ADBI Working Paper Series

TRADE LINKAGES AND TRANSMISSION OF OIL PRICE FLUCTUATIONS IN A MODEL INCORPORATING MONETARY VARIABLES

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No. 777
September 2017

Asian Development Bank Institute

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Suggested citation:

Taghizadeh-Hesary, F., E. Rasoulinezhad, and N. Yoshino. 2017. Trade Linkages and Transmission of Oil Price Fluctuations in a Model Incorporating Monetary Variables. ADBI Working Paper 777. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/trade-linkages-transmission-oil-price-fluctuations-model

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Abstract

This study is an attempt to ascertain how sharp oil price changes can affect oil-exporting and oil-importing economies. To this end, a simultaneous equation model (SEM) was applied through a weighted two-stage least squares estimation method to different countries (21 cases) with business relations over the period from Q1 2000 to Q4 2015. In the case of oil-exporting countries—consisting of Iran, the Russian Federation, United Arab Emirates, Indonesia, and Kazakhstan—the findings revealed that they totally benefit from oil price increases. In the case of oil-importing countries, the effects are more diverse. To derive a better interpretation, we divided them into four groups: European Union (EU) members (Germany, Italy, the Netherlands, and Poland); East Asian nations (Japan; the People's Republic of China; the Republic of Korea; Viet Nam; Taipei,China; Singapore; and Hong Kong, China); Commonwealth of Independent States (Ukraine and Belarus); and others (the United States, India, and Turkey). The results showed that all these countries importing oil face a negative supply shock, except Turkey which benefits directly from an oil price shock. Furthermore, the indirect effect coefficient received through trade for all these countries was positive.

Keywords: crude oil price, trade linkage, direct and indirect effect of oil shocks

JEL Classification: Q43, C30, E32

Contents

1. INTRODUCTION 1

2. LITERATURE REVIEW 3

3. MODEL 5

4. EMPIRICAL SURVEY 8

4.1 Data Analysis 8
4.2 Wald Test (Joint Significance Test) 9
4.3 Empirical Results 9

5. CONCLUSIONS 12

REFERENCES 14

APPENDIX 1: AUGMENTED DICKEY-FULLER UNIT ROOT TEST 18

APPENDIX 2: HETEROSCEDASTICITY TEST RESULTS 20

1. INTRODUCTION

One of the most important production inputs is energy, particularly crude oil. It is often pointed out (e.g., Heo et al. 2010 and Difiglio 2014) that oil plays a crucial role in the world economy. In spite of noticeable inclination toward alternative renewable natural sources like wind, water, nuclear, and solar power, the role of crude oil in macroeconomic movements has not yet waned. As Dehn (2001) argued, oil prices have been highly variable—twice as variable as those of other goods. Since the 1970s, fluctuations in global oil prices have been a focus of debate and a considerable issue for many countries, such as the oil-exporting ones in which the governmental budget is tied to oil incomes and economic growth in them can be hit by these shocks directly or indirectly, and oil-importing nations in which oil means the raw material for making goods and transportation fuels (Gupta 2008). From the vast number of related studies on this issue, we can point to Hamilton's (1983) influential paper on the effect of oil prices on the United States (US) economy, where it was expressed that exogenous oil price changes over the post-World War II period have an impact on the US economy. Cunado and Perez de Gracia (2003) also concluded that oil price fluctuations had a significant effect on economic growth for a sample of European economies, while a more recent finding by Du, Yanan, and Wei (2010) showed that global oil price affects PRC economic growth and inflation significantly.

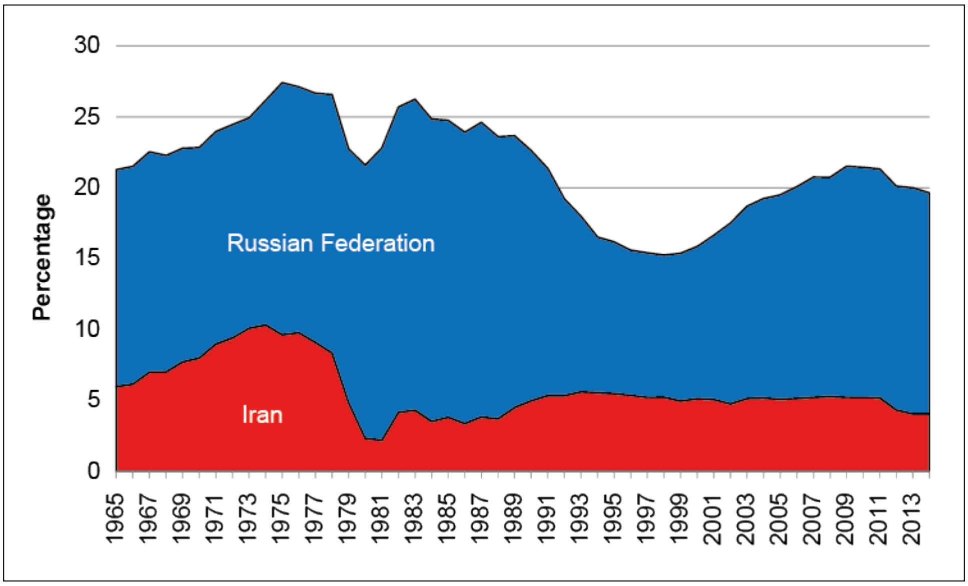
More recently, the sharp decrease in oil prices that started in mid-2014 and which decreased global crude oil prices to less than half drew attention to the role of oil prices on the macroeconomy and the causes of oil price fluctuation. Oil prices dropped from above $100 per barrel in June 2014 to less than $30 per barrel in February 2016. Since early April 2016, oil prices have started to increase again because of a fragile increase in demand, but prices are almost half those in 2014. There are several reasons for this sharp drop, relating to supply and demand and expectations in the oil market. Yoshino and Taghizadeh-Hesary (2016a) found that a significant portion of this oil price drop was rooted in the expansionary monetary policy of federal reserves and some other central banks following the subprime mortgage crisis of 2008–2009 which inflated oil prices due to cheap money, which increased the speculative demand for oil[1] while the global economy was in recession. In 2016, due to the recovery of US capital markets, these liquids went back to the capital market and shrank the demand for oil, which caused this oil price drop.

