transmission Channel of Negative Oil Price Shock (The green boxes denote the shock transmission for oil importers, while the red boxes indicate the transmission for oil exporters. The boxes other than these refer to common transmission mechanism*

2.3.2. Sovereign risk

Sovereign risk is a type of credit default risk that arises when a government fails to meet its internal or external debt and payment obligations. The financialization of oil has made sovereign risk more responsive to oil shocks.

Oil price shock can pose a risk for both advanced and developing countries (J. Wang, Sun, & Li, 2020). Following sharp movements in oil prices, a significant threat to the financial system may emerge in emerging markets, especially those with a high oil dependency ratio, such as BRIC. Indeed, the response of sovereign risk to oil shocks varies depending on the type of economy: oil-exporting economies (Russia and Brazil) and oil-importing economies (India and China). Negative oil price shocks increase the sovereign risk of oil exporters, while such shocks decrease the risk of oil importers[16] (Lee, Lee, & Ning, 2017). Since oil generates government revenue for exporters, a negative development in oil prices directly affects fiscal policy.[17] Consequently, the deterioration of fiscal balance is reflected in a country's risk (Devlin & Titman, 2004; El Anshasy & Bradley, 2012). However, oil price shocks play a key role in driving financial stress. Oil shocks influence financial systemic stress and investor sentiment (Qin, 2020; Shahzad, Bouri, Raza, & Roubaud, 2019). In an oil-exporting economy, sharp oil price decreases may cause investor panic and heighten volatility in the financial markets. Under these extreme volatile conditions, investors quickly flee from risky markets. Consequently, oil shocks may pose a significant threat to financial markets by jeopardizing the fiscal dynamics in a typical oil-exporting economy.[18]

2.3.3. Exchange rate

Oil trades in global markets in an international reserve currency, namely, the US dollar. Thus, the link between oil prices and the bilateral US exchange rate is crucial for both oil exporters and importers. Furthermore, the exchange rate is more responsive to oil shocks than other energy sources due to instruments such as oil futures (Lin & Su,

[16]This kind of oil price shock reduces the sovereign risk for oil importers. The cheapening of oil improves the payment of balance by reducing the oil expenditures. The fall in oil price also leads to surges in growth, creates positive macroeconomic prospects, and makes financial markets more attractive.
[17]Wegener, Basse, Kunze, and von Mettenheim (2016) shows that positive oil shocks reduce the sovereign risks through the boosting of revenue in oil producing countries.
[18]See relevant studies for further information (Antonakakis, Chatziantoniou, & Filis, 2014; Liu, Sun, Chen, & Li, 2016; Sharma & Thuraisamy, 2013).

2020). The rapid financialization of oil intensifies the responsiveness of the exchange rate to oil price fluctuations by strengthening the exchange rate-oil price nexus.

A common view in the literature is that oil prices affect the exchange rate[19] through three channels: wealth transfer, terms of trade, and common factors. P. Krugman (1983); (1980) and Golub (1983) claim that oil prices influence the exchange rate because of the distribution of wealth between importers and exporters. An oil price increase is the transfer of wealth from importers to exporters, resulting in the current account surplus (deficit) of exporters (importers) and appreciation (depreciation) of local currencies (Baghestani et al., 2019). In terms of trade channels, oil price surges increase the price of tradable goods more than in foreign countries, which leads to a depreciation of the home country's currency (S.-S. Chen & Chen, 2007). The third and final channel is the so-called common factor, which refers to the indirect relationship between exchange rate and oil. This channel indicates that inflation, GDP, stock, and interest rates may simultaneously affect oil and exchange rates (Soytaş & Sarı, 2019). Consequently, oil shocks influence the exchange rate through wealth transfers, terms of trade, and common factor mechanisms (Syed Abul Basher et al., 2016; Lizardo & Mollick, 2010).

On the other side, the exchange rate regimes also matter to the transmission of oil shocks. The literature suggests that flexible regimes are more effective in absorbing oil shocks than fixed (pegged) regimes (Broda, 2004; Hoffmann, 2007). The flexible exchange rate buffers the effects of oil shocks by facilitating price formation in the economy (Al-Abri, 2013). In contrast, the fixed or pegged exchange rate regime is inadequate for setting prices. This regime does not allow the economy to stabilize easily. Consequently, this line of literature reveals that the transmission of oil shocks to the economy depends not only on the type of economy [oil-exporter or oil-importer], but also on the exchange rate regimes [fixed or floating] adopted by the economy.

2.3.4. Short rate

Short-term interest rate is a conventional monetary policy instrument. Central banks in both oil-exporting and oil-importing economies actively respond to oil shocks by

[19] Although it is unanalyzed in this paper, studies in which the exchange rate affects oil prices are also quite prevalent in the literature (Beckmann & Czudaj, 2013; Reboredo, 2012; Sadorsky, 2000; Zhang, Fan, Tsai, & Wei, 2008; Zhang & Wei, 2010). See also for studies investigating the oil-exchange rate relation through disentangling oil shocks (Atems, Kapper, & Lam, 2015; Syed Abul Basher, Haug, & Sadorsky, 2016; Kilian et al., 2009).

changing their policy rates, because such shocks may disrupt price, output, and financial stability.

Monetary policy reactions to oil price shocks depend on the type of shock [negative or positive oil shocks] and the structure of the economy [oil-exporting or oil-importing]. Negative (positive) oil price shocks lessen (raise) government revenues and curtail (boost) consumption and investments, thus causing an economic downturn (demand-driven inflation) for oil exporters (Filis & Chatziantoniou, 2014). At the same time, oil price decreases worsen their revenue in foreign currencies, causing the depreciation of local currencies. By contrast, negative (positive) oil price shocks for oil importers decrease (increase) production costs, retain (transfer) wealth, and cause their economies to boom (stagnate). Finally, given that their payments in foreign currencies have also fallen, their currencies are expected to appreciate.

Monetary policy decisions vary according to the monetary authority's priorities. Central banks choose to stabilize their output or price level (Ahmed, Bhutto, & Kalhoro, 2019). As negative oil shocks trigger rising inflation in oil-exporting economies, monetary authorities can increase the interest rate to suppress depreciation and inflation; however, this may hinder economic growth. On the contrary, when the central bank lowers the policy rate to offset the negative impacts on output, it can put upward pressure on inflation. With the high oil dependency of oil-exporting economies, central banks are expected to implement tightening monetary policies because the depreciation of the exchange rate poses a severe inflation threat. On the other hand, the negative oil shock-monetary policy relationship differentiates in oil importers. The shock generates room to maneuver for the monetary authority, as it allows exchange rates to appreciate and reduce inflation. In these countries, central banks have the opportunity to support macroeconomic stabilization by decreasing interest rates.

Eventually, considering all of this context, the final decision is made through a trade-off between growth and inflation. If the monetary authority's priority is to stabilize prices, the central bank puts forward a contractionary monetary policy, whereas the choice is an expansionary monetary policy when the first concern is output stability.

2.3.5. Stock market

The stock market is an important financial system player that brings investors and corporations together. It allows companies to grow and develop while investors profit. Since stock markets play an active role in the financial structure, they remain vulnerable to external shocks such as oil shocks.

Oil price shocks affect stock markets through several channels. First, oil shocks cause fluctuations in companies' cash flow and expected earnings. The effect is either positive or negative, depending on the status of the country (oil exporter or importer). Because oil prices decrease (increase), corporations' cash flow in oil-exporting countries diminish (accelerates), and expected earnings weaken (strengthen). For oil importers, oil price declines have a positive effect on cash flow and earnings by reducing production costs.

The discount rate is the second channel through which oil shocks affect stock markets. It is composed of expected inflation and expected real interest rate. Oil price shocks have the power to affect both discount rate components. Negative (positive) oil price shocks generate upward pressure on oil exporters' (importers') inflation by depreciating the local currency (production costs). This also leads to an increase in interest rates to suppress inflation (R. D. Huang, Masulis, & Stoll, 1996). As the discount rate is negatively associated with stock returns, this process results in a downward slide for the stock market.[20]

The effects of oil shocks on the stock market have been proven, but the impacts might vary depending on the circumstances. The share of oil companies in the stock market, their profitability, and investor portfolios diversify the effects of oil shocks (Nandha & Faff, 2008). In addition, various effects might occur depending on the source of oil price shocks (Demirer, Ferrer, & Shahzad, 2019; Ready, 2018).

2.3.6. Bond market

The bond market is the final component of the financial market examined in this study. Since financial investors also hold bond in their portfolios as instruments, oil price fluctuations directly affect bond yields. Moreover, the bond market is closely related to

[20]Moreover, investors also shift from stocks to bonds as rising interest rates make the bond market more attractive (Syed A Basher & Sadorsky, 2006).

country risk, because it is a long-term asset issued by the government. A possible oil shock can cause negative expectations for the future and change bond investors' decisions.

The ways oil prices impact government bond yields are through economic prospects, inflation expectations, and budget balance (Filippidis, Filis, & Kizys, 2020). Negative oil price shocks adversely affect oil exporters' economic activities. The resulting pessimistic expectations and lower money demand lead to high interest rates and steep bond yields. On the other hand, investors may decide to withdraw their bonds from economies in which negative oil shocks pose risks. Risk aversion leads to the movement of bond prices and returns in opposite directions. On the importer side, oil price drops create a positive environment and encourage the acceleration of financial investments, including bonds (Nazlioglu, Gupta, & Bouri, 2020).

In oil-exporting economies, low oil revenues and deterioration in the balance of payments are associated with depreciation of the local currency and rising inflation expectations. Considering that bonds offer a fixed-rate return, pessimistic expectations for the future result in lower bond yields in real terms. When monetary authorities raise interest rates to suppress rising inflation expectations, bond yields tend to increase.

In the last channel, rising budget deficits of oil-exporting economies with decreasing oil revenues cause increased bond demand, a public debt instrument. Lower oil prices threaten to disrupt the fiscal structure, causing higher borrowing needs (Mishra & Roy, 2022). This borrowing demand is made possible by offering investors higher bond yield.

As negative oil shocks reflect increased risk for oil-exporting countries, financial investments in these economies fly to safe havens. During these times, investments in safer assets such as US Treasury bonds have become more preferable (Demirer et al., 2019). Considering that oil decline reveals a positive climate for oil importers, bond markets are expected to be stimulated. However, its effect on treasury bonds also depends on the strength of the economy. In economies whose financial markets are undeveloped and do not reassure investors, even if the oil shock has a positive outcome, bond markets deteriorate.

2.4. Uncertainty

Uncertainty is an environment in which negative expectations about the future, unpredictability, and risk aversion become widespread. Uncertainty may alter economic relations and policies by affecting the decision-making processes. Following the pioneering study of N. Bloom (2009), uncertainty has gained popularity. N. Bloom (2009) suggests that uncertainty leads to sharp declines and recovery in output, unemployment, investment, and productivity. Therefore, uncertainty is a major concern for consumers, investors, and policymakers.

Measuring uncertainty in an economy may be challenging. Because this is a much more intuitive phenomenon, there is no concrete and standard measurement technique. However, there are some uncertainty measures for consumption, investment, stock markets, fiscal policy, and many other areas.[21] Three of them are commonly used for uncertainty more than others since they cover a wide range interval and are updated regularly (Aastveit, Natvik, & Sola, 2017). These are economic policy uncertainty (EPU), macroeconomic uncertainty (JLN), and volatility index (VXO) (Table 2.1).

When there is uncertainty in an economy, different mechanisms come into play compared with normal times. First, companies and consumers adopt a wait-and-see approach to prevent undesirable consequences. This behavior pushes the economy into a recession by reducing investment and employment (Denis & Kannan, 2013). The wait-and-see mechanism worsens the economy.

Another channel that emerges during periods of uncertainty is precautionary savings. In the expectation that uncertainty fuels future investment and unemployment, and thus lowers income, consumers increase their precautionary savings to smooth out their consumption (Edelstein & Kilian, 2009). As an increase in savings boosts leakage in the economy, it ultimately triggers a further decrease in economic activity.

[21]See other significant studies for further information. (N. Bloom, 2009; Fernández-Villaverde, Guerrón-Quintana, Kuester, & Rubio-Ramírez, 2015)

Table 2.1. *The Measurements of Uncertainty*

Economic Policy Uncertainty (EPU)	Macroeconomic Uncertainty (JLN)	Volatility Index (CBOE-VXO)
The economic policy uncertainty (EPU) index constructed by Baker, Bloom, and Davis (2016) covers the period from 1996-December to the present day although it is available from 1985 for a few countries.[22] It consists of three components. The first component measures the number of terms that indicate economic-political uncertainties in newspapers. The other components are the number of federal tax code provisions set to expire and forecasters' disagreements over inflation, public and local government spending which is reached from federal surveys.	The macroeconomic uncertainty index, JLN [23], constructed by (Jurado, Ludvigson, & Ng, 2015) dates back to 1960 and is updated twice a year. Using time series data consisting of a large number of macroeconomic indicators, they separate unpredictable components. Considering that these parts are more closely related to uncertainty, they construct an uncertainty index through econometric modelling. Due to the wider range of analysis, it is considered to be much more comprehensive than other measures. JLN shows the common (aggregate) uncertainty more sharply since it tries to measure the uncertainties in many firms and sectors.	The Chicago Board Options Exchange's Market Volatility Index, CBOE VXO, is a gauge of uncertainty based on the options on S&P 100 Index. Moreover, a new version of VXO, called VIX is derived from put and call options of S&P 500 Index.[24] They are forward-looking indices as they measure the expected volatility. They are also called the investor fear index since it is a proxy of uncertainty in financial markets (Smales, 2014; Robert E. Whaley, 2000). The VIX is one of the key parameters driving investor expectations in financial markets. The high value of VIX is associated with uncertainty for the future. Since it is a measure of uncertainty in financial markets, it is much more appealing for our study.

Apart from the two macroeconomic channels revealed by uncertainty, investor fear is the last (financial) channel. Not much has changed since Keynes (1936) said that markets fluctuate because of the "animal spirits". Today, the term emerges as investor sentiment and describes the direct reflection of changes in investors' expectations of financial market volatility (Da, Engelberg, & Gao, 2015; De Long, Shleifer, Summers, & Waldmann, 1990). As uncertainty conditions pose a risk to investors, they move their financial assets to risk-free locations. Therefore, heightened uncertainty magnifies the

[22]Available at http://www.policyuncertainty.com/index.html .
[23]JLN abbreviation is inspired by the initials of the authors who construct the index.
[24]More details on methodology and data available at https://www.cboe.com/tradable_products/vix/. See also Robert E Whaley (2009).

effect of oil price shocks. For example, in an oil-exporting economy, while a negative oil price shock causes a decline in FX incomes, heightened uncertainty in financial markets, at the same time, causes capital outflows. Thus, the consequences of negative oil price shocks may be severe for oil exporters.

These three channels, which begin to function with uncertainty, change the effects of external shocks on the economy. Economic prospects decline rapidly in obscurity, and the effects of oil price shocks are amplified in uncertain times when compared to normal calm periods (Evgenidis, 2018). While a negative oil price shock already negatively affects oil exporters, uncertainty conditions deepen these effects of the oil price shock. Since issues such as how persistent the uncertainty is and what its severity is cannot be clearly measured, it is not known exactly how much and to what extent the effect of oil shocks differs. In the next section, we examine how uncertainty alters the impact of oil price shocks.

