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Research paper

Time-varying effect of oil price shocks on the stock market returns: Evidence from oil-importing and oil-exporting countries



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ABSTRACT

This paper performs a two-stage methodology based on the Structural VAR and time-varying parameter regression models to examine the dynamic reaction of a set of oil-related countries' stock markets to oil price shocks. Oil prices are studied by disentangling demand and supply shocks. Based on monthly data from the 1999–2018 period, the results report evidence of a time-varying reaction of all stock market returns to different oil shocks. Moreover, the stock returns react to the demand shocks more than to the supply shocks. Besides, the effect of supply shocks on stock returns is generally limited and negative, while the aggregate demand shocks exert a positive effect on almost all stock returns. Oil-specific demand shocks have positive effects on the oil-exporting stock returns and negative effects in the case of oil-importing countries, except for the Chinese market. These findings have important policy implications for policymakers and investors.

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1. Introduction

In recent decades, oil price has become one of the most unstable variables due to different events that have occurred in this market. In fact, the complicated pattern of oil price evolution has been a matter of great concern to economists and researchers, specifically with respect to understanding its linkage with other economic variables (Hamilton, 1983, 1996; Mork et al., 1994; Lee et al., 1995; Barsky and Kilian, 2004; Ratti and Vespignani, 2016). In this context, the connection between oil and stock markets inhabits most of the literature on this issue (Kling, 1985; Chen et al., 1986; Jones and Kaul, 1996; Sadorsky, 1999; Broadstock and Filis, 2014; Kang et al., 2015a,b; Maghyreh et al., 2016; Zhang, 2017). Moreover, the low correlation between oil prices and stock markets makes it an attractive asset for portfolio diversification and hedging purposes. Thus, it is important to understand the form and strength of this relationship for investors to plan suitable investment strategies.

Following the Asset Pricing Theory, oil price is considered as a risk factor for equity markets (Ferson and Harvey, 1994; Ferson and Harvey, 1995; Sadorsky, 1999; Hong et al., 2002). In this

context, several studies, including those of Huang et al. (1996), Arouri et al. (2011), and Salisu and Isah (2017), highlight that oil prices affect stock markets through various channels. Therefore, in oil-importing countries that employ oil as the main production factor, an increase in oil prices negatively affects firms' incomes. Consequently, analysts predict low cash flows, which directly influence the stock value of the firms, result in stock market depreciation. However, in oil-exporting countries, an increase in oil price lead to high profit expectations and stock market appreciation.

While there is abundant literature on the oil-stock market nexus, there is no clear consensus on the existence and the form of this relationship, as it has emerged. Indeed, early influential studies, including those of Jones and Kaul (1996), Sadorsky (1999), Nandha and Faff (2008), Miller and Ratti (2009) indicated that oil prices influence stock markets negatively. However, other studies by Bashar (2006), Mohanty et al. (2011), and Wang et al. (2013), among others, emphasize that the relationship between oil and stock markets is positive for oil-exporting countries and negative for oil-importing countries. On the other hand, other studies report that the relationship between oil prices and stock markets is not significant (Henriques and Sadorsky, 2008; Apergis and Miller, 2009; Sukcharoen et al., 2014).

Given the complexity and non-affirmative results concerning the oil-stock market nexus, an important contribution by Kilian

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(2009) and Kilian and Park (2009) that has attracted the attention of researchers, investors, and policymakers concerns whether stock markets respond to different oil price shocks separately. In this context, Kilian (2009) highlighted that “*Not all oil shocks are alike*”. Since this finding, numerous studies have examined the relationship between oil prices and stock markets by differentiating structural oil price shocks. The advantage of this framework is that it identifies the underlying source of oil price shocks and its impact on stock market returns. This framework has significantly improved the relationship between oil price changes and stock markets, but the results of studies employing this approach remain inconclusive because once the shocks are identified based on the structural VAR, a suitable framework to investigate the response of the stock market to these shocks is required.