Unlike previous studies that only provided specifications of oil price effects in oil-exporting countries or oil-importing nations, in this study we attempt to investigate how fluctuations in oil price affect the economy of oil-exporting countries (Iran, the Russian Federation), oil-importing countries (Japan, the People's Republic of China [PRC], and the Republic of Korea), and their business partners (16 cases).

The choice of countries in this study is also motivated by the fact that Iran and the Russian Federation are two of the world's largest exporters of crude oil, while Japan, the PRC, and the Republic of Korea are the main importers of crude oil in the world. Figure 1 and Figure 2 illustrate the status of these nations in the world oil market:

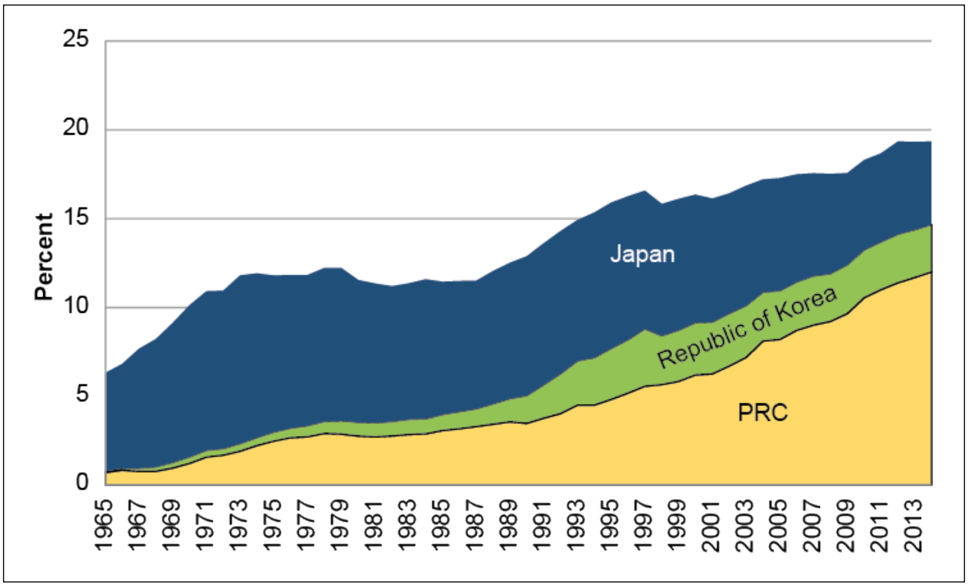
[1] Taghizadeh-Hesary and Yoshino (2014) and Yoshino and Taghizadeh-Hesary (2014a) found that monetary variables (short-term interest rate and exchange rate)—federal funds rate and real effective exchange rates of the US dollar—were channels of transmission of US monetary policy to global oil prices during 1981–2011 and 2009–2011.

Figure 1: Shares of Iran and Russia in Global Oil Production (1965–2014, %)



Note: we use data for the former Soviet Union for 1965–1991 and Russian Federation data for 1992–2014.
Source: Authors' compilation from British Petroleum statistical review of world energy (2015).

Figure 2: Shares of Japan, the PRC, and the Republic of Korea in Global Oil Consumption



Source: Authors' compilation from British Petroleum statistical review of world energy (2015).

As can be seen from Figure 1, the Russian Federation and Iran have contributed an average of almost 20% to global oil production over the period 1965–2014. This means that these two countries play a crucial role in this market and any changes in their supply and energy policies may be an influential factor in the global oil market. In addition, Figure 2 illustrates a remarkably large share of global oil consumption in the PRC, the Republic of Korea, and Japan. In the last decades, their contribution to global crude oil consumption has increased and in 2014 reached almost 20%. Hence, these three East Asian nations have an important role in the demand side of the global oil market and their crude oil demand policies may significantly affect the global market for this kind of energy.

As is clear, the share of Japan has reduced and instead the shares of the PRC and the Republic of Korea have increased. Oil demand in Japan has declined by nearly 15% since 2000. This decline stems from structural factors, such as fuel substitution, the declining population, and government-mandated energy efficiency targets (Yoshino and Taghizadeh-Hesary 2014b; Taghizadeh-Hesary and Yoshino 2015) in addition to the long-lasting slowed growth in the Japanese economy that reduced the demand for oil and production of raw material and as an energy carrier (Yoshino and Taghizadeh-Hesary 2016b).

In this paper, we follow the argument of Taghizadeh-Hesary et al. (2013) about the direct and indirect effects of sharp changes in crude oil prices: when global oil prices go up sharply (when a positive price shock happens), a positive direct effect on the oil exporter is expected, being an increase in oil revenues. At the same time, on the opposite side for the energy importer, this sharp rise in oil price is considered as a negative supply shock. As a result, energy demand from the energy importer decreases and this is the indirect effect that we predicted to be negative for the exporter. This negative impact leads to an increase in the energy exporters' revenue by less than the expected amount. On the other hand, for oil importers, a sharp oil price fluctuation will have two effects: a direct effect, which is a negative supply shock; and an indirect effect due to the production process, meaning that there will be a positive indirect effect due to an increase in the revenue of oil exporting countries, allowing oil importing nations to export more final products (automobiles, home appliances, and other goods) to these oil exporting countries, so decreasing their net loss.

Our main research purpose is to examine the existence and positivity or negativity of direct and indirect oil shocks on the gross domestic product (GDP) growth rate of several oil-exporting and oil-importing countries and their top trading partners in a model incorporating monetary variables. Furthermore, considering a new approach to estimations of the shock effects of oil price, a new group of case studies and inputting monetary variables are novelties in this research.