2.5. Oil, Uncertainty and Financial Markets: BRIC Case

Oil is an important source of energy for all economies, a revenue stream for oil producers, and a cost factor for oil importers. Thus, both oil exporters and importers closely follow movements in global oil prices. The recent rapid financialization of oil, on the other side, strengthens the link between global oil price and financial markets of oil producers and oil importers. For example, in a typical oil-producing country, oil price decreases reduce foreign currency revenue, raise country risk, and cause instability in the exchange rate and financial markets. This process works in the opposite way for oil importers. When oil prices decline, foreign currency payments decrease, pressure on the exchange rate diminishes, and financial markets are ultimately relaxed.

The key figure of this chapter, Figure 2.4, illustrates the transmission of negative oil price shocks into financial markets. For example, a drop in oil prices lowers oil inflows (oil revenue) in oil-exporting countries, leading to a current account deficit. The decrease in foreign currency revenue and the deterioration of the BoP (balance of payment) increases sovereign risk and puts pressure on the local currency. Central banks respond to a decrease in oil prices to stabilize the exchange rate and mitigate the negative effects of oil shocks on financial markets by tightening their policies.

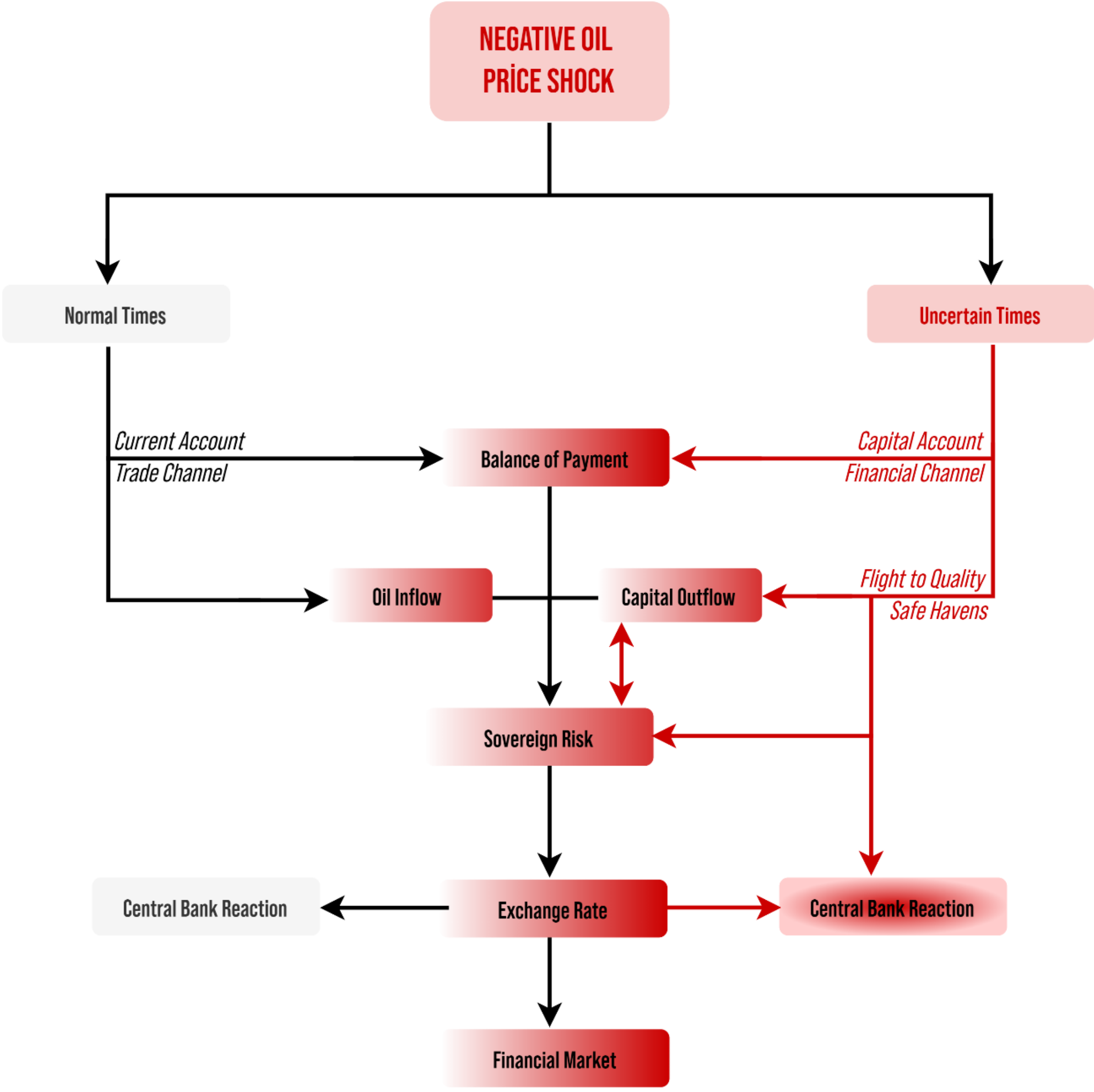

Figure 2.4. *The Transmission Channel of Negative Oil Price Shock in Uncertain and Normal Times. (The red indicates the power of uncertainty. The gray denotes the normal, calm, periods. The colors are used in a gradient way from uncertainty to normal.)*

On the other hand, the existence of uncertain conditions in international financial markets changes all the dynamics. Uncertainty is a phenomenon that delays the decision-making processes of economic agents. Bernanke (1983) and Dixit and Pindyck (1994) emphasize that it is more profitable for investors to delay their decisions. The need to gather more information and better predict how the future will shape is pushing investors to postpone their decisions (Cukierman, 1980). However, consumers tend to change their consumption preferences during periods of uncertainty (Currim & Sarin, 1983). This changes human behavior in all cases.

Delays in decision-making are also critical for oil companies. Uncertainty causes corporations to wait and see their production and investment decisions.[25] If there is global uncertainty in a period of oil price shocks, companies act even more precautionarily because the two effects together pose a higher risk (See Figure 2.4).

Investor perceptions of risk also change during times of uncertainty. Thus, they become more risk-averse. As the main purpose of financial investors is to make profits, they escape from economies where profits are at risk. The flight to quality/safe-haven mechanism works, and the capital flow is directed toward the developed financial markets. As a result, these dynamics in uncertain times make the effects of negative oil price shocks more severe for oil exporters.

The right panel of Figure 2.4 displays the transmission of negative oil price shocks under global uncertainty conditions. Uncertainty conditions lead to the functioning of the BoP's capital flow component. While there is a reduced oil inflow originating from the trade channel in normal times, uncertain conditions lead to a further worsening of the balance of payments through the capital account channel. The rising sovereign risk due to oil shocks in normal times is greater in uncertain times, as uncertainty affects investor behavior (flight to quality/safe haven). Thus, foreign currency outflows for oil exporters are greater through both channels, the exchange rate pressure is higher, and central banks have to take more drastic measures to calm financial markets in uncertain conditions. Therefore, uncertain conditions in international financial markets intensify the effects of oil shocks.

In general, during uncertain times, the transmission mechanism takes place more extremely in oil exporters; however, uncertainty creates a negative atmosphere in all economies, regardless of whether they are oil importers or exporters. Nevertheless, low oil prices might absorb the negative effects of uncertainty on oil importers.

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[25]See Bredin, Elder, and Fountas (2011) and Kellogg (2014) for further information on the link between uncertainty and investment decisions.

CHAPTER THREE

3. THE EMPRICAL ANALYSIS

The objective of this chapter is to present the empirical results of the study. It consists of 4 sections. The first section provides an in-depth literature review. Section two describes the data. The third section presents the econometric methodology. The fourth and final section document the results of the empirical analysis and robustness checks.

3.1. Literature Review

Since the oil shocks in the 1970s and the subsequent global recession, the interaction between oil and the real/financial markets has received considerable attention. A growing number of studies have analyzed this interaction in many countries and markets using different methodologies.

The effects of oil price shocks vary across countries, depending on their oil position. Most studies in the literature focus on the U.S and oil-importing countries. Nonetheless, a few but growing number of studies center on oil-exporting countries. On the other hand, the literature mostly uses a VAR model as a methodological tool to examine the link between oil and real/financial markets. However, recently, non-linear methodological tools such as TVAR and MSVAR have also been used to examine the regime-specific effects of oil shocks. Although different methodological tools have been used, there is a broad consensus in the literature. Accordingly, the consensus suggests that negative oil price shocks cause deterioration in oil-exporting economies and improvement in oil-importing economies.

Energy economics literature focusing on the impact of oil shocks can be classified into several branches (see Figure 3.1). The first two strands focus on the relationship between oil and real/financial markets. The third strand examines the impact of oil shocks on BRIC. Finally, the fourth strand centers on the oil-uncertainty nexus.

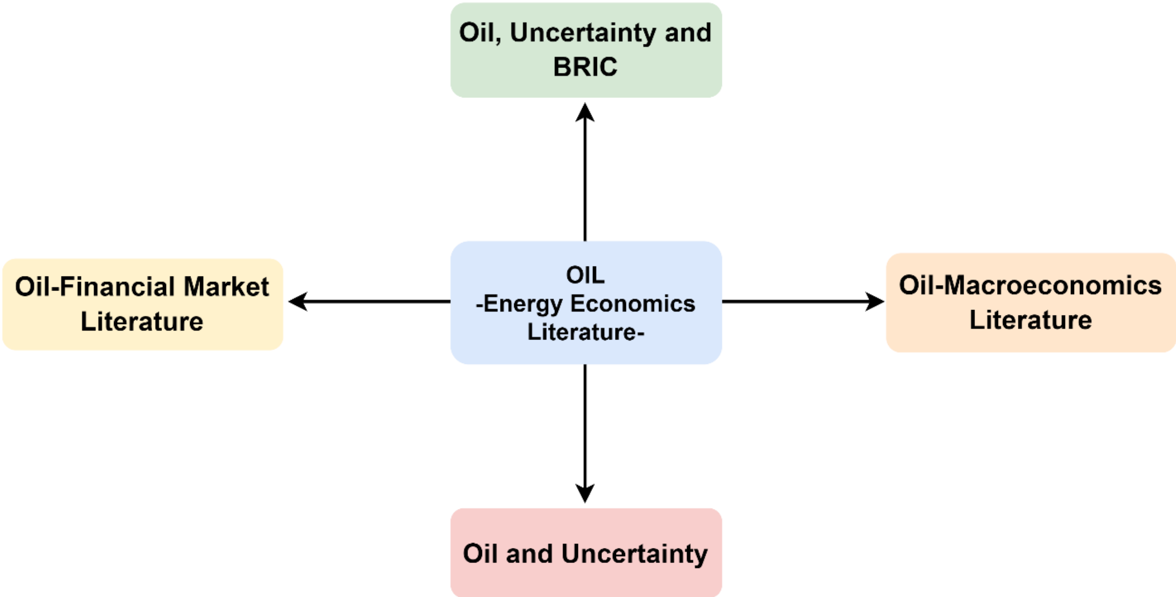

Figure 3.1. *The general structure of literature*

The literature table (Table 3.1) reflects the general structure of the literature through its panels. For instance, Panel A of this table includes studies that examine the macroeconomic effects of oil shocks; Panel B reports studies focusing on the financial effects of oil shocks; Panel C specifically reports studies that investigate the effects of such shocks on BRIC; Panel D documents studies focusing on the regime-specific effects of oil shocks.

3.1.1 The Oil-Macroeconomics Literature

Panel A offers a brief review of the oil macroeconomy literature. Hamilton (1983), a pioneering study, suggests that the seven post-World War II recessions in the US occurred after the rise in oil prices. Following Hamilton (1983), Burbidge and Harrison (1984), Mork (1989) and Rotemberg and Woodford (1996) also examined the effects of oil shocks on rich countries, such as Canada, the UK, and Germany, and found that these countries suffered from declines in economic activities following oil shocks. Ratti and Vespignani (2016) showed that oil prices are the cause of global interest rate and global output. On the contrary, Blanchard and Gali (2007) suggested that the impact of oil shocks was weakened in the 21st century due to the high credibility of the FED policy, the decline in wage rigidities, and reduced oil consumption.

Apart from these studies, this line of literature, the oil-macroeconomy literature, includes many studies focusing on the effects of oil price shocks on macroeconomic indicators of a single country, such as GDP, inflation, trade balance, and employment. For example, Iwayemi and Fowowe (2011) focused on the Nigerian economy, an oil exporter, and revealed that positive oil shocks had no effect on output and inflation, whereas negative oil shocks affected GDP. Papapetrou (2001) explores the responses of macroeconomic indicators to oil shocks in Greece. The author suggests that oil shocks have negative effects on economic activity and employment.

Regarding multiple country studies, Cologni and Manera (2008) analyzed the effects on G-7 countries using the VAR model. The authors suggest that oil price shocks are followed by rising inflation and falling output. Bodenstein, Erceg, and Guerrieri (2011) examine the impact of oil price fluctuations using a two-country DSGE model. The authors found that oil shocks deteriorated the trade balance of importers. Cuñado and de Gracia (2003) documented that oil prices affect inflation and the growth rate of 15 European economies. Using the SVAR method, Kilian et al. (2009) focused on 26 major oil exporters and 14 major oil importers. They showed that the response of external balance varied depending on both the source of the shock and the role of countries [oil exporting or importing] (see also Peersman and Van Robays (2012) for more information on cross-country effects). Focusing on 16 oil-exporting countries and using panel GMM, El Anshasy and Bradley (2012) found that rising oil prices increased their GDP and fiscal expenditures. Grigoli et al. (2017) also examined the impact of the 2014-16 oil price decline on 42 oil-exporting countries. The authors found that a decrease in oil prices adversely affected the economic growth of these countries. They emphasize that a strong fiscal structure, diversified exports, and reserve buffers are crucial for reducing the effects of negative oil price shocks. Nusair (2016) showed that the GDP of GCC countries responded positively to increases in oil prices, whereas negative oil shocks only reduced the GDP of Kuwait and Qatar.[26]

[26]For further information on oil-macroeconomy nexus in oil-exporting countries, see; Hou, Mountain, and Wu (2016); Koh (2017); and Mehrara and Oskoui (2007). The review studies also contain detailed information on oil-macroeconomic literature (Barsky & Kilian, 2004; Lang & Auer, 2020; Segal, 2011). In addition, for studies decomposing the source of oil shocks, see, Baumeister and Kilian (2016); Cashin, Mohaddes, Raissi, and Raissi (2014); Fattouh, Kilian, and Mahadeva (2013); Hamilton (2013); Kilian (2009); and Kilian and Park (2009). Also see Farzanegan and Markwardt (2009); Mendoza and Vera (2010); and Rahman and Serletis (2011) for the asymmetric effects of oil shocks.