Motivated by the changing behavior of consumers and firms over time, which results in time-varying effects of oil shocks on the real economy and then on stock markets (Kang et al., 2015a,b), this study contributes to the literature on several fronts. Firstly, we contribute to the strand of literature dealing with oil price shocks and stock markets by moving the debate into a dynamic framework. In fact, our paper is the first to examine the time-varying impact of various oil price shocks (supply, aggregate demand, and oil-specific demand) on stock market returns via regressions model, which extends previous studies that use switching-regime regression models (Reboredo, 2010; Zhu et al., 2016; Basher et al., 2018). Secondly, we contribute to the literature by conducting a comparative analysis of oil-importing and oil-exporting countries in relation to the reaction of stock markets to oil shocks during a sample period containing some economic events. To this end, we use a two-stage framework, based firstly on the identification of different oil price shocks, following the procedure of Kilian and Park's (2009), and then on a time-varying parameter (TVP) regression model, to investigate the dynamic feature of the oil shocks–stock return relationship.

The paper is organized as follows. Section 2 presents a brief discussion of the related literature on the relationship between oil and stock markets. The econometric framework is discussed in Section 3. Section 4 provides a description of the data and a preliminary analysis. Section 5 provides the empirical results and related discussion. Section 6 concludes and presents some policy implications of the results.

2. Previous studies

The literature on the oil price–stock market nexus started with the pioneer works of Chen et al. (1986) and Jones and Kaul (1996). In fact, these studies were the first to identify oil price as a risk factor for stock prices. After that, abundant literature examining the relationship between oil prices and stock markets have emerged. Huang et al. (1996) indicate the presence of a significant effect of future oil prices on American oil-related companies' stock returns. For the Canadian market, over the period between 1983 and 1999, Sadorsky (2001) shows that oil price shocks affect stock returns positively. The same results are found by El-Sharif et al. (2005) in the United Kingdom stock market using daily data over the period 1989–2001.

Additionally, Boyer and Filion (2009) use quarterly data for the Canadian market between 1995 and 2002 and find a positive and significant impact of oil price shocks on stock returns. In the Gulf Cooperation Council (GCC) countries, Mohanty et al. (2011) also show that stock markets react positively to oil price shocks. More recently, Hamdi et al. (2019) examine the extent of the volatility between oil prices and sectoral indices in the GCC countries. All sectors are found interdependent of oil price volatility. Additionally, Shahrestani and Rafei (2019) investigate the effect of oil price shocks on the Tehran stock exchange index

using the MS-VAR model. They conclude that the effects of oil price shocks are positive and negative in various regimes. Sakaki (2019) investigates the impact of oil shocks on ten S&P 500 sectoral indices. The results confirm the evidence of a positive impact of oil shocks on stock returns.

Other studies report a negative impact of oil prices on stock markets. Indeed, Nandha and Faff (2008) realize a sectoral analysis in the United Kingdom and report that the impact of oil prices on stock returns is negative for all sectors, except those of mining, oil, and gas. Other studies, including those of Ciner (2001, 2013), Papapetrou (2001), Sadorsky (1999), Driesprong et al. (2008), Chen (2009), Park and Ratti (2008), and Miller and Ratti (2009), also find a negative relationship between oil prices and stock markets. Recently, in Mexico, as a major oil-exporting country, Singhal et al. (2019) investigate the dynamic relationship between stock markets, other than gold prices, and exchange rates. The main results of this study report that oil prices negatively affect stock prices in this country. Rahman and Serletis (2019) use US high-frequency data and find that oil price shocks have negative and statistically significant effects on stock market returns.

However, some studies, including those of Lescaroux and Mignon (2008), Cong et al. (2008), Apergis and Miller (2009), Al-Fayoumi (2009), and Al Janabi et al. (2010), report low or insignificant effect of oil prices on stock market returns.

In the face of these conflicting results, numerous studies have distinguished the impacts of different oil shocks on stock returns. In this context, Kilian (2009) and Kilian and Park (2009) propose to distinguish between supply and demand shocks, as being different sources of variation in oil prices. Kilian and Park (2009) find that oil-demand shocks have a negative impact on stock prices, whereas oil price shocks driven by global economic expansion have a positive effect. Additionally, they find that oil-supply shocks have a less significant impact on stock prices. These two seminal studies led to accelerated literature investigating the linkage between oil prices and stock markets through differentiation between oil price variation sources. As an example, Apergis and Miller (2009) investigate the effects of structural oil market shocks on a sample of developed economies' stock markets during the period 1981–2007. They find that the different stock market returns do not respond in a significant way to oil market shocks.