The rest of this paper is organized as follows. In the next section, we present a brief literature review. The third section describes data analysis and our empirical model, and the fourth section presents the estimation results in more detail. The last section is for the conclusions.

2. LITERATURE REVIEW

The related literature can be divided into two strands of study: (i) investigation of oil price shock effects on the macroeconomic activity of a certain country or group of countries; and (ii) exploration of the effects of oil price shocks on the trade patterns of a certain country or group of countries.

In the first strand of the study, the authors concentrated on the influence of oil price shocks on the macroeconomic activity of countries. In fact, the oil price shock which happened in 1973 in response to the oil embargo of Organization of Arab Petroleum Exporting Countries (OAPEC) and the subsequent recession gave rise to a plethora of studies investigating the impacts of oil price rises on the macroeconomic variables. The early studies include those by Pierce and Enzler (1974), Rasche and Tatom (1977), Mork and Hall (1980), Bruno and Sachs (1982), Darby (1982), Sachs (1982), Shigehara (1982), Vangrevelinghe (1982), and Burbidge and Harrison (1984), all of which documented and explained the inverse relationship between oil price increases and aggregate economic activity. Later empirical studies such as Gisser and Goodwin (1986), Hickman et al. (1987), Mork (1989) and Lee, Shawn, and Ratti (1995) confirmed the inverse nexus between oil prices and aggregate economic activity. More recently, Ali Ahmed and Mokhtarul Wadud (2011) examined the impact of oil price uncertainty on Malaysian macroeconomic activities and monetary responses by using a structural vector autoregressive (VAR) model based on monthly data over the period 1986–2009. They found that levels of Consumer Price Index (CPI) decline with a positive shock to oil price uncertainty. This is the consequence of a negative demand shock due to the postponement of consumption of big ticket items by individuals, households, and other sectors of the economy. Difiglio (2014) reviewed why the price inelastic demand and supply of oil causes oil price shocks and why oil price shocks reduce economic growth through dislocations of labor and capital. The author concluded that oil price spikes will remain a threat to world economic growth and strategic oil reserves can protect the worldwide economy if sufficiently large releases are promptly announced.

Idrisov, Kazakova, and Polbin (2015) attempted to represent a theoretical interpretation of oil prices' impact on economic growth in the contemporary Russian Federation. Their main conclusion was that a constant increase in oil prices cannot influence the long-term economic growth rate of this country and only predetermines short-term transitional trends from one long-term equilibrium to another. Basnet and Upadhyaya (2015) investigated the impacts of oil price shocks on output, inflation, and exchange rate in selected member countries of the Association of Southeast Asian Nations (ASEAN) using a structural VAR approach. The findings revealed that oil price shocks do not impact on the ASEAN-5 economies in the long run and much of the effect is absorbed within five to six quarters. Ratti and Vespignani (2016) tried to determine the relationships between oil prices, global industrial production, CPI, central bank policy interest rate, and monetary aggregates using a global factor augmented error correction model. The results showed that positive innovation in global oil price is connected with the global interest rate tightening and positive innovation in global interest rate is associated with a decline in oil prices. Taghizadeh-Hesary et al. (2016) assessed the impact of crude oil price movements on two macro variables—the GDP growth rate and consumer price index inflation rate—in the developed economies of the US and Japan, and an emerging economy, the PRC. Their results suggested that the impact of oil price fluctuations on developed oil importers' GDP growth is much lower than on the GDP growth of an emerging economy. On the other hand, the impact of oil price movements on the PRC's inflation rate was found to be milder than in the two developed countries that were examined.

In a study, Gozgor, Chang, and Bilgin (2017) focused on the relationship between crude oil price shocks and macroeconomic performance in the panel data set of 10 ASEAN economies over the period 1970–2013. They found that there was a significant pairwise causal relationship between levels of crude oil price and real GDP per capita. Arezki et al. (2017) presented a macroeconomic model of the oil market in order to analyze the effects of a change in oil price on the world GDP growth rate. They found that a period of prolonged low oil prices is likely to be followed by a period where oil prices overshoot their long-term upward trend. Taghizadeh-Hesary, Yoshino, and Rasoulinezhad (2017) assessed the elasticity of oil consumption in Japan's various economic sectors and the crude oil price before and after the Fukushima disaster in March 2011 that led to a shutdown. To do so, the study applied a co-integration analysis and performed a vector error correction (VEC) variance decomposition by using quarterly data from Q1 1981 to Q4 2010 and from Q1 2011 to Q4 2015. Their findings revealed that the absolute value of elasticities of oil consumption by some economic sectors reduced after this disaster because of increased dependency on oil consumption, which endangered energy security in the country.

The second strand of literature attempted to discover the effect of oil price shocks on countries' trade patterns. Svensson (1982) applied an intertemporal model to show responses of the trade balance to changes in oil price and interest rate for a small open economy oil-importing country. The results showed that a temporary oil price increase unambiguously improves the present trade balance through an increase in saving and a decrease in investment. Le and Chang (2013) examined whether a large part of the variability of trade balances and their oil and non-oil components is associated with oil price fluctuations. Akerstrom and Jungqvist (2016) investigated the effects of oil price shocks on the overall trade and non-oil trade balances for ten oil-importing euro area countries by using a VAR model from Q1 1980 to Q4 2014. The findings revealed that the euro area countries' non-oil trade balances responded similarly to oil price shocks. In their study, Allegret, Mignon, and Sallenave (2015) attempted to ascertain the relationship between oil price shocks and global imbalances through a model with trade and financial interdependencies over the period 1980–2011. They showed that the nature of the shock—demand-driven or supply-driven—matters in understanding the effects of oil price shocks on global imbalances. Furthermore, the results indicated that the main adjustment mechanism for oil shocks is based on the trade channel.

Taghizadeh-Hesary et al. (2013) evaluated the impact of oil price shocks on oil-producing and oil-consuming economies, employing a simultaneous equation framework for different countries with business relations and using Q1 1990–Q4 2011 data. As expected, the researchers found that oil producers benefit from oil price shocks. However, results for oil-importing countries where diverse. In this survey, the authors did not include any monetary variables.