Table 3.1. *The Literature Review*

Panel A. The macroeconomic effects of oil price shocks

Study	Country	Method	Relation
Hamilton (1983) /Mork (1989)	The US	Correlation Granger / VAR	Oil - recessions
Burbidge and Harrison (1984)	The US, Japan, Canada, Germany, The UK.	VAR	Oil - inflation and industrial production
Rotemberg and Woodford (1996)	The US	Regression-VAR	Oil price - wages and output
Papapetrou (2001)	Greece	VAR	Oil shock – output, employment
Cuñado and de Gracia (2003)	15 European countries	Cointegration, Causality	Oil shock – growth / inflation
Blanchard and Gali (2007)	The US, France, Germany, Italy, Japan, UK	VAR	Oil price - economic activity
Kilian et al. (2009)	26 Major oil exporting and 14 oil-importing countries	VAR	Oil – external balance
Bodenstein et al. (2011)	Two countries	DSGE	Oil shocks – external balance
Iwayemi and Fowowe (2011)	Nigeria	Granger / VAR	Oil shocks -output, inflation
Cologni and Manera (2008)	G-7 countries	VAR	Oil shocks - macroeconomy
El Anshasy and Bradley (2012)	16 Oil-exporting countries	Panel GMM	Oil price – output, fiscal policy
Nusair (2016)	GCC Countries	Panel Cointegration	Oil price - GDP
Ratti and Vespignani (2016)	The Euro area, China, India, Japan, USA	VECM	Oil - global macroeconomic indicators
Grigoli et al. (2017)	42 Oil-exporting countries	Cross-Section Regressions	Oil – economic growth

Panel B. Oil shocks and financial markets

Study	Country	Method	Relation
P. Krugman (1983)	Germany, OPEC, the US	----------	Oil – exchange rate
R. D. Huang et al. (1996)	The US	VAR	Oil future prices – stock market
Bernanke, Gertler, Watson, Sims, and Friedman (1997)	The US	VAR	Monetary policy - oil
Amano and Van Norden (1998)	The US	Causality- ECM	Oil prices – exchange rate
Sadorsky (1999)	The US	GARCH - VAR	Oil – stock market
Syed A Basher and Sadorsky (2006)	21 emerging markets	Pooled OLS	Oil price changes – stock market

S.-S. Chen and Chen (2007)	G-7 Countries	FMOLS-DOLS-PMG	Oil prices – exchange rates
Park and Ratti (2008)	The US and 13 European countries	VAR	Oil price – stock market
Bjørnland (2009)	Norway	VAR	Oil – stock market
Lizardo and Mollick (2010)	22 Countries	Johansen Cointegration	Oil price fluctuations – exchange rate
Kilian and Lewis (2011)	The US	VAR	Oil price – monetary policy
Bodenstein, Guerrieri, and Kilian (2012)	The US	Max. likelihood	Monetary policy – oil shocks
Natal (2012)	The US	OR - SLR	Oil – monetary policy
Y. Wang, Wu, and Yang (2013)	9 oil-importers 7 oil-exporters	VAR	Oil – stock market
Filis and Chatziantoniou (2014)	8 European countries (Oil exporter and importer)	SVAR	Oil – financial and monetary response
Kang, Ratti, and Yoon (2014)	The US	SVAR	Oil shocks – bond market
Volkov and Yuhn (2016)	Russia, Mexico, Canada, Brazil, and Norway	GARCH-M	Oil price shocks – exchange rate
Ioannidis and Ka (2018)	Canada, Norway, the US, South Korea	SVAR	Oil shocks – interest rate
Gupta and Kotze (2017)	South Africa	Bayesian VAR	Oil – interest rate
Kim, Hammoudeh, Hyun, and Gupta (2017)	China	TVP-SVAR, SVAR, GIR VAR	Oil shocks – monetary policy
Tule et al. (2017)	Nigeria	VARMA-AGARCH	Oil shocks – bond market
Nazlioglu et al. (2020)	7 oil-exporters and 7 oil-importers	VAR - GARCH	Oil prices - bond market
Filippidis et al. (2020)	11 European Countries	SVAR and Scalar-BEKK	Oil shocks – bond market
Shangle and Solaymani (2020)	Malaysia	CGE	Oil price – monetary policy
Yildirim and Arifli (2021)	Azerbaijan	SVAR	Oil shocks – exchange rate, monetary policy
Urom, Guesmi, Abid, and Dagher (2021)	The US, Euro area, and 12-Asian Countries	TVP-VAR	Oil shocks – interest rate

Panel C. Oil price shocks and BRIC / Uncertainty and BRIC

Study	Country	Method	Relation
Khan (2010)	BRIC	SVECM	Oil – stock market, interest rate, industrial production
Ono (2011)	BRIC	VAR	Oil price shocks – stock market
Bal and Rath (2015)	China-India	Granger / VAR	Oil shocks – exchange rate
Bouoiyour and Selmi (2016)	BRICS	VAR	Oil shocks – stock market
Bouri, Shahzad, Raza, and Roubaud (2018)	BRICS	CQ	Oil volatility – sovereign risk
Nasir et al. (2018)	BRICS	TV-SVAR	Oil – GDP, inflation, and external balance
Baghestani et al. (2019)	BRIC	Forecasting approach	Oil shocks – exchange rate
Chen, Sun, and Wang (2019)	BRIC	Wavelet	Oil price - uncertainty
Mo et al. (2019)	BRICS	Wavelet / quantile on quantile	Oil price – economic growth
Wang, Ma, Niu, and He (2020)	BRICS	SVAR	Oil- stock market - uncertainty
Su, Huang, Qin, and Umar (2021)	BRICS	Quantile Granger-Causality	Oil - uncertainty

Panel D. Uncertainty / Oil-uncertainty

Study	Country	Method	Relation
Bloom (2009, 2014); (Bloom, Bond, & Van Reenen) Bachmann, Elstner, and Sims (2013)	The US	VAR	Uncertainty - economy
Wan and Kao (2015)	The US	TVAR	Oil – interest rate / exchange rate - uncertainty
Van Robays (2016)	Global economy	TVAR	Uncertainty - macroeconomy
Aastveit et al. (2017)	The US	SVAR	Uncertainty – monetary policy
Caggiano, Castelnuovo, and Nodari (2017)	The US	VAR	Uncertainty – monetary policy
Tan and Ma (2017)	Global commodity market	TVAR	Uncertainty – commodity price
Castelnuovo and Pellegrino (2018)	The US	Non-linear VAR DSGE	Uncertainty – monetary policy
Evgenidis (2018)	Euro area	TVAR	Uncertainty – oil - macroeconomy

Živkov, Njegić, and Balaban (2019)	10 emerging markets	Wavelet Coherence	Uncertainty – oil – exchange rate
Qin (2020)	20 countries	SVAR	Oil – uncertainty-financial market
Yong Jiang et al. (2021)	The US	TVAR	Uncertainty – oil – stock returns
Lin and Bai (2021)	14 oil importers 6 oil exporters	Bayesian VAR	Oil prices - uncertainty
Xiao and Wang (2021)	G-7 and BRIC	Regression	Uncertainty – oil
Hong, Wang, Liang, and Umar (2022)	The US and oil market	Markov switching - GARCH	Uncertainty - oil

3.1.2 The Oil-Financial Market Literature

Panel B provides a brief survey of the literature on the oil-financial market. After a chief study of P. Krugman (1983) on the transmission channel of oil shocks to exchange rates, the oil exchange rate nexus was examined for different countries and periods in the literature.[27] Employing error correction models, Amano and Van Norden (1998) find that oil prices are the source of currency shocks in the United States. Since oil is traded in dollars, an increase in its price raises the inflow of foreign currency to oil-exporting countries and appreciates their currencies. Lizardo and Mollick (2010) showed that rising oil prices have caused the US dollar to depreciate against net oil exporter currencies (Mexico, Russia, and Norway). Volkov and Yuhn (2016) also demonstrate that exchange rate fluctuations are associated with oil price shocks in five major oil exporters. The authors point out that countries with efficient financial markets and stable economies (Canada and Norway) are less affected than others (Brazil and Russia). In contrast, S.-S. Chen and Chen (2007) found that a key source of exchange rate movements is oil prices in the oil-importers of G-7 countries. The authors also mentioned that oil prices are a significant predictor of exchange rates in these countries.[28]

There is a significant body of research on how monetary policy responds to oil shock. Bernanke et al. (1997), a groundbreaking study, emphasized that the FED tightened monetary policy by raising the interest rate in response to the oil price shock. Moreover, they pointed out that tight monetary policy played a significant role in driving

[27]For studies that are not within the scope of our study but examine the effects of oil shocks depending on the implemented exchange rate regime, see; Al-Abri (2013); Kamin and Rogers (2000); and Lv, Lien, Chen, and Yu (2018)
[28]See Soytaş and Sarı (2019) to review the major studies focusing on oil-exchange rate nexus.

the effects of oil shocks. However, Kilian and Lewis (2011) documented no evidence that systemic monetary policy responses to oil shocks magnified the effects of the oil shock in the US. Bodenstein et al. (2012) also found that US monetary policy was influenced by oil shocks and that the FED reacts differently depending on the source of the shock. Although the literature focuses on the US in this regard, the monetary policy response to oil shocks has also been investigated for other countries. For example, Ioannidis and Ka (2018) examined the link between oil and interest rates for four advanced economies, including oil exporting (Norway-Canada) and importing countries (US-S. Korea). The authors argue that the effects differ across countries depending on the source of oil shocks and the characteristics of the countries [oil-importer or oil-exporter]. Urom et al. (2021) explored the integration of oil and interest rates in US, the Euro area, and twelve Asian economies by using the VAR model. They proposed that integration strengthened after 2001 and accelerated the spread of oil shocks to monetary policy through oil financialization.

Since the effects of the oil shock vary depending on whether the country is an oil importer or exporter, the monetary policy strategy is also different in these countries. Yildirim and Arifli (2021) examined a single oil-exporting country, Azerbaijan, and stated that the central bank increased interest rates in response to the oil shock. Shangle and Solaymani (2020) analyzed another oil-exporting country, Malaysia, using the CGE model. The authors found that loosening monetary policy is more efficient in reducing the negative impact of oil shocks on output. On the other hand, Kim et al. (2017) explored the Chinese economy, an oil importer. The authors showed that China's monetary authority reacted differently to negative oil price shocks. The central bank lowered the interest rates during 1992-2001 while increased the rates during 2001-2014. Filis and Chatziantoniou (2014) reveal that monetary policy regimes (inflation or currency targeting) implemented by countries play an important role in interest rate responses to oil shocks. In addition, Natal (2012) investigated the optimal monetary policy response to oil shocks and found that the monetary policy to stabilize prices led to a loss of welfare (see also Nazlioglu, Gormus, and Soytas (2019), the emerging markets' monetary policy response to oil price shocks.) In sum, how monetary policy responds to oil shocks has been widely covered in the literature.

The oil-stock market nexus has also received significant attention in the oil-financial market literature. Employing US data, Sadorsky (1999) showed that oil prices significantly affected stock price movements, even more so than interest rates. R. D. Huang et al. (1996) documented that oil price changes significantly affect oil-related stocks. The authors also find no correlation for all stocks.[29] Syed A Basher and Sadorsky (2006), examining 21 emerging stock markets, stated that these countries are more energy-intensive than developed countries, and suggested that oil price increases negatively affect stock markets. Park and Ratti (2008) found that oil price shocks had a positive effect on the Norway stock market and oil exporters, but not on 13 oil importer countries in Europe. Bjørnland (2009) argued that a 10% increase in oil prices increased the Norwegian stock market by 2.5%. Another breakthrough study investigating oil-importing and oil-exporting countries was Y. Wang et al. (2013). The authors found that the magnitude, duration, and direction of the oil shock depended on the country's net oil position.[30]

Bond yield, an investment instrument, is also affected by oil price movements. Kang et al. (2014) showed that oil shocks caused US bond yields to decrease significantly over eight months. For Nigeria, a major oil exporter in Africa, Tule et al. (2017) suggest that rising oil prices have a positive impact on the bond market by boosting economic confidence. Investigating major oil importing and exporting countries, Nazlioglu et al. (2020) showed that oil has the power to predict bond prices in most exporters and importers (China-India). On the other hand, Filippidis et al. (2020) examined 11 European countries and revealed that oil shocks have an impact on bond markets, but the effect varies depending on the period and country. The authors revealed that depending on the magnitude of the shock, the bond market might be seen as a hedge instrument and that advanced countries are less affected than peripheral ones since their government bonds seem safe and liquid.

[29]For further information on the oil shock-stock market nexus, see Broadstock and Filis (2014); Miller and Ratti (2009); Nandha and Faff (2008); and Narayan and Narayan (2010). See also the survey of Lang and Auer (2020) for the relationship between oil and stock markets.

[30]For further information on the impact of oil shocks on the stock market through decomposing the source of shock, see Apergis and Miller (2009); Demirer et al. (2019); and Y. Wang et al. (2013). For the asymmetric effects of oil price shock, see Ciner (2001) and for spillover effects, see Arouri, Jouini, and Nguyen (2011).

3.1.3 The Oil, Uncertainty and BRIC Literature

Panel C reports studies focusing on the effects of oil shocks on BRIC. Mo et al. (2019) examined the effects of oil on economic growth in BRICS countries using the wavelet method and found heterogeneous results. In another study, Nasir et al. (2018) claimed that oil shocks have diverse consequences in terms of GDP, inflation, and the balance of trade, which differ for importers and exporters within the group. They noted that Russia was much more affected by oil shocks due to its extreme oil dependency, whereas India was vulnerable to oil price fluctuations due to its economic underdevelopment. Khan (2010) investigated the monetary policy reaction to oil shocks in BRIC economies and showed that oil price shocks lead to increased interest rates in the short term but a decrease in the long term for Russia-Brazil (oil exporters); however, the reverse is true for China-India (oil importers).

Another branch of the literature focusing on BRIC concentrates on the link between oil and BRIC financial markets. Ono (2011) examined the impact of oil prices on BRIC stock markets and found that BRIC countries, except Brazil, show a significant response. The author also documented that oil price shocks have a relatively large impact on stock return volatility in Russia. Baghestani et al. (2019) examined the link between exchange rates and oil prices in the BRIC using a forecasting approach. They suggest that oil prices predict the exchange rate in Brazil and Russia; however, oil prices have no predictive power for the Chinese exchange rate. On the other hand, Bal and Rath (2015) analyzed the oil-exchange rate nexus for India and China by using Granger causality. The author found bidirectional causality between oil and exchange rates for both countries. Bouoiyour and Selmi (2016) showed that the stock markets of BRIC economies respond differently to oil shocks; however, especially in Russia, oil shocks are a crucial cause of stock market volatility.[31]

Studies focusing on the effects of uncertainty in BRIC countries are relatively scarce. Su et al. (2021) and Chen et al. (2019) found that oil prices affect economic policy uncertainty in BRIC countries, and the latter also showed that there is a spillover effect

[31] See also Du, Yanan, and Wei (2010); Y. Huang and Feng (2007); and You, Guo, Zhu, and Tang (2017) for China, Ghosh (2011); and Tiwari and Albulescu (2016) for India, Ferreira et al. (2020) for Brazil and Alekhina and Yoshino (2019); and Fedoseeva (2018) for Russia.

on uncertainty from oil prices.[32] Bouri et al. (2018) argued that developing economies are energy-intensive, thus, oil volatility puts upward pressure on the sovereign risk of BRIC countries. The authors also suggest that Brazil and Russia are more vulnerable to positive oil shocks, while China and India are sensitive to negative oil shocks.[33] Wang et al. (2020) documented that oil shocks had stronger effects on the stock market of BRIC economies in extreme conditions.