Additionally, Basher et al. (2012) analyze the relationship between oil price structural shocks, exchange rates, and emerging stock markets over the period 1988–2008. The results suggest that oil prices respond negatively (positively) to supply (demand) shocks. In European countries, Degiannakis et al. (2014) investigate the effects of oil price shocks on stock market volatility. The findings suggest that supply-side shocks and oil-specific demand shocks do not affect volatility. However, oil price increases, driven by aggregate demand shocks, have a positive impact on stock market volatility.

Moreover, a considerable strand of the literature has also been focussed on oil-related countries' stock markets. For instance, Cunado and de Gracia (2014) examine the relationship between 12 European oil-importing countries and oil prices between 1973 and 2011. The authors find a negative response of European stock returns to oil prices, and they indicate that oil supply shocks usually drive stock market returns in these countries. Filis et al. (2011) investigate the time-varying correlation between stock market prices and oil prices in a sample of oil-importing and oil-exporting countries. Using a DCC-GARCH-GJR approach over the period 1988–2009, they find a positive relationship between stock returns and oil demand-type shocks. Wang et al. (2013) find that the reaction of the stock market to oil price shocks depends highly on the net position of the countries in the world oil market and the type of oil price shock. Le and Chang (2015)

investigate the effect of the different structural oil shocks on stock returns in a sample of oil-exporting and oil-importing countries. The results of this study show evidence of an insignificant effect of oil shocks on the stock returns of these countries. Based on a regime-switching model, Jammazi and Nguyen (2015) examine the relationship between oil price and stock returns in a sample of oil-dependent countries. They find that the stock markets in these countries react differently to oil price shocks. In fact, the sign of the effects of oil shocks on the stock market depends greatly on the degree of reliance on imported oil, the share of the cost of oil in the national income, and the degree of improvement in the energy efficiency of a given country.

Recently, more attention has been paid to analyze the influence of structural oil price shocks on the stock markets of oil-related countries, using more sophisticated econometrics approaches in order to understand better this complicated relationship between oil price shocks and stock market returns. Zhu et al. (2016) and Reboredo (2010) use a regime-switching model to investigate the asymmetric effects of oil price shocks on stock returns between 1986 and 2015. Bouoiyour et al. (2017) examine the dependence structure of stock returns and oil price shocks using a quantile regression model. In the same way, Tchatoka et al. (2018) use the quantile-on-quantile (QQ) regression model. They find that the oil–stock market relationship is not stable over time. The oil shock–stock return relationship in oil-related countries is also examined by Basher et al. (2018), based on a Markov-switching model. The results suggest that most of the selected stock markets react significantly to oil-demand shocks, while the oil supply shocks affect only the UK, Kuwait, and UAE markets. Furthermore, other approaches have been used, such as the impulse-response function (Wei and Guo, 2016; Wang et al., 2013; Fang and You, 2014; Kang and Ratti, 2015; Bastianin et al., 2016), the quantile regression model (Bouoiyour and Selmi, 2016), the time-varying VAR model (Kang et al., 2015b), the BEKK model (Broadstock and Filis, 2014), and NARDL models (Hu et al., 2018).

The recent literature has reported a time-varying pattern in the oil–stock market relationship. For example, Chang and Yu (2013) use an MS-ARJI-GJR-GARCH-X model to verify the difference in the oil–stock market linkage between a turbulent and a stable regime. More recently, Inchauspe et al. (2015) propose to estimate an asset pricing model, with time-varying coefficients, based on the Kalman Filter to examine the dynamics of excess returns for renewable energy companies. They find that oil prices had a more pronounced effect on stock markets after 2007. Kang et al. (2015b) use a time-varying parameter VAR model to examine the impact of structural oil price shocks on U.S. stock market returns. The results support the evidence of a time-varying relationship between these two markets.

3. Methodology

To examine the time-varying effect of different oil shocks on the stock markets in major oil-importing and oil-exporting countries, we implement a two-stage approach. The first stage applies a structural VAR model in order to separate and identify different structural shocks, following Kilian and Park (2009). In the second stage, we use a time-varying parameter (TVP) regression model to investigate the reaction of each stock market to different shocks during every period.

3.1. Identification of oil shocks

Kilian (2009) uses a Structural VAR (SVAR) model to identify supply shocks, aggregate demand shocks, as well as the oil-specific demand shocks among global oil price shocks. In this

context, the advantage of SVAR, compared to standard VAR, is that it is able to differentiate between endogenous models.