Overall, with the exception of Taghizadeh-Hesary et al. (2013), it seems that there has been no serious attempt to examine whether and how, under the presence of oil price shocks, the economic growth of oil-exporting and oil-importing countries and their main trading partners changes when including monetary variables that have a significant impact on the whole economy, and the effect on commodities' prices, including oil prices (see Keynes 1936; Ricardo 1951; Kormilitsina 2011; Taghizadeh-Hesary and Yoshino 2014; Yoshino and Taghizadeh-Hesary 2014; Yoshino et al. 2014). Therefore, this study will provide new and useful insights for readers, scholars, and policy makers.

3. MODEL

This study covers a quarterly sample period from Q1 2000 to Q4 2015 for Iran and the Russian Federation as oil-exporting countries and the Republic of Korea, Japan, and the PRC as oil-importing countries and their major trade partners.

In order to develop our model, we need to determine the main trade partners of Iran and the Russian Federation as oil-exporting countries and of Japan, the PRC, and the Republic of Korea as oil-importing countries. We extended the period and used nine annual (2007–2015) moving average export shares. The results of the main exporting partners are reported in Table 1 and Table 2.

Table 1: Main Trading Partners of Iran and the Russian Federation (Oil-exporting Countries)

Percentage of Total Russian Federation Export Volume	Country Trading Partner	Percentage of Total Iranian Export Volume	Country Trading Partner
12.18	Netherlands	15.68	PRC
6.62	Italy	13.23	United Arab Emirates
5.89	PRC	10.81	India
5.65	Germany	10.80	Turkey
4.52	Belarus	9.24	Republic of Korea
3.91	Turkey	9.22	Japan
3.91	Ukraine	5.56	Netherlands
3.73	Poland	3.83	Italy
2.89	Kazakhstan	3.26	Germany
2.71	United States	1.91	Indonesia

Source: Applying moving averages trade shares data from Direction of Trade Statistics (DOTS) of the IMF (2007–2015).

Table 2: Main Trading Partners of Japan, the PRC, and the Republic of Korea (Oil-importing Countries)

Percentage of Total Chinese Export Volume	Country-trading Partner	Percentage of Total Chinese Export Volume	Country-trading Partner	Percentage of Total Chinese Export Volume	Country-trading Partner
18.18	US	19.24	US	23.35	PRC
15.08	Hong Kong, China	16.62	PRC	12.03	US
8.02	Japan	7.75	Republic of Korea	6.85	Japan
4.47	Republic of Korea	6.35	Taipei,China	5.50	Hong Kong, China
3.77	Germany	5.50	Hong Kong, China	3.47	Singapore
3.03	Netherlands	4.14	Thailand	3.10	Taipei,China
2.44	United Kingdom	3.18	Singapore	2.42	Viet Nam
2.20	India	2.94	Germany	2.21	Germany
2.16	Singapore	2.17	Malaysia	2.04	India
1.90	Taipei,China	2.11	Australia	1.92	Indonesia

Source: Applying moving averages trade shares data from Direction of Trade Statistics (DOTS) of the IMF (2007–2015).

Tables 1 and 2 state the main trade partners of our survey's oil exporters (Iran and Japan) and oil importers (Japan, the PRC, and the Republic of Korea). Below we add their major country partners to our model: the Netherlands; Italy; Germany; Belarus; Turkey; Ukraine; Kazakhstan; Poland; the US; the United Arab Emirates (UAE); India; Indonesia; Hong Kong, China; Singapore; Taipei,China; and Viet Nam. It means our model consists of 21 countries, among which Iran, the Russian Federation, the UAE, Indonesia, and Kazakhstan are oil-exporting economies and the rest are oil-importing countries.

According to Stevens (2002), the proper selection of methodology is a crucial part of any academic research. In this study, we choose simultaneous equation modeling (SEM) to estimate our econometric model. The main reason for choosing this method is that one of the necessary conditions for estimating the coefficients in a regression by ordinary least square (OLS) is the independence of explicative variables from the model residuals. When modeling economic variables, we may face a situation in which the variables intended to be explicative, and hence exogenous, variables in the regression model have a simultaneous behavior with the endogenous variables and consequently lose their exogeneity characteristics. The endogeneity of explicative series makes the estimation of efficient parameter estimators through OLS impossible (Ruxanda and Muraru 2010). A system with *n* simultaneous equations can be written as

$$BY_t + \Gamma X_t = \mu_t \tag{1}$$

where *Y* represents the *n*1* vector of endogenous variables, *X* shows the *q*1* vector of predetermined exogenous variables, and *μ* indicates the *n*1* residuals' vector. *B* is the *n*n* matrix of coefficients for the endogenous variables and Γ shows the *n*q* matrix of coefficients for the predetermined variables.

In this paper, a New Keynesian aggregate demand in the SEM framework for all countries (oil exporters and oil importers) is used to find the effects of oil price fluctuations on oil exporter and oil importer economies in a trade-linked case by incorporating the monetary variables (Model 2):

$$\begin{aligned}(y_t - \bar{y}_t) = {} & \left[\left\{C_t^{oil}\left(y_t - \bar{y}_t, P_t^{oil}\right) + C_t^{noil}\left((y_t - \bar{y}_{t_t}\right)\right\} - \bar{C}\right] \\ & + [I_t(i_t^{LN} - E_t\{\pi_{t+1}\}) - \bar{I}] + (G - \bar{G}) \\ & +[\{(X_t(e_t) - (M_t(e_t\ )\} - (\bar{X} - \bar{M})]\end{aligned} \tag{2}$$