3.1.4 The Uncertainty Literature

Panel D shortly reviews the other line of the literature, namely the uncertainty literature. Bernanke (1983) analyzed the effect of uncertainty on firm decisions and stated that the best decision when uncertainty exists is to wait and collect more information. More recent studies, see, for example, Bloom (2009, 2014) and Bloom et al. (2007) documented that uncertainty discourages firms from investing and hiring, and consumers from spending. Bachmann et al. (2013) and Caggiano et al. (2017) showed that uncertainty causes a significant decrease in production and economic activity in the US, while Castelnuovo and Pellegrino (2018) pointed out that uncertainty creates a much more severe and sudden drop in real activity, especially during recessions. On the other hand, Aastveit et al. (2017) suggested that uncertainty reduces the effectiveness of US monetary policy and should be carefully considered if it is to be used as a policy tool in response to possible shocks.[34]

Few studies examine whether uncertainty alters the effects of oil price shocks. Van Robays (2016) found that high macroeconomic uncertainty triggered fluctuations in oil prices, and that the price of oil elasticity significantly decreased during these periods. Tan and Ma (2017) investigated the effects of uncertainty on 19 commodities, including oil, and concluded that fluctuations in commodity prices stem from uncertainty, particularly during periods of high uncertainty. Xiao and Wang (2021) also showed that oil prices are affected by investors' risk aversion, and especially with the financialization of oil, uncertainty raises the negative expectations of the oil market. Lin and Bai (2021) is

[32]See Dakhlaoui and Aloui (2016); Demir and Ersan (2017); and Salisu, Cunado, and Gupta (2022) for further information on uncertainty-BRIC nexus

[33]For the impact of oil prices on country risks and uncertainty, see Breunig and Chia (2015); Chuffart and Hooper (2019); Lee et al. (2017); Pavlova, De Boyrie, and Parhizgari (2018); Sharma and Thuraisamy (2013); J. Wang et al. (2020); and Wegener et al. (2016)

[34]For detailed information on the effects of uncertainty on monetary policy, see Balcilar, Demirer, Gupta, and Van Eyden (2017); Mumtaz and Surico (2015); and Pellegrino (2018)

influential study for the literature that examines the relationship oil and uncertainty. In their analysis of 14 oil-importing and 6 oil-exporting countries, the authors documented that positive oil shocks reduced uncertainty in oil exporters, while such shocks increased uncertainty in oil importers.

Evgenidis (2018) focused on the Euro area and showed that uncertain conditions alter the transmission of oil shocks. Wan and Kao (2015) investigated the role of financial stress in the impact of oil shocks in the US and found that oil shocks produced larger and longer effects in a stressed regime than in a normal regime. Qin (2020), in his study of 20 countries, showed that oil shocks affect the financial stress of economies and the integration between their financial markets. The author also revealed that risks spread from financial markets to the oil market during a financial crisis. Živkov et al. (2019) examined the exchange rates of 10 emerging countries. The authors suggested that negative oil shocks caused exchange rate depreciation in oil-exporting countries; however, capital outflows during the global financial crisis overshadowed the favorable effects of oil prices in oil-importing countries. Yong Jiang et al. (2021) find that financial regimes play a significant role in the influence of oil on US stock returns. The authors also suggested that under normal credit conditions, a positive oil shock decreases stock returns, while a shock increases returns in tight credit regimes. Finally, Hong et al. (2022) stress that financial stress can have worse consequences in the oil market. They stated that investors consider financial stress when adjusting their portfolios.

Overall, the literature contains several studies examining the oil-macroeconomics and oil-financial market nexus. However, this literature is broadly focused on advanced oil-importing countries, such as the US and the Euro areas. In addition, the literature adopts a linear modelling strategy to analyze the impact of oil shocks. On the other hand, uncertainty literature focuses directly on the impact of uncertainty on macroeconomic indicators or oil price fluctuations. Few studies have examined whether uncertain conditions alter the transmission of oil shocks. This work combines several branches of literature, namely energy economics, financial markets, and uncertainty. This thesis attempts to show how global uncertain conditions change the effect of negative oil shocks on the financial markets of BRIC economies by employing a threshold structural vector auto regressive (TSVAR) model.

3.2. Data

This thesis works with an interesting country sample, the BRIC, namely, Brazil, Russia, India, and China. It is tempting to investigate how oil price shocks have had a different effect on oil importers (China-India) and oil exporters (Russia-Brazil). Owing to data availability, especially for Russia, the dataset started[35] in 2002 and ended in 2019. The COVID-19 period is not considered to exclude the overwhelming effects of the Covid-19 pandemic on oil prices and financial variables of BRIC. The data are weekly[36] because they offer more clues to the financial markets. In addition, weekly frequency is the most efficient frequency in terms of compliance with the econometric model used.

The threshold auto regressive (TAR) model includes four variables: the CBOE volatility index, VXO (proxied for financial uncertainty in global financial markets), Brent oil price (Europe Brent Price Dollars per Barrel)[37], oil production (barrel produced), and geopolitical risk index. In this model, VXO is used as a threshold variable. The TSVAR model includes two global variables and five domestic financial variables: oil prices, VXO, EMBI spread, exchange rate, short rate, stock price index, and bond yields. The EMBI spread is used to capture the impact of oil prices on the sovereign risk of the BRIC. The exchange rate is defined as the local currency unit per US dollar. Depreciation refers to an increase in the exchange rate while appreciating its decrease. We use the short-term interest rate (policy rate) to measure the impact of shocks on the monetary policy. Stock price is proxied by Morgan Stanley Capital International[38] (MSCI) and measured in US dollars. The government bond market is represented by 3-year government bond yields. All variables are measured in logarithms, except for short rate and bond yields. Data were collected from DataStream, except for geopolitical risk, which was obtained from Caldara and Iacoviello (2018).[39] Table 3.2 provides a detailed description of these data. Figure 3.2 also shows how the variables changed during the entire period.

[35]The year of BRIC emergence (2001) was also instrumental in the selection of start date.
[36]Arouri, Dinh, and Nguyen (2010); Arouri et al. (2011) suggest that weekly data can overcome some problems that may occur in daily or monthly data. Arouri et al. (2011) argue that the bid-ask effect and asynchronous trading days are biases for daily data, while time aggregation is a drawback for monthly data.
[37]US Energy Information Administration suggests that Brent broadly used as a benchmark across the World. (Europe, The Mediterranean, Africa, Australia, Asia).
[38]Since MSCI focuses emerging markets, it is much more suitable for this thesis (Syed Abul Basher, Haug, & Sadorsky, 2012).
[39]For further information; https://www.matteoiacoviello.com/gpr.htm

Table 3.2. *Data description. Source: DataStream*

		Notation	Variable	Data
TAR Model		q_t	Oil production	Weekly production per barrel
		gpr_t	Geopolitical Risk	The Geopolitical Risk Index
VAR Model	Oil Block	p_t^O	Oil Price	Crude oil brent in US dollars per barrel
		vxo_t	Volatility Index	The CBOE Market Volatility Index, VXO
	BRIC Block	$\rho_{i,t}$	Sovereign Risk	Country-Level JP Morgan EMBI Global Spread
		$e_{i,t}$	Exchange Rate	The bilateral US dollar exchange rate
		$i_{i,t}$	Short Rate	The policy rate of central banks
		$s_{i,t}$	Stock	Country-Level Morgan Stanley Capital International Index (MSCI)
		$b_{i,t}$	Bond Yields	3-year treasury rate

3.3. Methodology

This thesis adopts a nonlinear VAR modelling approach proposed by Nguyen and Sato (2020). Their approach combines VAR modelling with threshold autoregressive (TAR) estimation. This approach allows us to obtain time-varying thresholds, thereby identifying the states of the economy and analyzing the effects of shocks for different states of the economy. Following Nguyen and Sato (2020), we first estimate a TAR model to obtain time-varying thresholds and determine two regimes of international financial markets. We then estimate a structural VAR model for these regimes (uncertain and normal) to document the effects of oil price shocks on the BRIC markets.

3.3.1. Threshold Autoregressive (TAR) model

The TAR model, with VXO acting as a threshold variable, is constructed to find the time-varying threshold (λ_t) for this variable as follows.

$$\begin{aligned}\Delta oilp_t = {} & I_t\left(c_1+\sum_{s=1}^{k}\alpha_{1s}\Delta p_{t-s}+\sum_{s=0}^{l}\gamma_{1s}\Delta vxo_{t-s}+\sum_{s=0}^{m}\beta_{1s}\Delta q_{t-s}+\sum_{s=0}^{n}\delta_{1s}\Delta gpr_{t-s}\right)\\ & +(1-I_t)\left(c_2+\sum_{s=1}^{k}\alpha_{2s}\Delta p_{t-s}+\sum_{s=0}^{l}\gamma_{2s}\Delta vxo_{t-s}+\sum_{s=0}^{m}\beta_{2s}\Delta q_{t-s}+\sum_{s=0}^{n}\delta_{2s}\Delta gpr_{t-s}\right)+\varepsilon_t\end{aligned} \qquad \textbf{(1.1)}^{40}$$

I_t is an indicator function that differs depending on the threshold value. If $vxo_t < \lambda_t$, I_t= 1 and $vxo_t > \lambda_t$, $I_t = 0$. p represents the oil price per barrel, vxo is the volatility

[40] The lowercase letters indicate that the variables are in natural logarithm.

index, q is the weekly oil production, and gpr denotes geopolitical risk. All variables are natural logarithms. The lag length of each variable (k,l,m,n) was determined using Akaike Information Criterion (AIC).

In the estimation process, the observation values of the VXO are sorted in ascending order within the selected window.[41] The threshold model evaluates each observation as a potential threshold and chooses the one with the smallest residual sum of squares.[42] Periods when VXO exceeds the threshold are defined as uncertain, whereas periods when VXO is below the threshold are specified as normal.

3.3.2. Threshold structural VAR model

The VAR is constructed with block exogeneity as follows:

$$\begin{cases} \sum_{s=0}^{p} \begin{bmatrix} A_{11}(s) & 0 \\ A_{21}(s) & A_{22}(s) \end{bmatrix}^{(1)} \begin{bmatrix} y_1(t-s) \\ y_2(t-s) \end{bmatrix} = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}^{(1)} & if \ w_t \geq 0 \\ \sum_{s=0}^{p} \begin{bmatrix} A_{11}(s) & 0 \\ A_{21}(s) & A_{22}(s) \end{bmatrix}^{(2)} \begin{bmatrix} y_1(t-s) \\ y_2(t-s) \end{bmatrix} = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}^{(2)} & if \ w_t \leq 0 \end{cases} \quad \textbf{(1.2)}^{43}$$

where $y_1(t)$ is a vector of external variables, and $y_2(t)$ is a vector of domestic variables. The vector of structural shocks, $\varepsilon(t)$ satisfy $E[\varepsilon(t)|y(t-s), s > 0] = 0$ and $E[\varepsilon(t)\varepsilon'(t)|y(t-s), s > 0] = I$. In addition, $\varepsilon_1(t)$ denotes a vector of external structural shocks and $\varepsilon_2(t)$ denotes the vector of domestic structural shocks. The vector of the external variables,$[y_1(t)]$, includes p_t^O and vxo_t, whereas the vector of domestic variables, $[y_2(t)]$, contains $i_{i,t}$, $e_{i,t}$, $s_{i,t}$, $b_{i,t}$, $\rho_{i,t}$.

The model is designed to be estimated separately for each BRIC country. Moreover, the model assumes that BRIC economies are small open economies. Thus, the model included a block exogeneity restriction. The exogeneity assumption implies that domestic shocks do not have contemporaneous or lagged effects on the global variables.

[41] The selected window is 104 weeks for our study. We made this selection arbitrarily, similar to Nguyen and Sato (2020). We tried multiple lengths, but we settled on the 104-week window through graphical inference.

[42] We would like to express our deepest appreciation to the authors for sharing their econometric codes with us. See Nguyen and Sato (2020) for further information.

[43] Superscript 1 denotes the VAR model estimated for uncertain periods, while superscript 2 indicates the model estimated for normal times.

Furthermore, structural shocks are identified by restricting the coefficient matrix A0 to a lower triangular[44]

There was a three-step estimation process. First, we separate uncertain times by finding thresholds from the estimation of the TAR model. Then, the difference between VXO and the predicted threshold value, λ_t, is included in the VAR model $w_t = VXO_t - \lambda_t$. Second, we estimate the reduced-form VAR for uncertain periods ($\lambda_t < VXO$) using SUR with the level of variables and two lags selected by the Schwarz information criterion.[45] We also estimated the linear SVAR model using the same process without period separation. Finally, the impulse response functions (IRFs) were obtained by Markov chain Monte Carlo (MCMC) Gibbs sampling (Nguyen & Sato, 2020; Yildirim, 2016; Yildirim & Ivrendi, 2021).

[44]We estimate the model by changing the ordering of variables. The alternative orderings do not change the results. The results are available upon request.

[45]Unit root tests show that the variables are non-stationary in the level. However, cointegration tests indicated that each member of BRIC has multiple cointegration vectors. Therefore, the VAR model is estimated in level specification. All preliminary test results are presented in tables in Appendix A.