In this study, we use this type of model for a vector $y_t = (\Delta OP_t, \Delta REA_t, \Delta WTI_t)'$, where ΔOP_t denotes the percentage change in global crude oil production at time t , ΔREA_t denotes the percentage change in Kilian's global real economic activity index at time t , and WTI denotes the percentage change in the real price of oil represented by the WTI price at time t . Kilian (2009) name this vector as the “block”, which includes the fluctuation of oil prices according to oil supply, aggregate demand, and oil-specific demand shocks. The structural vector autoregression (SVAR) model of order p is specified as:

$$By_t = \alpha + \sum_{i=1}^p A_i y_{t-i} + e_t \quad (1)$$

where $\alpha = (\alpha_1, \alpha_2, \alpha_3)'$, A_i ; $i = 1, 2, \dots, p$ are a (3×3) contemporaneous matrix of coefficients to be estimated with those of the vector α . $e_t = (e_t^{OS}, e_t^{AD}, e_t^{OSD})'$ is a vector of structural disturbances, with different components that may be contemporaneously correlated, but each component is supposed to be serially uncorrelated. The vector e_t captures the different oil price shocks, in which $e_t^{OS, AD}$ and e_t^{OSD} reflect the oil supply shocks, aggregate demand shocks, and oil-specific demand shocks, respectively.

According to Kilian and Park (2009), the structural shocks could be identified through structural disturbance transformation by a triangular matrix B as follows:

$$e_t = B\varepsilon_t \quad (2)$$

where

$$B = \begin{pmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \text{ and } \varepsilon_t = \begin{pmatrix} \varepsilon_t^{OS} \\ \varepsilon_t^{ADS} \\ \varepsilon_t^{OSD} \end{pmatrix}$$

where ε_t denotes the vector of the reduced-form VAR residuals.

Following Kilian (2009), in such an SVAR specification, taking a lag number of $p = 24$ is sufficient to remove the serial correlation and allows for a potentially long delay in the shock effects of oil prices. Moreover, the use of long lags in oil price shocks, which persist for more (less) than a year, have a positive (negative) impact on stock returns (Ciner, 2013; Kang et al., 2015a,b).

In Eq. (2), the lower triangular matrix is the structural restriction of the SVAR model. Following Kilian (2009), this restriction has some of the following implications. First, the oil supply shocks identified by the component e_t^{OS} are innovations in the oil supply. Global oil production is not affected by either global real activity shocks or the real price of oil within a month. This is a result of the fact that the supply function of crude oil becomes inelastic within a month.¹ The second restriction (e_t^{ADS}) implies that “the aggregate demand shocks are innovations in global economic activity that cannot be explained by oil supply shocks”. Besides, within a month, the aggregate demand will not respond to variations in the real price of oil driven by demand shocks. The third restriction (e_t^{OSD}) postulates that “oil-specific shocks are innovations in oil prices that cannot be explained by oil supply shocks or aggregate demand shocks”.

¹ The inelastic pattern of the supply function is justified by the cost of oil production changing. Indeed, oil producers set their production based on the expected trend growth in demand and do not revise the production level in response to high-frequency variations in demand (Kilian, 2009).

3.2. The response of stock markets to oil shocks

To examine the oil price–stock market relationship, we refer to theoretical models, including the Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT). These models assume that the asset returns (r_t) are explained by a set of risk factors $F_t = (F_{1t}, F_{2t}, \dots, F_{kt})'$, following the linear equation:

$$r_t = \alpha + \gamma'F_t + \epsilon_t \quad (3)$$

where α denotes the unconditional expected return, and ϵ_t is a residual term, which resumes the other risk factors. The vector $\gamma = (\gamma_1, \gamma_2, \dots, \gamma_k)'$ measures the influence that each risk factor has on the asset returns. In seminal works in the literature, oil price is identified as a risk factor for the stock prices (Chen et al., 1986; Ferson and Harvey, 1994; Sadosky, 1999; Jones and Kaul, 1996). This is also the case for Salisu and Isah (2017). Therefore, we only isolate the effect of oil prices on stock returns to obtain a reduced version of the APT model, which is given by the following equation:

$$r_t = \beta_0 + \beta_1 Oil_t + \epsilon_t \quad (4)$$

where Oil_t denotes oil price global shock, which indicates the expected risk from a sudden change in oil price. Meanwhile, an oil price shock may be expected to have different effects, depending on the type of shock, i.e., the supply, the aggregate demand or the oil-specific demand shock (Kilian, 2009; Kilian and Park, 2009). In this context, recent previous studies, including those of Zhu et al. (2016) and Tchatoka et al. (2018), among others, have shown that driven oil price shocks on stock market returns do not have the same effect, and the effect of each shock should be investigated separately. Then, we exploit the partition of different oil price structural shocks, as presented in the previous paragraph, by providing Eq. (4) with more details, as follows:

$$r_t = \beta_0 + \beta_1 e_t^{OS} + \beta_2 e_t^{ADS} + \beta_3 e_t^{OSD} + \epsilon_t \quad (5)$$

where the coefficients β_i ; $i = 1, 2, 3$ indicates the reaction of the stock market returns to the oil supply, aggregate demand, and oil-specific demand shock, respectively.

Most empirical studies investigating the oil price–stock market relationship adopt the constant parameter approach. However, a shortcoming of these methods is that the static assumption implicitly attaches the same weight to each observation. On the other hand, stock market indices and oil prices are determined with dynamic factors, which could change from one period to another (Kang et al., 2015b; Inchauspe et al., 2015). Additionally, the relationship between stock markets and oil price, as a risk factor, may vary over time, since the different transmission channels of oil shocks to stock markets, especially the stock valuation, and uncertainty channels exhibit a dynamic feature. Additionally, the variations of investors' and analysts' attitudes in cash flow prediction could change in every time period, according to the information flow and oil price variation. To overcome this shortcoming of Eq. (5), we adopt a time-varying parameter (TVP) regression model to investigate the reaction of stock markets in oil-importing and oil-exporting countries during different periods. Formally, the model is described by the following equation:

$$r_t = \beta_{0,t} + \beta_{1,t} e_t^{OS} + \beta_{2,t} e_t^{ADS} + \beta_{3,t} e_t^{OSD} + u_t; u_t \sim N(0, \sigma_u^2) \quad (6)$$

$$\beta_{i,t} = \beta_{i,t-1} + v_{i,t}; v_{i,t} \sim N(0, \sigma_{v_{i,t}}^2); i = 0, 1, \dots, 3. \quad (7)$$

This model is then divided into two types of equations: The measurement (Eq. (6)) and state equations (Eq. (7)), which could easily be written in the so-called 'state-space' form to implement the Kalman filter algorithm in order to estimate the model. This model allows for different parameters β_i ; $i = 0, 1, 2, 3$ to vary

with time. The state equation (Eq. (7)) describes the different parameter dynamics by supposing that each parameter follows a random walk.

The state-space form of the model described by Eqs. (6) and (7) considers the time-varying parameters $\beta_{i,t}$; $i = 0, 1, 2, 3$ as unobserved variables. Then, it allows these variables to be estimated based on the observable variables r_t and the explanatory variables of the vector e_t (Durbin and Koopman, 2001). The TVP model may be specified in the state space form as follows:

$$Y_t = X_t \beta_t + u_t \quad (8)$$

$$\beta_t = \emptyset \beta_{t-1} + v_t \quad (9)$$

where Y_t is the dependent variable, which is the stock market returns (r_t) in this study. X_t is a matrix of the independent variables (in this study, this matrix consists of different parameters of the model). u_t denotes the error term, which is normally distributed with a zero mean and constant variance. $\beta_t = (\beta_{0,t} \ \beta_{1,t} \ \beta_{2,t} \ \beta_{3,t})'$ is the so-called 'state vector,' which consists of the set of unobserved variables $\beta_{i,t}$. $v_t = (v_{0,t} \ v_{1,t} \ v_{2,t} \ v_{3,t})'$ denotes a 4×1 vector of serially uncorrelated residual terms, which are normally distributed with a zero mean and constant covariance P_t .² Finally, \emptyset is a matrix of coefficients, which determine the relationship between the current and the past value of the state vector β_t .³

The transition equation (Eq. (9)) is supposed to follow a random walk process, in which the state variable is supposed to be serially uncorrelated because the changes of the parameter $\beta_{i,t}$ are independent of each other, allowing breaking at different points in time. This point is important because changes in the parameters might have different reasons, given that the reaction of stock markets to oil shocks could not be stable and exhibit a dynamic character.