where $(y_t - \bar{y}_t)$ is the GDP gap, which is deviations of (*log*) output from (*log*) steady state; consumption consisting of two parts—oil consumption (C_t^{oil}) and non-oil consumption (C_t^{noil}). Oil consumption is a function of crude oil price (P_t^{oil}) and the income level (GDP gap), and for the non-oil consumption it is a function of the income (GDP gap). $\bar{C}$ denotes consumption in steady state. I_t denotes the real investment, which is a function of the long-run real interest rates; i_t^{LN} denotes the long-run nominal interest rate and $E_t\{\pi_{t+1}\}$ is the expected consumer price index inflation rate. Deviations of these two shows the long-run real interest rate. $\bar{I}$ is the investment in steady state. G and $\bar{G}$ denote real government expenditures and steady state government expenditures. The last part of the aggregate demand equation is the trade balance, which is the difference between the country's export (X_t) and import (M_t). For many oil importers, oil import comprises a significant portion of their trade; hence import volume is affected by oil price movements. The same happens for oil exporters, where oil price fluctuations change the amount of their exports. Both import and export are affected by exchange rate (e_t) fluctuations. $\bar{X}$ and $\bar{M}$ are export and import in steady state respectively.

This aggregate demand model enables us to capture the impact of higher crude oil price, consumption, exchange rate fluctuations, government expenditures, and investment on the GDP gap.

By considering oil price shock as an exogenous variable, economic growth (logarithm of real GDP) as an endogenous variable, and control variables (long-term real interest rate and real effective exchange rate) as two monetary variables, our econometric model SEM can be formulated as in Model 3:

$$y_{1t} = \lambda_1 + \sum_{k=1}^{4} \varphi_{1,k} y_{1,t-k} + \sum_{k=0}^{4} \beta_{1k}\left(W_{1,2}.\, y_{2,t-k} + \cdots + W_{1,21}.\, y_{21,t-k}\right) + \sum_{k=0}^{4} \gamma_{1,k} OS_{1,t-k} + \sum_{k=0}^{4} \delta_{1,k} {i^{LN}}_{1,t-k} + \sum_{k=0}^{4} \theta_{1,k} e_{1,t-k} + \varepsilon_{1t}, \quad (3)$$

$$y_{21t} = \lambda_{21} + \sum_{k=1}^{4} \varphi_{21,k} y_{21,t-k} + \sum_{k=0}^{4} \beta_{21k}\left(W_{21,1}.\, y_{1,t-k} + \cdots + W_{21,20}.\, y_{21,t-k}\right) + \sum_{k=0}^{4} \gamma_{21,k} OS_{21,t-k} + \sum_{k=0}^{4} \delta_{21,k} {i^{LN}}_{21,t-k} + \sum_{k=0}^{4} \theta_{21,k} e_{21,t-k} + \varepsilon_{21t}$$

where y_{it} $(i=1, \ldots, 21)$ represents the GDP growth rate of country *i*, since there are 21 countries in our study; W_{ij} is the share of exports of country *i* to country j; OS_{it} indicates an oil price shock to country *i* (changes in oil prices). i^{LN}_{it} indicates long-term real interest rate and e_{it} denotes real effective exchange rate. φ, β, γ, δ, and θ are parameters to be estimated. Moreover, in our model, γ shows a direct effect of an oil price shock on the GDP growth rate of country *i* and β denotes the indirect effect of oil price shock that country *i* receives through its trading partners.

4. EMPIRICAL SURVEY

4.1 Data Analysis

This study uses quarterly data of real GDP in US dollars (we compute this variable by deflating nominal GDP according to the base year of 1990); real oil price in US dollars (in our study, this variable was calculated by an average of West Texas Intermediate and Brent oil crude oil prices); long-term interest rate;[2] real effective exchange rate (REER);[3] and export share in percentages.

[2] We employed the government bond interest rate in each country. It should be noted that since in Iran there is no government bond, we used the HP (Hodrick-Prescott) filter of inflation as the benchmark interest rate.

[3] Based on the IMF definition, REER is the effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

Sources of data are the Direction of Trade Statistics (DOTS) of the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD) database, and the US Energy Information Administration (EIA) database. It is important to note that all data in this study are converted into natural logarithms. In time series analysis, this transformation is often considered to stabilize the variance of a series (Brooks 2008).

First of all, it is necessary to ascertain the presence of unit roots and then check for the heteroscedasticity in our series. To this end, we have applied the Augmented Dickey Fuller (ADF) to all series in our model. The results report that all series are stationary and the null hypothesis for the existence of unit roots is rejected (Appendix 1).

In addition, it would be instructive to test for the existence of heteroscedasticity for all equations in our SEM. For this purpose, we regressed all 21 SEM through the OLS estimator and analyzed the residuals for the presence of heteroscedasticity through Glejser and Harvey tests (these tests are similar to the Breusch-Pagan-Godfrey test). Results show no heteroscedasticity problem for all countries' residuals (Appendix 2).

4.2 Wald Test (Joint Significance Test)

As the second step of estimating, we apply the Wald test, which has the null hypothesis of all of the foreign variables as jointly zero in each equation of our SEM. The findings illustrate that the null hypothesis is rejected for all foreign variables and oil price shocks. In other words, 21 countries in our study were influenced by an indirect effect of an oil price shock through their trading partners and were also affected by a direct effect of an oil price shock.

4.3 Empirical Results

The method of SEM estimation in this survey is the weighted two-stage least squares (W2SLS). This estimation method is an instrumental-variable estimation methodology that allows different variances of the disturbance terms in the different equations. We divide the results of SEM into two groups of countries: net oil-exporting countries group as in Table 3 (Iran, the Russian Federation, Kazakhstan, Indonesia, UAE) and net oil-importing countries group as in Table 4 (Japan; US; the PRC; the Republic of Korea; Belarus; Germany; Italy; Netherlands; Viet Nam; Taipei,China; Singapore; Hong Kong, China; India; Poland; Ukraine; Turkey).