GLOBAL BLOCK

Figure 3.2. *The Data Illustration of Global Block*

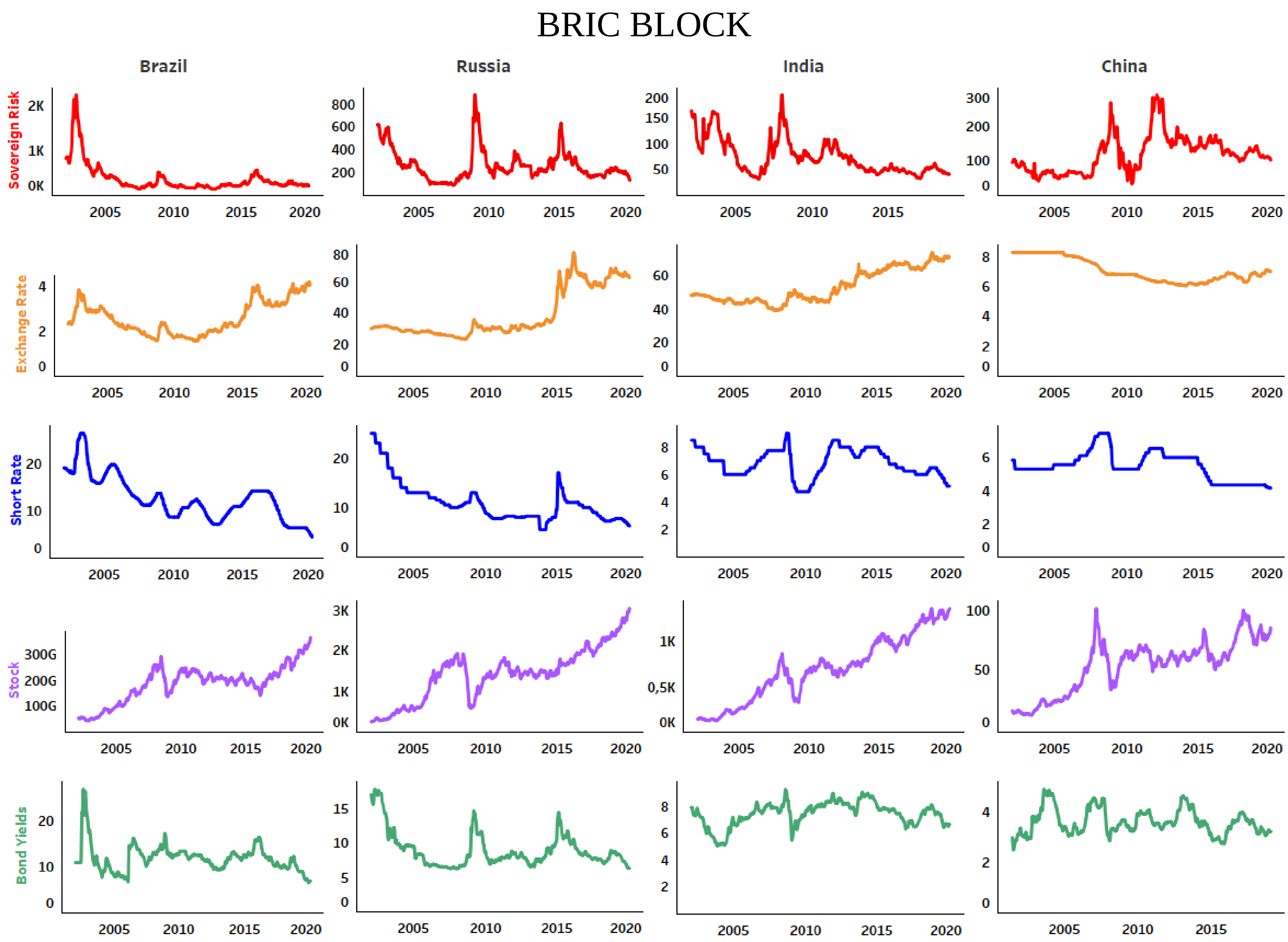

Figure 3.2. (Continue) *The Data Illustration of BRIC Block (For a better presentation, each variable is shown in a different color.*

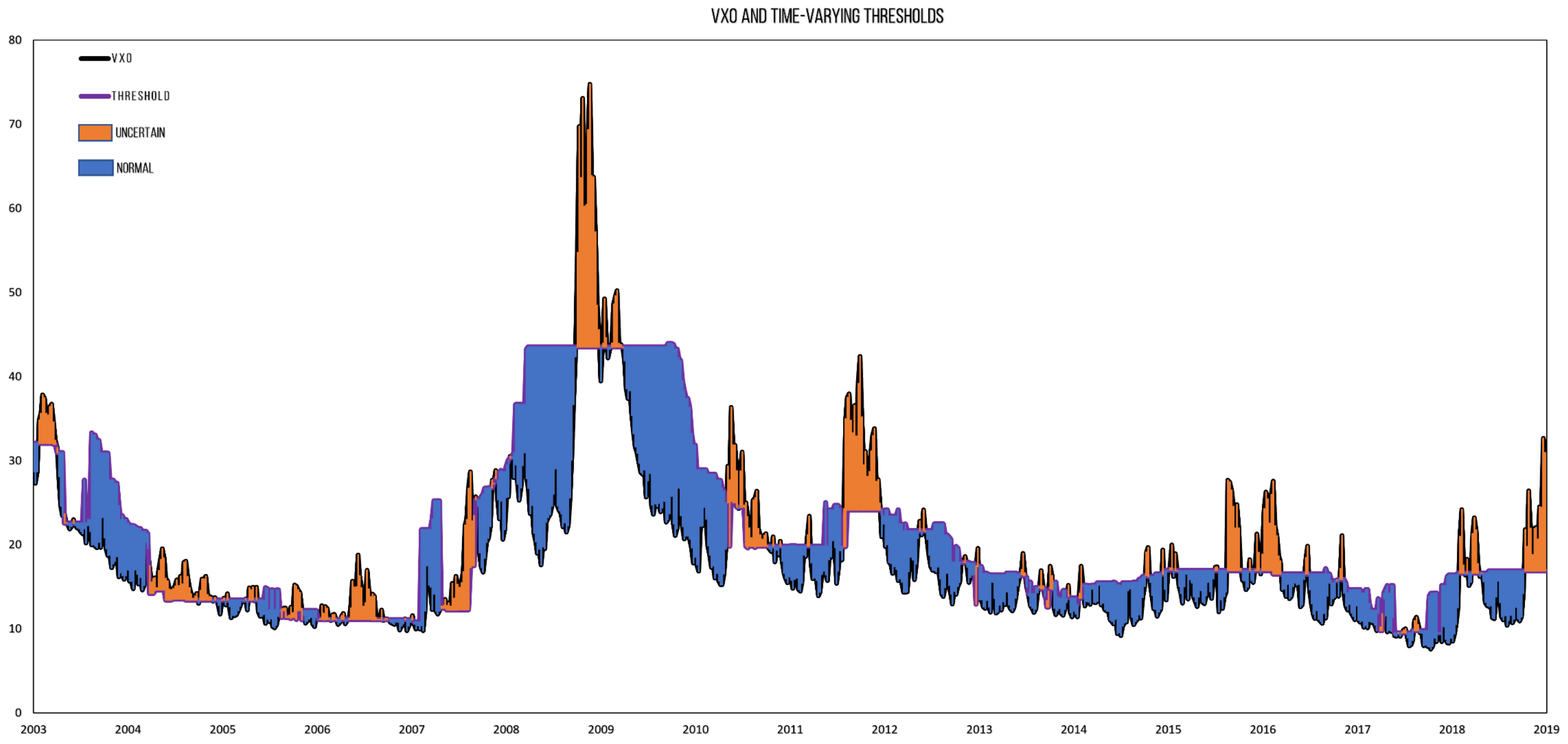

Figure 3.3. *The uncertain and normal times. (Author's own visualization based on TAR model estimation)*

3.4. The Empirical Results

In the empirical analysis, we first obtain time-varying thresholds by employing 2-year (104 weeks) rolling window from 2003 to 2019, allowing us to identify two states of international financial uncertainty:1) uncertain times and 2) normal times. Figure 3.3 shows the behavior of uncertainty in international financial markets and its estimated time varying thresholds. Uncertain and normal times can be clearly observed in this figure. Uncertain (normal) times denote the periods in which VXO remains above (under) the thresholds. As shown in Figure 3.3, during the great recession of 2008-2009, uncertainty in international financial markets spikes sharply. Similarly, the peak of the European debt crisis during 2011-2012 heightened uncertainty and increased unpredictability. Moreover, from late 2015 to 2016, developments such as Brexit, the refugee crisis, and negative Chinese growth also led to heightened uncertainty in international financial markets. The main purpose of this thesis is to measure the effects of a negative oil price shock on BRIC during periods of heightened uncertainty.

Table 3.3. *Descriptive Statistics*

Panel A *Linear SVAR All Observations: 835*		**DOMESTIC BLOCK**				
		EMBI	Exc. Rate	Short Rate	Stock	Bond Yields
BRAZIL	*Average*	5.6349	0.8790	12.5507	25.8911	11.7176
	Stdev	0.4382	0.2669	4.3469	0.3946	2.0744
RUSSIA	*Average*	5.4236	3.5746	10.4282	7.1571	8.5264
	Stdev	0.4352	0.3407	2.8199	0.4780	1.7880
CHINA	*Average*	4.6880	1.9421	5.5774	3.9183	3.6473
	Stdev	0.4837	0.1056	0.8462	0.4513	0.4953
INDIA	*Average*	4.2376	3.9513	6.8444	6.4137	7.4709
	Stdev	0.4186	0.1766	0.9946	0.5726	0.9177

		GLOBAL BLOCK	
		VXO	OIL PRICE
	Average	2.8221	4.1924
	Stdev	0.4000	***-0.0255***

Panel B *TSVAR* *Uncertain Observations: 275*		**DOMESTIC BLOCK**				
		EMBI	Exc. Rate	Short Rate	Stock	Bond Yields
BRAZIL	*Average*	5.7647	0.9131	13.5608	25.7800	12.0870
	Stdev	0.4969	0.2671	4.3183	0.4176	2.5251
RUSSIA	*Average*	5.4567	3.5531	10.8978	7.0435	8.5989
	Stdev	0.5471	0.3474	2.8954	0.5216	1.9767
CHINA	*Average*	4.6319	1.9723	5.5393	3.7741	3.6132
	Stdev	0.5265	0.1093	0.7687	0.4701	0.5395
INDIA	*Average*	4.3454	3.9278	6.7691	6.2528	7.3912
	Stdev	0.4797	0.1740	0.8798	0.6025	0.8915

		GLOBAL BLOCK	
		VXO	OIL PRICE
	Average	3.0185	4.09
	Stdev	0.4481	***-0.0444***

Table 3.3 indicates the descriptive statistics of the variables for two different periods, enabling us to compare the statistics of the variables for the full and uncertain periods. In most cases, the volatility of all the variables is greater during uncertain times. In particular, oil price volatility is very high in the turmoil periods compared to all periods, indicating that oil price shocks are expected to be more persistent and have greater effects on BRIC during uncertain times.

3.4.1. The impulse response analysis

This section examines the responses of the BRIC to a one-standard-deviation decrease in oil prices. The impulse response functions (IRFs) are based on two models: the linear SVAR model and TSVAR model. The former model includes all periods, whereas the latter includes only uncertain periods determined by the TAR model. This section compares the estimated effects of a negative oil price shock on BRIC for all periods (linear SVAR) and uncertain periods (TSVAR). Thus, this comparison allows us to indicate how uncertainty in the international financial market alters the transmission of oil price shocks to BRIC. The responses of the variables were illustrated for a period of 52 weeks with error bands.

3.4.1.1. *Do the effects of oil shocks differ across oil-importers and oil-exporters of BRIC?*

Before proceeding to the estimated responses of BRIC to negative oil price shocks based on the two models (linear SVAR and TSVAR), we first discuss how the effects of the oil price shock vary across oil exporters and importers of BRIC. Figure 3.4 shows the estimated responses of a typical oil exporter (Russia) and importer (India) to a negative oil price shock, which is based on the linear VAR model. A negative oil price shock increases the sovereign risk of the oil-exporting countries. These effects are statistically significant for the first ten weeks following the shock. However, oil shocks decreased the sovereign risk of oil-importing countries, and the decline was statistically significant until the end of the period. The responses of other variables also differ between a typical oil exporter and a typical BRIC oil importer. In response to a negative oil price shock, the exchange rate increases (depreciates), long- and short-term interest rates increase, and stock prices decrease in oil exporters. These effects were statistically significant. On the other hand, following the oil shock, the exchange rate and stock prices remain steady, and long- and short-term interest rates decrease for a typical oil importer. As in a typical oil exporter, all reactions are statistically significant, with the exception of the responses of stock and exchange rates, which are statistically insignificant.

These effects can be explained as follows: i) following the fall in oil prices, decreasing oil revenues and worsening trade balance increase the sovereign risks of the oil exporter, while lessening foreign payments leads to a decrease in the oil importer's sovereign risks. ii) The monetary authority of a typical oil exporter tightens its policy to stabilize the exchange through an increase in the interest rate. However, the central bank of a typical oil importer loosens its policy to support economic growth as the interest rate decreases.

In summary, a negative oil shock has an adverse effect on the financial markets of a typical oil exporter, while it generates a positive climate in the financial markets of a typical oil-importing country.

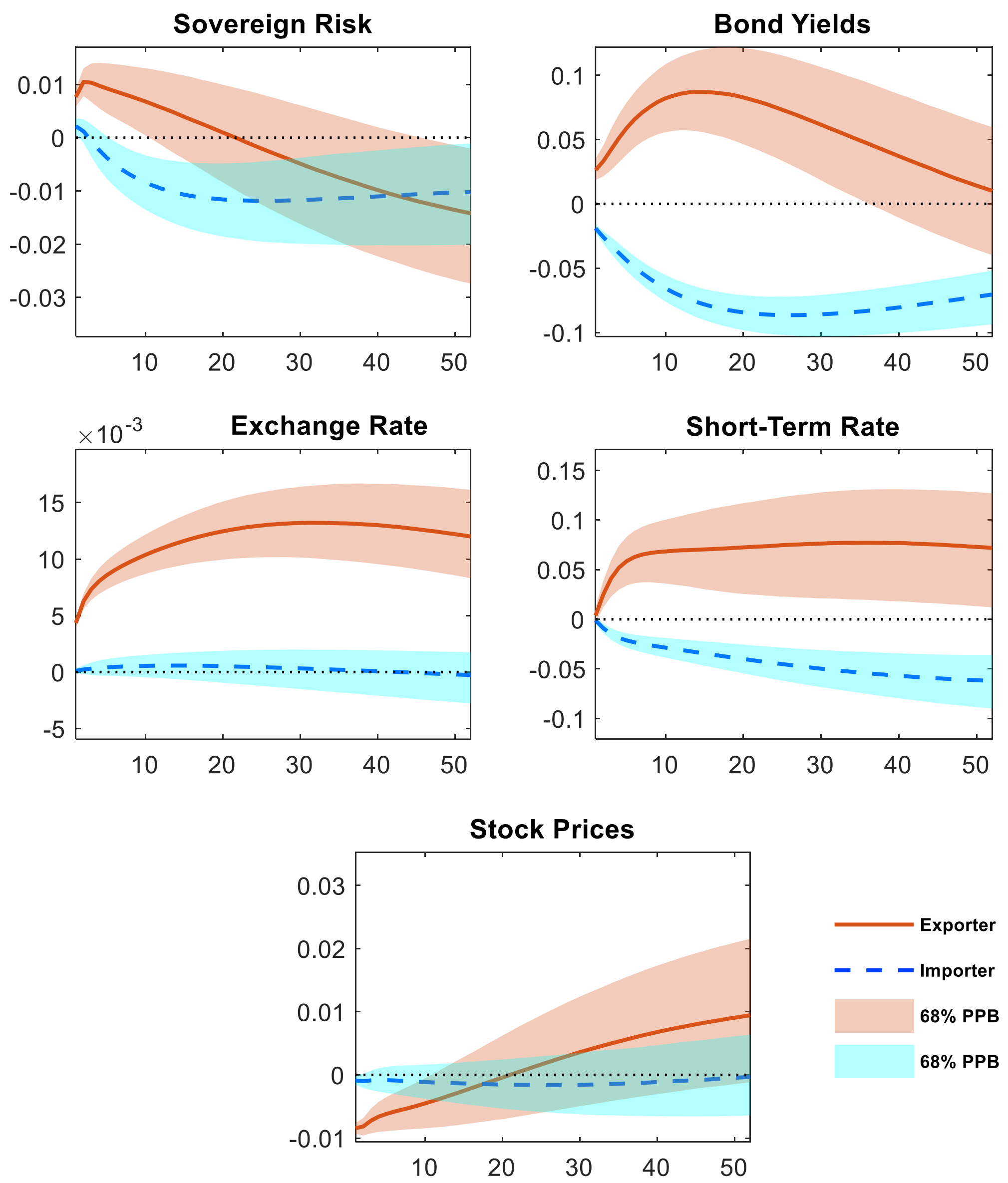

Figure 3.4. *The responses of a typical oil-exporter and oil-importer.*

(*Notes:* Dashed blue lines indicate the responses of a typical oil-importer while straight brown lines denote the responses of a typical oil-exporter based on the estimated conventional SVAR model. Shaded areas denote 68 % posterior probability bands.)

3.4.1.2. *The effects of oil shock on international financial uncertainty: TSVAR vs SVAR*

Figure 3.5 represents the response of international financial uncertainty to oil price shocks for the entire period (linear SVAR) and uncertain periods (TSVAR). This figure indicates that oil price shocks are highly persistent in uncertain times. However, the persistence of oil shocks is quite small during the entire period (see right panels of Figure 3.5). On the other hand, a negative oil price shock reduces uncertainty in international financial markets in both whole and uncertain periods. The decline in uncertainty was more profound at uncertain times. This decrease in uncertainty can be explained as follows. A reduction in global energy expenditure brings comfort to the international financial market.

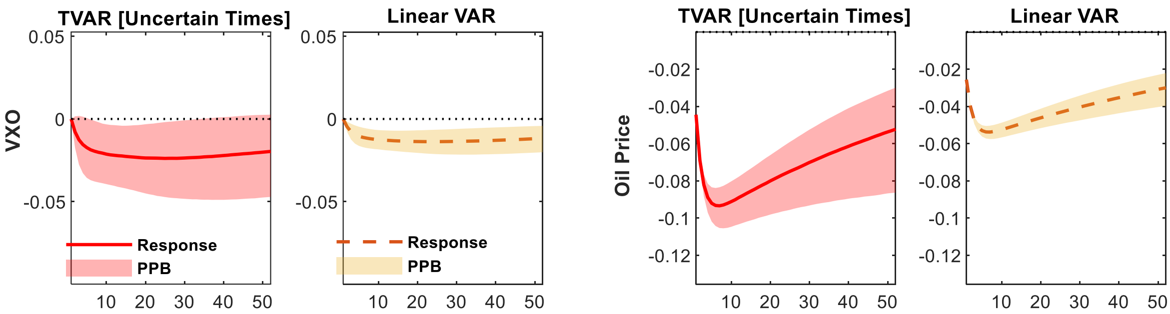

Figure 3.5. *The responses of VXO and Oil Price.*

(Notes: Dashed orange lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods. Shaded areas denote the 68% posterior probability bands.)

3.4.1.3. *The effects of oil shock on the financial market of BRIC exporters: TSVAR vs VAR*

Figure 3.6 demonstrates the effects of a negative oil price shock on BRIC financial markets in uncertain times (TSVAR) and whole periods (linear SVAR). The first thing that catches the eye is that the magnitude and persistence of the effects are quite greater during uncertain periods. In addition, the responses of the variables take place in the opposite way in oil-importing and oil-exporting countries, which is consistent with the BRIC characteristics.

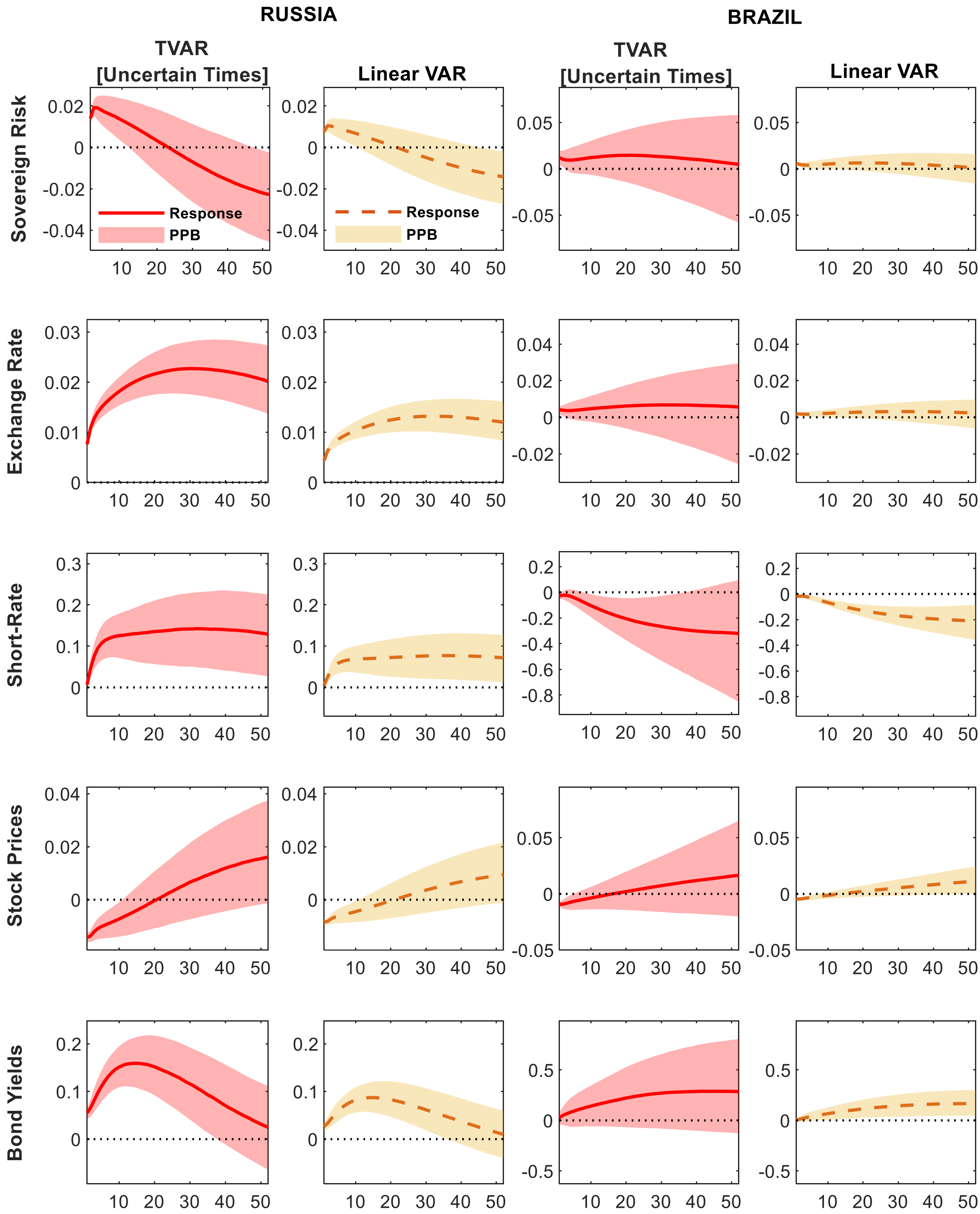

Figure 3.6. *The Responses of BRIC's Oil-Exporters Financial Markets.*

(Notes: Dashed orange lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods. As a significance indicator, the responses involve 68% confidence interval estimation. Shaded areas denote 68 % posterior probability bands. If the zero line is located between bands, there is a statistical insignificance.)

Negative oil price shocks raise sovereign risks in BRIC oil exporters. The rise in sovereign risk is large in uncertain periods (TSVAR), implying that uncertain conditions magnify the effects of oil shocks on sovereign risk. While the effects are statistically significant for Russia in the first ten weeks, they are statistically insignificant for Brazil. The exchange rates of oil-exporting countries increase (depreciate) in response to the negative oil price shocks. The responsiveness of the Russian ruble is especially evident in both the whole and uncertain periods. The figure also shows that the depreciationary effects of oil shocks are stronger in uncertain periods, indicating that uncertain conditions deepen currency depreciation. The response of the Russian ruble was statistically significant in both periods. However, the effects on the Brazilian real were not statistically significant in the two periods.

Negative oil shocks also caused a decline in the stock prices of oil exporters. Specifically, the Russian stock market experienced a 20-week decline, with statistically significant effects for the first 10 weeks. On the other hand, the decline in Brazilian stock prices is short-lived and statistically significant for only one month. Short-term interest rates, policy rates, respond positively to negative oil price shocks in Russia. On the other hand, Brazilian monetary policy responds to shocks by lowering short-term rates. These effects were statistically significant. Moreover, in both economies, the monetary policy reaction to an oil shock is more aggressive under uncertain conditions (TSVAR). Finally, the bond yields of the two oil exporters increased in response to a negative oil price shock. The responses of the bond yields were quite strong during uncertain periods. The effects are also statistically significant for Russia in both periods. However, in Brazil, they are statistically significant only for the entire period (linear SVAR).

Two interesting findings stand out from the financial market reaction of BRIC oil exporters: i) stronger effects on the Russian economy and ii) the difference in monetary policy reaction. First, the heavy dependence on oil in the Russian economy makes it vulnerable to oil shocks. Considering that oil exports provide substantial revenue in foreign currency for the economy, the sharp fall in Petro-dollars, accompanied by a plunge in oil prices, has stronger effects on Russian financial markets for both uncertain and whole periods. (See left panel of Figure 3.6). However, the Russian monetary authority tightened its policy in response to negative oil price shocks[46]. This reaction partly reflects the efforts of the authorities to prevent the outflow of foreign currency and thereby stabilize the exchange rate. However, Brazil's monetary authority loosened its monetary policy in response to negative oil price shocks. This reaction is particularly strong during uncertain periods (TSVAR). The Brazilian policy reaction can be explained by the fact that policymakers prioritize mitigating the adverse effects of oil shocks and uncertain conditions on the real economy[47].

The responses of BRIC financial markets are theoretically and intuitively consistent. A negative oil price shock reduces the oil revenue in oil-exporting countries. The deteriorating trade balance puts upward pressure on the currencies of oil exporters and raises the sovereign risk of these countries. Monetary authorities tightened the policy to decrease pressure on the exchange rate (See Lizardo & Mollick, 2010; Volkov & Yuhn, 2016, for similar findings). In addition, rising budget deficits and poor economic prospects lead to increased bond yields and long-term rates. However, a negative oil price shock causes a decrease in the profitability of oil companies. Due to the large presence of oil companies in the stock markets of oil-exporting economies, stock prices decline in these economies. [48]

Uncertain conditions in the global markets magnify the effects of negative oil price shocks on oil-exporting economies. The commercialization of oil intensifies the interactions between oil and financial markets through different channels. If there is international financial uncertainty, as new channels (wait-and-see/flight to quality) come into play, oil shocks influence the financial markets of BRIC more strongly during uncertain times. Uncertain conditions trigger capital outflow through these channels. This outflow also causes stock prices to fall.[49] Moreover, such outflows cause greater pressure on the exchange rate. Therefore, the central banks of oil-exporting countries have to take more severe measures in response to negative oil price shocks during uncertain periods

[46]Because of the excessive depreciation in uncertain periods, the Russian central bank greatly hikes the short rate during these periods.
[47]It can be also explained by the fact that Brazil is a relatively small oil exporter compared to Russia; thus, its government prudently acts in the face of oil price fluctuations
[48]Khan (2010) found similar findings for the monetary policy reaction to oil shocks, while Ono (2011) documents similar findings for oil-stock prices nexus.
[49]This finding is in line with Y. Wang et al. (2013) suggesting that the uncertainty causes lasting impact on oil exporters' stock market during the oil shock.

(See Chapter 2/Figure 2.4). Consequently, the financial markets of BRIC oil exporters are strongly affected by negative oil shocks, particularly during uncertain periods.

In summary, negative oil price shocks adversely affect the financial markets of oil-exporting BRIC economies. Moreover, these effects are much stronger under international financial uncertainty. These findings are also consistent with the past experiences of oil-exporting countries (See Chapter 1/Figure 1.11). Following the past oil price drops in 2009, 2014, and late 2018, sovereign risk and bond yields increased, local currencies depreciated, and short-rates increased. In addition, our results are in line with studies in the literature that focus on the link between oil and financial markets in oil-exporting economies (Syed A Basher & Sadorsky, 2006; Shangle & Solaymani, 2020; Yildirim & Arifli, 2021). Our findings are similar to those of Evgenidis (2018) and Hong et al. (2022).

3.4.1.4. *The effects of oil shock on the financial market of BRIC importers: TSVAR vs VAR*

On the importer side of the BRIC, negative oil shocks have contrasting effects compared to oil exporters. As seen in the follow-up of Figure 3.7, following the fall in oil price in China, sovereign risks significantly decline after the immediate increase. Note that, during uncertain times (TSVAR), a negative oil price shock causes a much greater decline in sovereign risk. Similarly, in India, sovereign risk decreased considerably after the oil shock. The effects on sovereign risk are statistically significant for the two economies. Following the oil price shocks, the Indian rupee and Chinese yuan seem to depreciate by the end of the period. However, the effects on currencies are statistically insignificant for the entire period. On the other hand, Indian and Chinese short rates react negatively to such shocks. In addition, as expected, monetary authorities loosened their policy stance more aggressively in uncertain times (TSVAR) to lessen the effects of uncertainty.

Chinese stock prices respond positively to negative oil price shocks in both the periods. However, these differences were not statistically significant. However, the stock response of India, an oil importer, is contrary to that of China. India's stock prices showed a steady decline throughout the period. However, its effects on Indian stock prices are statistically significant. Bond yields, an indicator of long-term rates, also fall in a statistically significant way in India following a decrease in oil prices. However, Chinese bond yields moved upward after a sudden and short-lived decline.

It is noteworthy that the stock price response varies between the two oil importers. Falling oil prices are expected to stimulate a positive atmosphere in the stock market, by increasing corporate profitability. The response of the Chinese stock market is consistent with theoretical expectations and exhibits an upward trend. However, the steady decline in the Indian stock market can be explained by a low share of oil companies. The oil corporations have a share of only 1.4% of the Indian stock market (Bouoiyour & Selmi, 2016).

The responses of oil importers to negative oil price shocks are in line with theoretical expectations. Intuitively, a fall in oil prices generates a positive climate for oil-importing economies, as it means a decrease in foreign expenditures. Moreover, the decline in inflationary expectations due to the reduction in oil prices allows the central banks of oil-importing countries to loosen the monetary policy that supports economic growth (See Kim et al., 2017, for similar findings). The increasing profitability of companies leads to an increase in their stock prices. Bond yields, on the other hand, fall due to the good economic prospects of the oil importers of BRIC.[50]

Uncertain conditions in international financial markets also strengthen the effects of oil shocks on importers. In particular, in response to a negative oil price shock, under uncertain conditions, the responses of all the variables are quite strong. The sharp decline in sovereign risk under uncertain conditions can be explained by the fact that oil-importing countries are considered less risky than other countries due to low oil prices. In addition, when international financial uncertainty exists, central banks may aim to keep domestic demand alive and offset the negative effects of uncertainty conditions.