Table 3: Crude Oil Balance Trade, Oil Exporters (1990–2015, Mt**)**

Country	1990	1995	2000	2005	2010	2015
Iran	–117.0	–127.1	–115.3	–128.4	–123.9	–35.0
Russian Federation	–203.3	–113.8	–138.5	–253.4	–245.9	–240.7
Kazakhstan	–6.2	–8.9	–28.4	–50.9	–63.3	–59.1
Indonesia	–31.7	–30.2	–17.0	–3.1	2.2	5.0
UAE	–78.0	–92.2	–93.2	–104.9	–103.0	–130.2

Note: Balance trade = (Import – Export).

Source: Authors' compilation from Global Energy Statistical Yearbook (2016).

Table 4: Crude Oil Balance Trade Oil Importers (1990–2015, Mt)

Country	1990	1995	2000	2005	2010	2015
Japan	202.9	227.3	217.8	212.7	181.4	162.4
US	339.4	407.6	505.1	576.4	513.3	339.3
PRC	–21.1	–1.1	60.0	118.8	234.7	333.9
Republic of Korea	41.8	87.4	123.2	115.0	118.7	137.7
Germany	88.1	100.1	100.5	111.6	92.6	90.9
Italy	83.7	81.9	89.9	93.8	84.0	67.6
Netherlands	47.7	58.6	60.4	60.6	59.6	58.9
India	20.7	27.3	74.1	99.4	163.6	199.2
Poland	13.1	14.1	18.1	18.1	23.1	26.4
Ukraine	53.1	13.3	5.7	14.8	7.8	0.2
Turkey	20.1	24.7	21.6	23.4	17.0	24.7

Note: Balance trade = (Import – Export). Since we did not find the related data for Belarus; Viet Nam; Taipei,China; Singapore; and Hong Kong, China in the Global Energy Statistical Yearbook, the analysis of the balance of these countries is based on the International Energy Agency (IEA).

Source: Authors' compilation from Global Energy Statistical Yearbook (2016).

Results for Oil-exporting Economies

In the case of our five oil-exporting countries, the W2SLS estimation results are presented in Table 5. The direct effect of a positive oil price shock on the GDP growth rate is positive and significant for Iran, the Russian Federation, and the UAE, while it is not significant for Kazakhstan and Indonesia. The result of the positive effect of an oil price shock on the GDP growth rate of an oil-exporting country is in line with Taghizadeh-Hesary et al. (2013) and in contrast with Rasoulinezhad (2016), Abeysinghe (2001), and Korhonen and Ledyaeva (2010), who found a negative relationship between oil price shock and economic growth in this kind of country. Based on the direct effect, we can see that if in an oil exporter's oil economy plays a more significant role or the government budget has a higher dependency on oil revenues, oil price shock affects its GDP growth rate more. As we can see, Iran, the Russian Federation, and the UAE are members of the world's top oil producers and exporters and their coefficient of direct effect (γ) is positive and significant, while in the case of Indonesia, the share of crude oil export in the total country's export is less than 5%; hence γ is not significant. For Kazakhstan, recently the share of oil and petroleum product exports in the total country exports has increased from 56.06% in 2001 to nearly 60.73% in 2016 (Trade Map database): this means that γ is expected to be significant as well, and our results prove this fact. In the case of indirect effect, β is negative and significant for all oil-exporting countries except for Indonesia and Kazakhstan, where the coefficients are not statistically significant. As an overall result, we can consider the total value, which is the sum of the direct and the indirect effect. It can be noted that all of these five oil-exporting countries (Iran, the Russian Federation, Kazakhstan, Indonesia, and the UAE) benefit from a positive oil shock. A main reason for this finding is that these five countries, which have developing economies, always trade with nations that do not suffer from oil shocks. Hence, they received a positive indirect effect from their trade partners.

Table 5: W2SLS Estimation Results for Oil-exporting Countries

Country	γ Direct Effect	β Indirect Effect
Iran	0.28 (3.53)**	–0.21 (–3.92)**
Russian Federation	0.33 (4.12)**	–0.11 (–2.03)*
Kazakhstan	0.24 (3.15)**	–0.08 (–0.66)
Indonesia	0.16 (1.53)	0.005 (1.92)
UAE	0.29 (4.01)**	–0.14 (–2.35)**

Note: Values in parentheses are t-values; * indicates significant at the 5% level; ** denotes significant at the 1% level.

Results for Oil-importing Economies

In the case of oil-importing countries and based on the W2SLS estimation, results are summarized in Table 6. Since the findings are varied, we may classify these nations into several groups of countries in order to provide a better interpretation of direct and indirect effects.

Group A consists of countries which are members of the European Union (Germany, Italy, the Netherlands, and Poland). For these economies, an oil price shock has a significant direct effect (γ) and leads to a decrease in the GDP economic growth of these countries. Moreover, the coefficient of indirect effect (β) for all these oil-importing nations is significantly positive. The total effect of an oil price shock will be negative—because the magnitude of the indirect effect coefficient (β) is smaller than the direct effect coefficient (γ)—meaning that group A will not benefit from any sharp and sudden changes in global oil prices.

Group B includes the East Asian oil-importing countries (Japan; the PRC; Republic of Korea; Viet Nam; Taipei,China; Singapore; Hong Kong, China). In all these countries except Viet Nam and Taipei,China, oil price shock has a statistically significant effect on GDP economic growth This means that oil price shock can accelerate the economic growth of most countries in this group. Our finding is in line with Zaouali (2007); Du, Yanan, and Wei (2010); Tang, Wu, and Zhang (2010); Taghizadeh-Hesary et al. (2013); and Joong Kim et al. (2016). The main reason for a negative relationship between oil price shock and the GDP growth rate of these countries is their dependency on the imported crude oil. Moreover, the indirect effect for all countries in this group is positive and statistically significant, except in the cases of Viet Nam and Taipei,China, where the coefficients are not statistically significant. Since the indirect effect coefficient (β) of these nations is smaller than the direct effect coefficient (γ), the overall effect of oil price shock for these nations is negative.

Group C consists of the Commonwealth of Independent States (Belarus and Ukraine). One of the interesting results of our study is in this group. The direct effect and indirect effect coefficients are not statistically significant. Hence, we cannot discuss the effects of oil price shock on these two nations. The specification of their oil-importing in the global oil market is an important reason for this finding. These two countries heavily depend on the Russian Federation's energy export based on a clear contract and they do not have any other oil import destinations. Therefore it can be said that any oil price shock cannot have a significant effect on their macroeconomic variables.

Group D consists of the other countries in our sample (the US, India, and Turkey). Any oil price shock can decelerate the GDP growth rate of these countries. Furthermore, the indirect effects that these three oil-importing nations receive are positive and statistically significant. Overall, since the indirect effect coefficient (β) is smaller than the direct effect coefficient (γ) in these three nations, it can be noted that they will not benefit from the oil price shock.

Table 6: W2SLS Estimation Results for Oil-importing Countries

Country	γ Direct Effect	β Indirect Effect
Japan	–0.18 (–3.11)**	0.11 (2.81)**
US	–0.27 (–2.85)**	0.19 (2.79)**
PRC	–0.48 (–4.01)**	0.36 (4.12)**
Republic of Korea	–0.22 (–3.41)**	0.18 (3.03)**
Belarus	0.11 (0.29)	0.09 (0.24)
Germany	–0.31 (–3.22)**	0.22 (2.90)**
Italy	–0.25 (–3.66)**	0.11 (2.92)**
Netherland	–0.19 (–2.93)**	0.14 (2.88)**
Viet Nam	–0.09 (–0.31)	0.01 (0.72)
Taipei,China	0.14 (0.23)	0.05 (0.58)
Singapore	–0.21 (–3.15)**	0.19 (3.04)**
Hong Kong, China	–0.19 (–3.26)**	0.15 (2.97)**
India	–0.38 (–4.07)**	0.29 (3.77)**
Poland	–0.18 (–2.81)**	0.13 (2.95)**
Ukraine	0.11 (0.67)	0.06 (0.21)
Turkey	–0.26 (–3.42)**	0.23 (3.26)**

Note: Values in parentheses are t-values; * indicates significant at the 5% level; ** denotes significant at the 1% level.

5. CONCLUSIONS

This study was an attempt to ascertain how oil price shock can affect a trade-linked system. Following Abeysinghe (2001) and Taghizadeh-Hesary et al. (2013), we divided the oil price effect into two sub-effects: i) the direct effect that nations receive from an increase in the global oil price; and ii) the indirect effect that countries receive through their trading partners if an oil price shock happens. The two main exporters of oil and three main oil importers used in our model were Iran, the Russian Federation, the Republic of Korea, the PRC, and Japan, and we added 15 other countries. Among these 21 nations, five are net oil exporters—Iran, the Russian Federation, Kazakhstan, Indonesia, and the UAE—and the other 16 are net oil importers. To discover the effects, we applied a W2SLS method for the data set over the period of Q1 2000 to Q4 2015. The main conclusions of our results can be summarized as follows.

- The direct effect of a positive oil price shock on the GDP growth rate of oil-exporting countries is positive. This effect for gigantic oil exporters—Iran, the Russian Federation, and the UAE—is statistically significant and larger than the effects on other oil producers. Hence, it can be concluded that among oil-exporting nations, a larger contribution to the oil supply side means a greater benefit from an oil price shock.

- In line with Abeysinghe (2001) and Korhonen and Ledyaeva (2010), the indirect effect for oil-exporting countries is negative and statistically significant, except in the cases of Kazakhstan and Indonesia in which the coefficients were not significant. The UAE and Iran as two members of OPEC have a large indirect effect, while the Russian Federation does not receive an indirect effect as large as other gigantic oil-exporting countries. The economic sanctions imposed against the Russian Federation since 2014 and the floating exchange rate system used as a tool to control exogenous shocks may be considered the main reasons for the low indirect effect of any oil price shock in this country.
- Countries importing oil face a negative supply shock, while the indirect effect coefficient for all these countries was positive.
- Group A of oil-importing countries (Germany, Italy, the Netherlands, and Poland), who are members of the EU, do not have a total benefit from an oil price shock. An oil price shock leads to a decrease in GDP economic growth in these countries. Moreover, the coefficient of indirect effect (β) for all these oil-importing nations is significantly positive. The total effect of any oil price shock will be negative.
- In Group B of oil-importing nations (Japan; the PRC; the Republic of Korea; Viet Nam; Taipei,China; Singapore; and Hong Kong, China), which are the East Asian countries, except Viet Nam and Taipei,China, oil price shock has a statistically significant effect on GDP economic growth. In other words, oil price shock can decelerate PRC economic growth.
- The direct and indirect effect coefficients were not statistically significant for Group C of oil importing countries, which consists of the Commonwealth of Independent States (Belarus and Ukraine). Hence, we cannot discuss the effects of oil price shock on these two nations. An important reason for this finding is the specification of their oil importing in the global oil market. These two countries heavily depend on the Russian Federation’s energy export based on a clear contract and they do not have any other oil import destinations. Therefore, it can be said that any oil price shock cannot have a significant effect on their macroeconomic variables.
- Group D consists of the US, India, and Turkey. Any oil price shock can decelerate the GDP growth rate of these three nations. Furthermore, the indirect effects that these three oil-importing nations receive are positive and statistically significant. Overall, it can be noted that they will not benefit from an oil price shock.

However, it is noticeable that our exercise has limitations given the changing dynamics of global energy markets. As a low oil price has persisted, the trade pattern between countries has possibly turned into a different phase. The development of alternative energy in the world could affect the trade relationships between oil-exporting and oil-importing nations. However, these issues would be a different arena of study that remains for later research works.

The main policy recommendation suggested by this study is to increase the efficiency of policies to reduce negative oil price shock effects (such as reserve funds) for those countries that are negatively affected by any sudden oil price change. Furthermore, the countries for which oil price shocks are of benefit, such as Iran and the Russian Federation, can enhance the transmission channels of oil price shock effects in their macroeconomic variables in order to achieve the full positive potential of positive oil price shocks.