Essentially, negative oil price shocks positively affect the financial markets of BRIC oil importers. These countries experienced these documented effects during past oil shocks (See Chapter 1/Figure 1.11). The sovereign risk, bond yields, and short rate decreased, and stock prices increased during the 2014/16 oil price decline. Our findings

[50]Filippidis et al. (2020); Nazlioglu et al. (2020); and Tule et al. (2017) also found the oil price shocks affect the bond market of oil exporters. See also Bal and Rath (2015); S.-S. Chen and Chen (2007) for similar findings on oil shocks-exchange rate nexus.

are also consistent with those in the oil-financial market literature for oil importers (Bodenstein et al., 2012; Filis & Chatziantoniou, 2014; Park & Ratti, 2008).

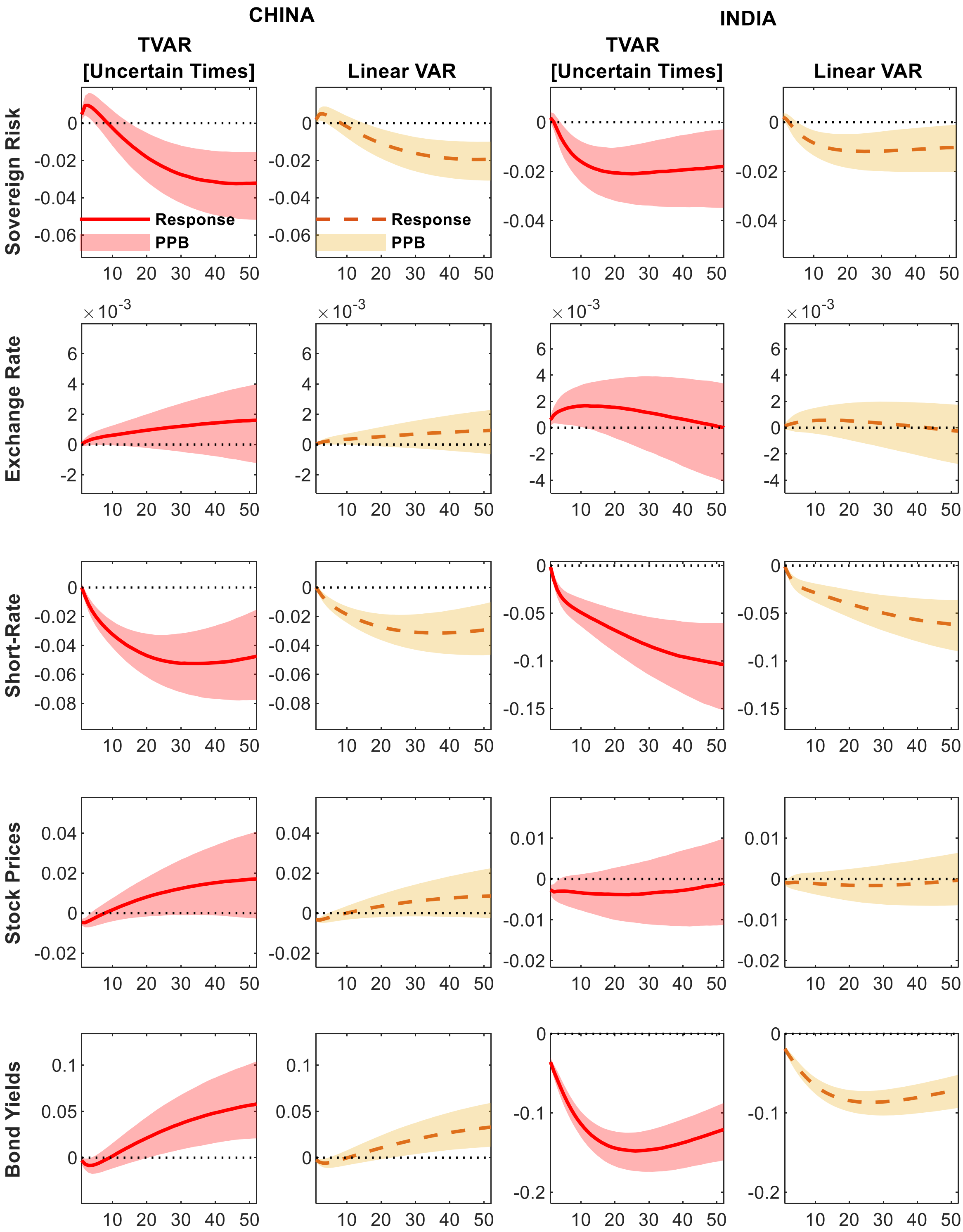

Figure 3.7. *The Responses of BRIC's Oil-Importers Financial Markets*

(*Notes:* Dashed orange lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods. Shaded areas denote 68 % posterior probability bands.)

3.4.1.5. *The effects of oil shock on the financial market of BRIC: An overall assessment*

Negative oil price shocks have positive consequences for BRIC oil importers, but harmful consequences for BRIC oil exporters. The financial markets of oil-exporting economies are negatively influenced by negative oil shocks, while those of oil-importing economies are positively affected. On the other hand, uncertainty conditions in international financial markets make the effects stronger, regardless of the type of country [oil exporter or importer].

3.4.2. Robustness Check

This subsection documents the robustness tests to establish the reliability of our results. Robustness analysis shows that our results remain unchanged when we alter the data frequency and sample.

3.4.2.1. *An alternative frequency*

The literature also uses monthly data to examine the link between oil and financial markets (Apergis & Miller, 2009; Bjørnland, 2009; Filis & Chatziantoniou, 2014; S. Huang, An, & Lucey, 2020). Motivated by these studies, we re-estimate the TSVAR and SVAR models using monthly data. Figure B.1 presents the responses of the BRIC financial market to negative oil price shocks. In oil exporters, a negative oil price shock increases the exchange rate, sovereign risk, and short- and long-term bond yields while decreasing stock prices. The effects are the opposite for oil importers. Furthermore, uncertain conditions intensify these effects for both two country groups, oil exporters and oil importers. Therefore, the main results did not change with the use of alternative frequencies.

3.4.2.2. *Subsample analysis*

To check the robustness of our results, we report the empirical results for three different periods: the pre-crisis period (2003-206), crisis period (2007-2012) and post-crisis period (2013-2019). Figure B.2 presents the responses of BRIC's financial markets to negative oil price shocks during these periods. The results for the first two periods are similar to the main results. However, in the post-crisis period, more severe effects from a negative oil price shock are found. In general, the main results are largely robust to the subsample subperiods.

CONCLUSION

This thesis focuses on the effects of negative oil price shocks on the BRIC markets during uncertain times. The BRIC group includes both oil-exporting and oil-importing countries. Thus, this group has attracted attention when examining the impact of oil shocks. Furthermore, with the recent financialization of oil, the financial markets of these economies have become more vulnerable to oil shocks.

Most studies in the oil literature have focused on developed markets. A few but growing number of studies have examined the oil-financial market nexus of BRIC. However, no research has studied this nexus for BRIC under uncertain conditions. This thesis aims to fill this gap by examining the interaction between the oil and BRIC markets during uncertain times.

The results suggest that negative oil price shocks exert adverse effects on the financial markets of oil-exporting BRIC countries. Specifically, after such shocks, sovereign risk and short- and long-term interest rates rise, the exchange rate depreciates, and stock markets experience a downward trend. Uncertain conditions in the international financial markets magnify these effects. On the contrary, in oil-importing BRIC countries, negative oil shocks positively affect financial markets. International financial conditions also influence these countries, but the decline in oil prices offsets the negative impact of uncertain financial conditions. Our findings are robust to the use of alternative frequency and subsample analyses.

In general, several factors, such as heavy dependence on oil, low diversification of exports, and underdeveloped non-oil sectors make oil-exporting BRIC economies more vulnerable to oil shocks. Furthermore, the financialization of oil and the international financial integration of these countries causes oil shocks to spread easily to their financial markets. In addition, the lack of structural reforms, high levels of corruption, and underdeveloped democracies make them among the first countries to which investors flee in case of any uncertainty. Thus, the negative oil shocks deteriorate financial markets of BRIC’s oil-exporters, and the international financial uncertainty even worsens the negative effects of oil shocks. On the other hand, in oil-importing countries, a decline in oil prices generates a positive mood; however, uncertain conditions in international markets also have negative effects on their financial markets as well.

The policy recommendations for policymakers are as follows: Particularly for oil-exporting countries, diversification in exports and improvement in non-oil sectors are among the first steps to be taken. They should also improve on issues such as developing democracy and reassuring investors. Thus, these economies may mitigate the negative effects of oil shocks and avoid the worsening effects of international financial uncertainties.

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APPENDIX A

Table A.1. *Unit root test results*

Variables		Augmented Dickey Fuller (ADF) Level	First diff	Results
vxo		-1.88**	-29.55*	I(1)
p^o		-0.59	-9.99*	I(1)
ρ	**B**R	-2.16	-16.38*	I(1)
	RS	-2.15**	-13.04*	I(1)
	IN	-1.80	-20.71*	I(1)
	CH	-0.99	-34.28*	I(1)
e	**B**R	0.46	-14.17*	I(1)
	RS	0.48	-12.00*	I(1)
	IN	-2.40	-18.79*	I(1)
	CH	-1.38	-10.59*	I(1)
i	**B**R	-2.55	-3.83*	I(1)
	RS	-3.33	-19.97*	I(1)
	IN	-2.53	-7.59*	I(1)
	CH	-1.63	-9.25*	I(1)
s	**B**R	-1.76	-26.79	I(1)
	RS	-2.03	-20.56*	I(1)
	IN	-3.24	-24.28*	I(1)
	CH	-2.76	-24.52*	I(1)
b	**B**R	-0.93	-13.08*	I(1)
	RS	-1.76	-9.64*	I(1)
	IN	-2.28	-24.32*	I(1)
	CH	-0.14	-27.39*	I(1)

Notes: Test equation properties (intercept, trend intercept, and none) are determined by the characteristics of the data. The Schwarz information criterion is used for the lag length selection. */** denotes the rejection of null hypothesis of a unit root at a 1/5 percent significance level.

Table A.2. *Cointegration test results for Brazil*

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	1	1	1
Maximum Eigenvalue	2	2	1	1	1

Table A.3. *Cointegration test results for Russia*

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	2	3	3
Maximum Eigenvalue	2	2	2	3	3

Table A.4. *Cointegration test results for India*

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	3	3	3	4
Maximum Eigenvalue	2	3	3	3	4

Table A.5. *Cointegration test results for China*

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	4	4	2	2
Maximum Eigenvalue	2	2	1	2	2

APPENDIX B

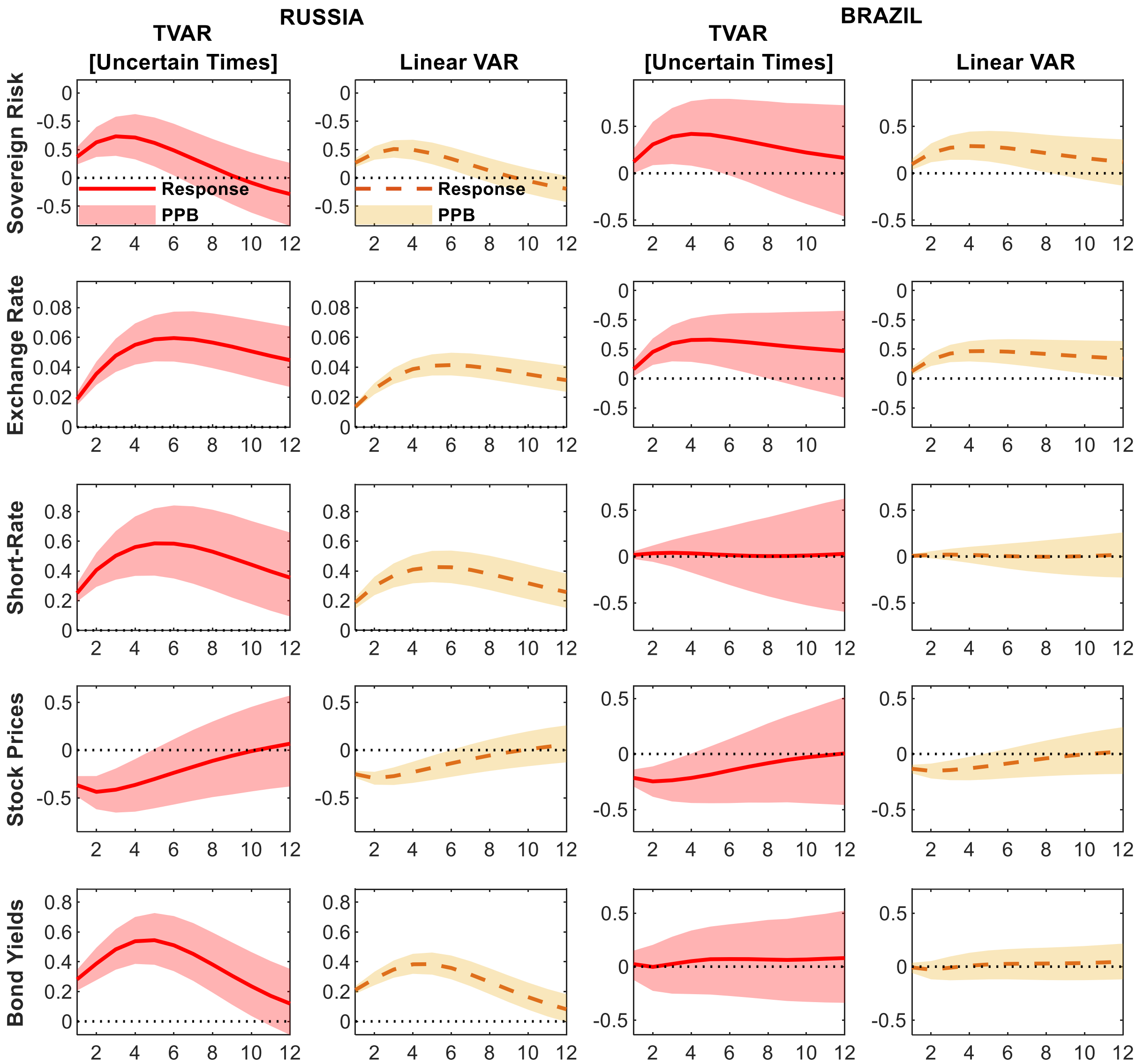

Figure B.1. *The Effects of Negative Oil Price Shocks: Monthly Data*

(*Notes:* Dashed yellow lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on the TSVAR, covering only uncertain periods. Shaded areas denote 68 % posterior probability bands)