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APPENDIX 1: AUGMENTED DICKEY-FULLER UNIT ROOT TEST

Country	Variables	ADF Statistic	H0	Result
Russian Federation	y	–4.29	Reject	Stationary
	W	–5.11	Reject	Stationary
	i^{LN}	–3.99	Reject	Stationary
	e	–4.01	Reject	Stationary
Iran	y	–5.24	Reject	Stationary
	W	–4.13	Reject	Stationary
	i^{LN}	–3.81	Reject	Stationary
	e	–4.66	Reject	Stationary
Japan	y	–3.95	Reject	Stationary
	W	–3.91	Reject	Stationary
	i^{LN}	–4.41	Reject	Stationary
	e	–4.28	Reject	Stationary
PRC	y	–3.77	Reject	Stationary
	W	–4.36	Reject	Stationary
	i^{LN}	–4.12	Reject	Stationary
	e	–3.82	Reject	Stationary
Republic of Korea	y	–4.03	Reject	Stationary
	W	–4.63	Reject	Stationary
	i^{LN}	–3.95	Reject	Stationary
	e	–4.31	Reject	Stationary
Netherlands	y	–3.99	Reject	Stationary
	W	–3.82	Reject	Stationary
	i^{LN}	–4.22	Reject	Stationary
	e	–4.10	Reject	Stationary
Italy	y	–3.18	Reject	Stationary
	W	–5.19	Reject	Stationary
	i^{LN}	–4.39	Reject	Stationary
	e	–5.11	Reject	Stationary
Germany	y	–3.79	Reject	Stationary
	W	–6.31	Reject	Stationary
	i^{LN}	–5.19	Reject	Stationary
	e	–3.90	Reject	Stationary
Belarus	y	–4.25	Reject	Stationary
	W	–4.18	Reject	Stationary
	i^{LN}	–3.88	Reject	Stationary
	e	–4.05	Reject	Stationary
Turkey	y	–4.93	Reject	Stationary
	W	–3.84	Reject	Stationary
	i^{LN}	–3.97	Reject	Stationary
	e	–4.01	Reject	Stationary

continued on next page

Appendix 1 table *continued*

Country	Variables	ADF Statistic	H0	Result
Ukraine	y	–5.76	Reject	Stationary
	W	–4.93	Reject	Stationary
	i^{LN}	–3.99	Reject	Stationary
	e	–6.08	Reject	Stationary
Kazakhstan	y	–4.35	Reject	Stationary
	W	–4.15	Reject	Stationary
	i^{LN}	–4.28	Reject	Stationary
	e	–5.30	Reject	Stationary
Poland	y	–3.82	Reject	Stationary
	W	–4.11	Reject	Stationary
	i^{LN}	–4.18	Reject	Stationary
	e	–5.32	Reject	Stationary
US	y	–3.86	Reject	Stationary
	W	–6.15	Reject	Stationary
	i^{LN}	–5.92	Reject	Stationary
	e	–4.54	Reject	Stationary
UAE	y	–5.10	Reject	Stationary
	W	–4.92	Reject	Stationary
	i^{LN}	–3.86	Reject	Stationary
	e	–4.16	Reject	Stationary
India	y	–5.32	Reject	Stationary
	W	–4.92	Reject	Stationary
	i^{LN}	–4.36	Reject	Stationary
	e	–3.92	Reject	Stationary
Indonesia	y	–5.09	Reject	Stationary
	W	–4.26	Reject	Stationary
	i^{LN}	–4.11	Reject	Stationary
	e	–5.26	Reject	Stationary
Hong Kong, China	y	–7.25	Reject	Stationary
	W	–6.89	Reject	Stationary
	i^{LN}	–6.01	Reject	Stationary
	e	–5.94	Reject	Stationary
Singapore	y	–4.66	Reject	Stationary
	W	–3.90	Reject	Stationary
	i^{LN}	–5.93	Reject	Stationary
	e	–5.43	Reject	Stationary
Taipei,China	y	–4.69	Reject	Stationary
	W	–4.36	Reject	Stationary
	i^{LN}	–4.77	Reject	Stationary
	e	–3.89	Reject	Stationary
Viet Nam	y	–6.52	Reject	Stationary
	W	–3.95	Reject	Stationary
	i^{LN}	–4.81	Reject	Stationary
	e	–4.59	Reject	Stationary

Source: Authors' compilation from Eviews 9.0.

APPENDIX 2: HETEROSCEDASTICITY TEST RESULTS

No.	SEM Equations	Glejser's Heteroscedasticity Test	Harvey's Heteroscedasticity Test
1	Russian Federation	Prob. 0.27	Prob. 0.19
2	Iran	Prob. 0.10	Prob. 0.16
3	Japan	Prob. 0.72	Prob. 0.79
4	PRC	Prob. 0.59	Prob. 0.50
5	Republic of Korea	Prob. 0.15	Prob. 0.13
6	Netherlands	Prob. 0.21	Prob. 0.19
7	Italy	Prob. 0.37	Prob. 0.41
8	Germany	Prob. 0.26	Prob. 0.24
9	Belarus	Prob. 0.29	Prob. 0.28
10	Turkey	Prob. 0.31	Prob. 0.33
11	Ukraine	Prob. 0.12	Prob. 0.09
12	Kazakhstan	Prob. 0.38	Prob. 0.33
13	Poland	Prob. 0.62	Prob. 0.60
14	US	Prob. 0.53	Prob. 0.56
15	UAE	Prob. 0.13	Prob. 0.16
16	India	Prob. 0.43	Prob. 0.43
17	Indonesia	Prob. 0.19	Prob. 0.22
18	Hong Kong, China	Prob. 0.08	Prob. 0.11
19	Singapore	Prob. 0.35	Prob. 0.31
20	Taipei,China	Prob. 0.44	Prob. 0.46
21	Viet Nam	Prob. 0.12	Prob. 0.18

Source: Authors' compilation from Eviews 9.0.