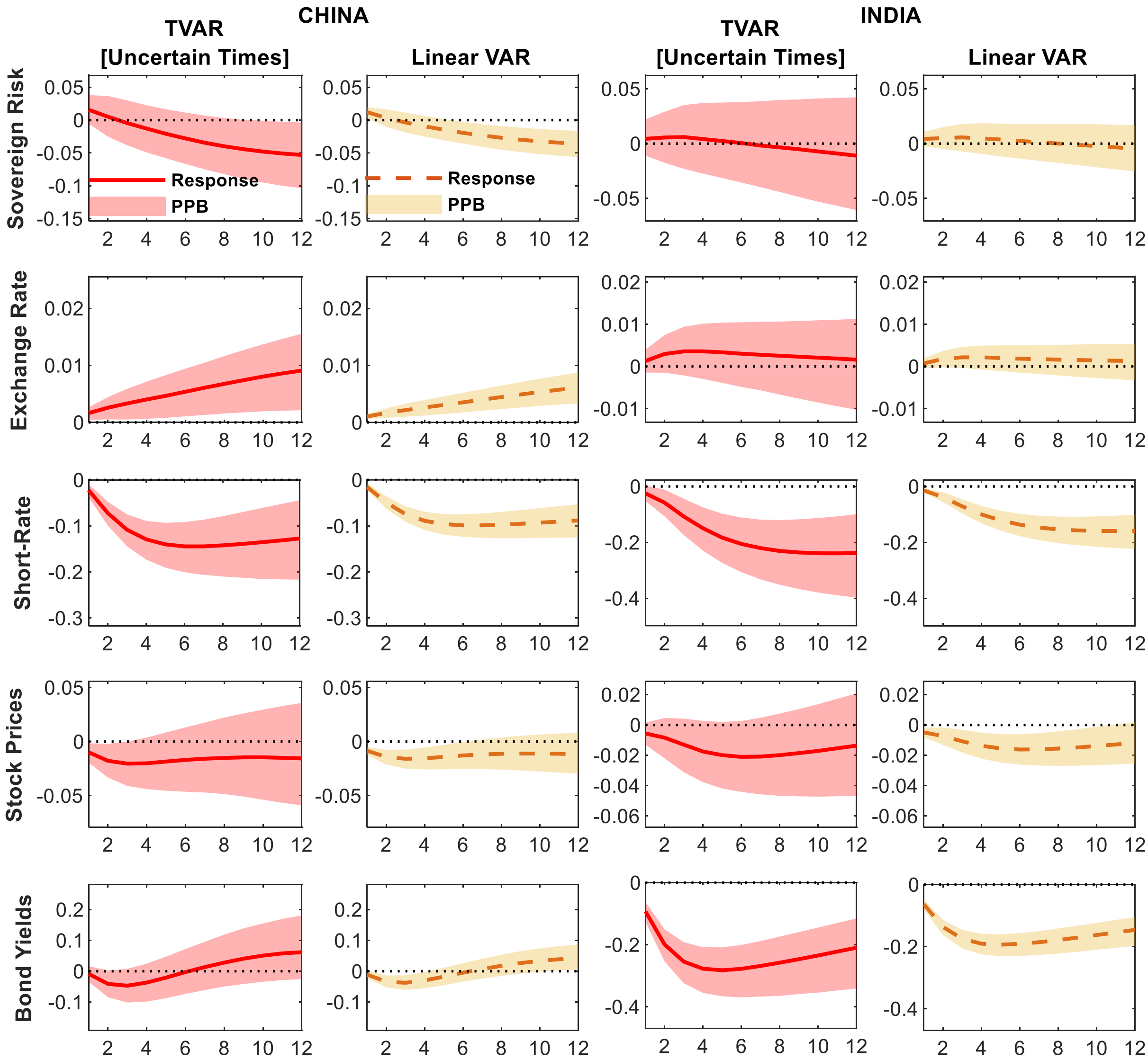

Figure B.1. (Continue) *The Effects of Negative Oil Price Shocks: Monthly Data*

(*Notes:* Dashed yellow lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on the TSVAR, covering only uncertain periods. Shaded areas denote 68 % posterior probability bands)

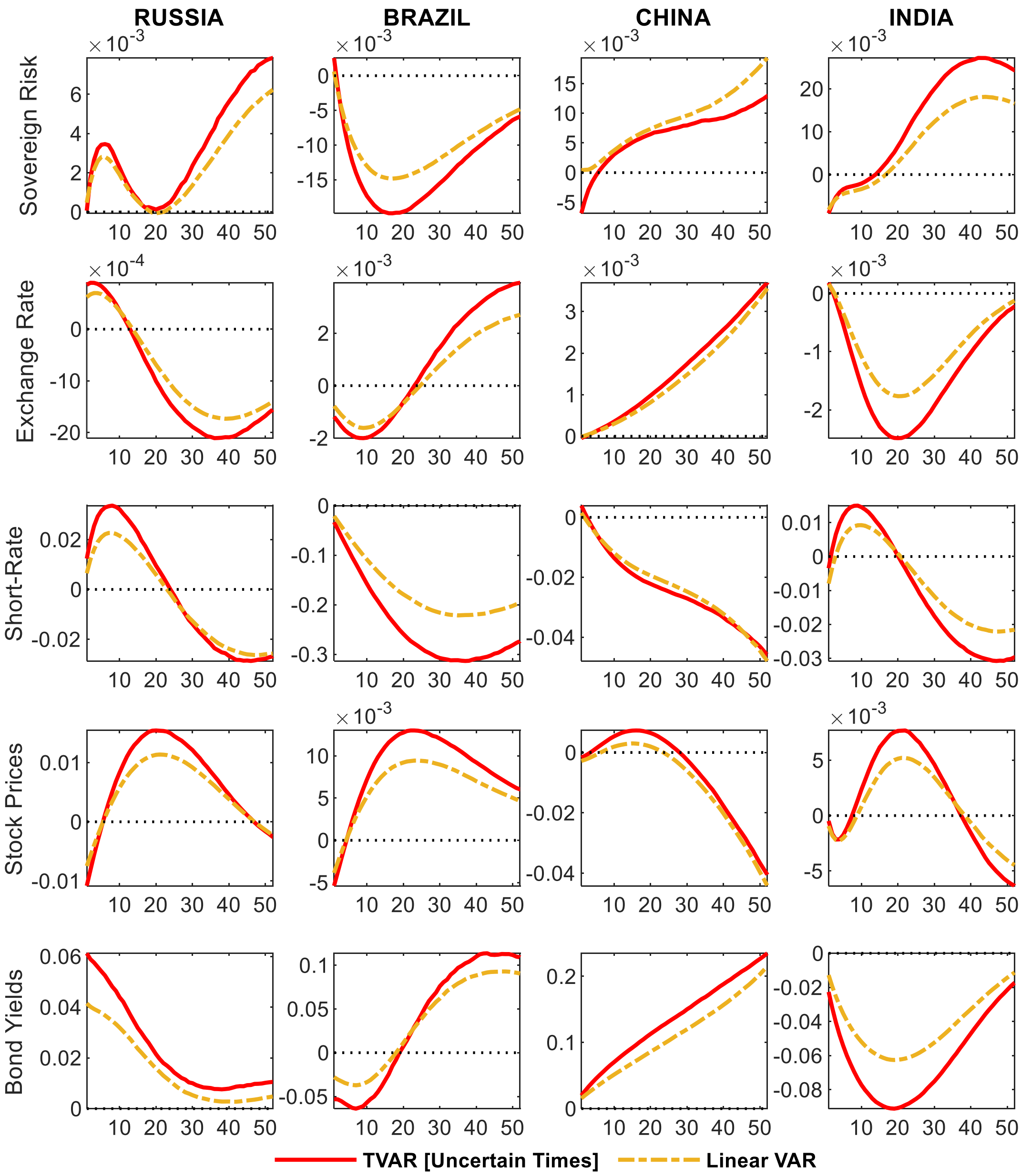

Figure B.2. *The Effects of Negative Oil Price Shocks. (2003-2006)*

(*Notes:* Dashed yellow lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods.)

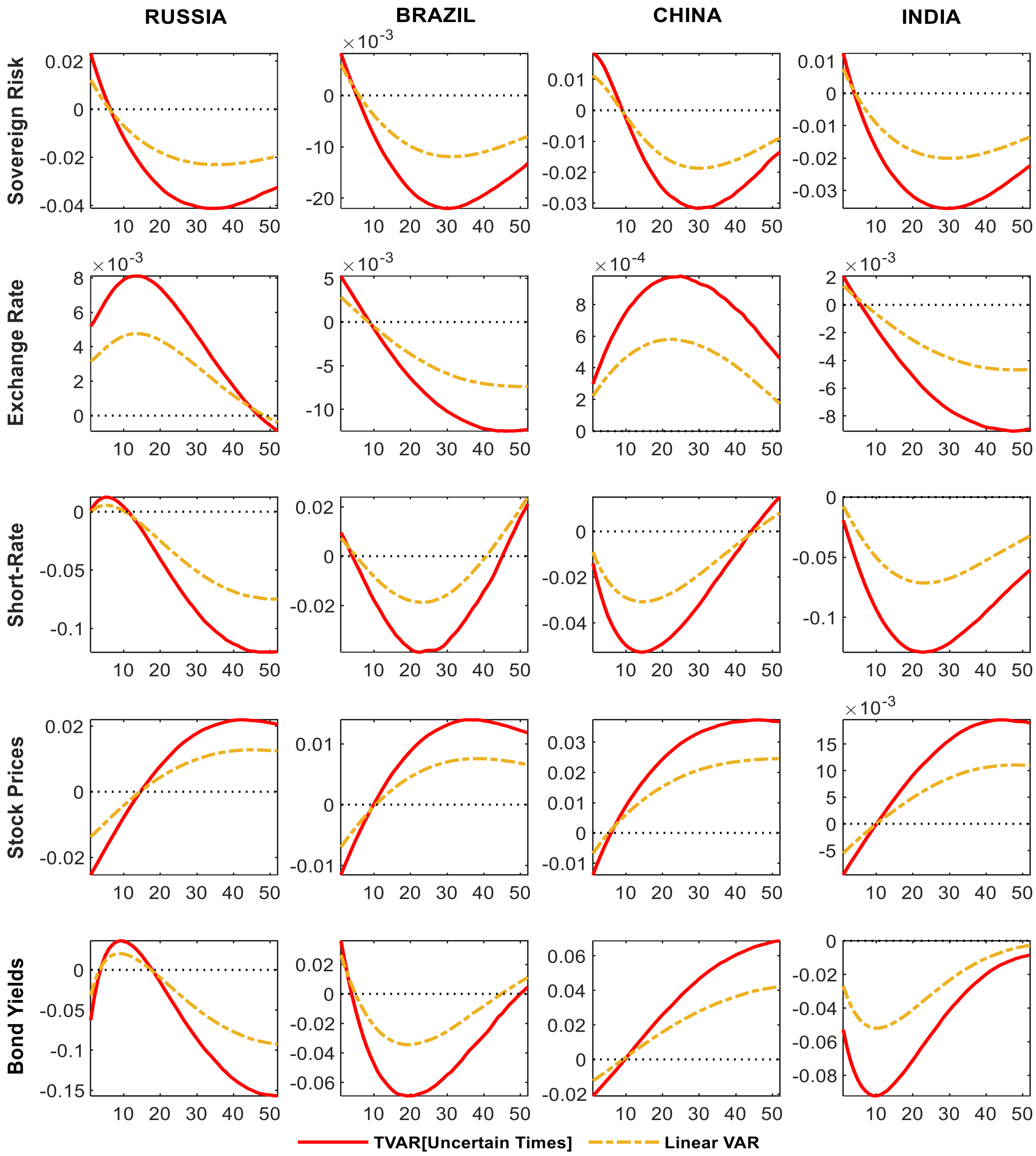

Figure B.2.(Continue) *The Effects of Negative Oil Price Shocks. (2007-2012)*

(*Notes:* Dashed yellow lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods.)

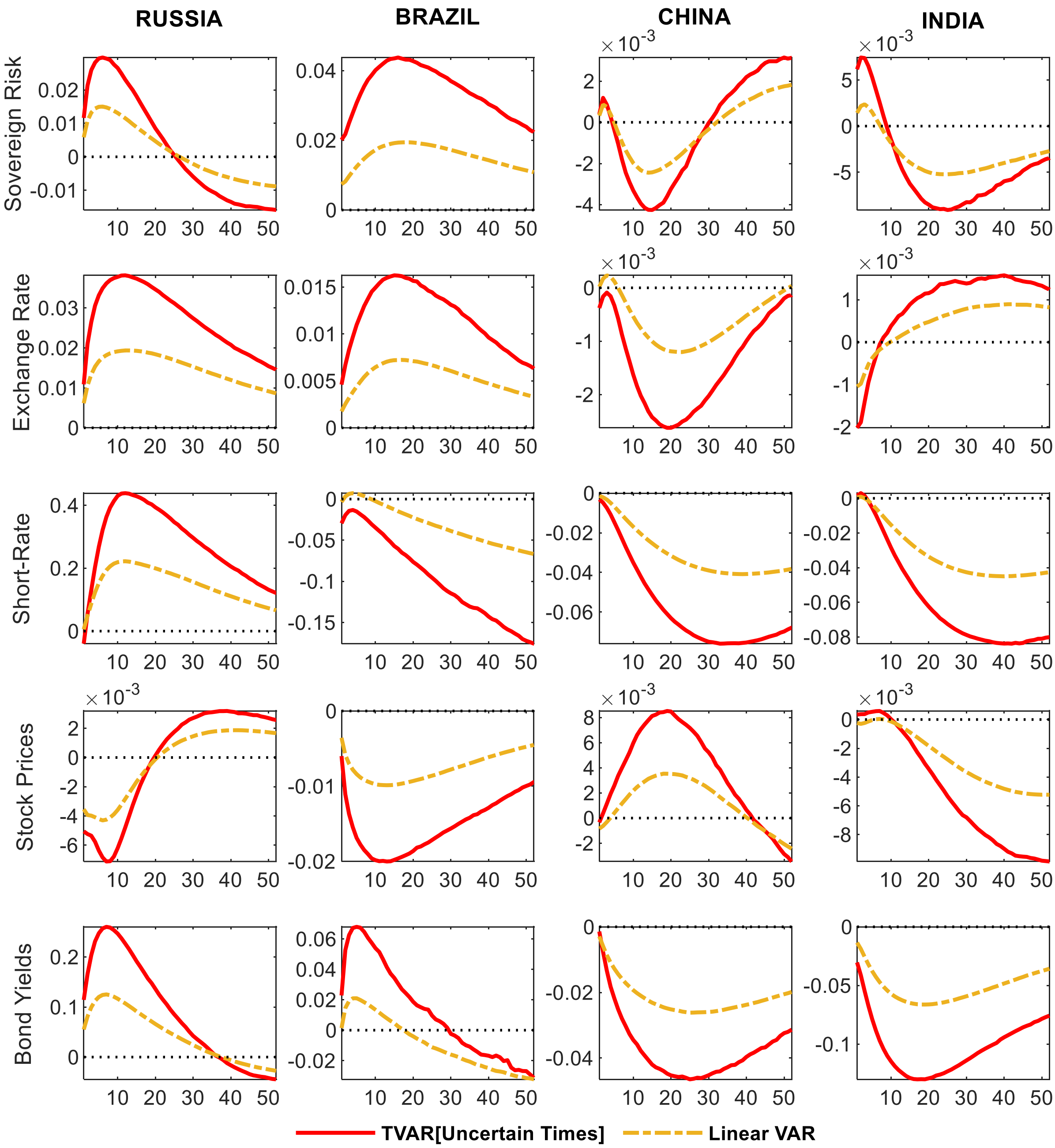

Figure B.2.(Continue) *The Effects of Negative Oil Price Shocks. (2013-2019)*

(*Notes:* Dashed yellow lines indicate the responses of BRIC based on the estimated conventional SVAR model, while straight red lines denote the responses based on TSVAR, covering only uncertain periods.)