The implementation of the Kalman filter algorithm leads to the estimation of the state vector β_t . Then, the optimal estimation of the parameters vector, noted by b_t , and its covariance matrix, noted by P_t , are obtained by the following recursive formulas:

$$b_{t/t-1} = \emptyset b_{t-1} \quad (10)$$

$$P_{t/t-1} = \emptyset P_{t-1} \emptyset' \quad (11)$$

Given Eqs. (10) and (11), the dependent variable Y_t can then be estimated, based on the information at $t - 1$, by the following equation:

$$\hat{Y}_{t/t-1} = X_t b_{t-1} \quad (12)$$

Then, the prediction error of the dependent variable Y_t is obtained by the difference between the observed and the estimated values as follows:

$$Y_t - \hat{Y}_{t/t-1} = \emptyset(\beta_t - b_{t/t-1}) + u_t \quad (13)$$

Other than the prediction error of the dependent variable, we can also obtain the mean squared error of Y_t by the following equation:

$$F_t = \emptyset P_{t/t-1} \emptyset' + H_t \quad (14)$$

where H_t is the covariance matrix of u_t . The estimator of the state vector and its covariance matrix can be updated when a new

² There are some assumptions related to the state space form defined by Eqs. (8) and (9). First, the residual term u_t is not correlated with any variable of the vector v_t . Second, the initial state vector β_0 has b_0 and Q_0 as the mean and the covariance matrix, respectively. Third, the different matrices X_t and \emptyset are supposed to be non stochastic.

³ A special case that is frequently used in the dynamics of TVP models involves taking $\emptyset = I$, supposing that each component of the vector β_t follows a random walk, with a zero mean and constant variance.



Fig. 1. Monthly global oil production, global economic activity index, and real oil price (WTI) for the period 1999:03 to 2018:06.

Table 1

Crude oil imports, exports, and net position of the countries of the sample.

Source: Tchatoka et al. (2018).

	Crude oil imports (1000 barrels/day)	Crude oil exports (1000 barrels/day)	Net position (1000 barrels/day)
<i>Oil-exporting countries</i>			
Russia	36	4891	4855
Norway	20	1800	1780
Venezuela	132	1594	1462
Mexico	10	1303	1293
<i>Oil-importing countries</i>			
China	4082	104	−3978
Japan	3725	0	−3725
India	3185	0	−3185
South Korea	2348	6	−2342

observation becomes available, according to the updating process, which is expressed as follows:

$$b_t = b_{t/t-1} + P_{t/t-1} X_t' F_t^{-1} (Y_t - \emptyset b_{t/t-1}) \quad (15)$$

$$P_t = P_{t/t-1} - P_{t/t-1} \emptyset' F_t^{-1} \emptyset P_{t/t-1} \quad (16)$$

This procedure defines the Kalman filter. This algorithm firstly needs initial values b_0 and P_0 for the state vector and its covariance matrix in order to be implemented based on Eqs. (15) and (16). The estimation of the initial values is generally based on the maximum likelihood methods, which are applied with a particular focus on the field observation of Y_t and the matrix X_t .

The advantages of the time-varying regression models are numerous. First, the effect of the different oil price shocks is not under a constant assumption, but it is supposed to be time-varying, according to the behavior of dynamic consumers and firms. Second, this model overcomes the assumption of the constant parameter models, which attach the same weight to each observation. Besides, the TVP model allows for a more comprehensive picture of the effect of oil price shocks on stock returns by estimating this effect in each studied period. Then, there is no reason to presume that the reaction of stock market returns, estimated with constant parameter models, reflects an accurate analysis. Third, this type of model can easily clarify the consensus on the existence and the form of relationship between stock markets and oil prices in oil-related countries, for which there are no conclusive results in the literature. Fourth, the dynamic pattern of the oil–stock return nexus is vital for investors and policymakers, who must make suitable decisions according to changes in this relationship. Thus, given the importance of the oil–stock return relationship, the TVP regression model offers a more suitable basis for both investors and policymakers to make decisions from a time-varying perspective.

4. The data and preliminary analysis

4.1. The data

In this study, we use two sets of monthly data, spanning from 1999:3 to 2018:7. The first set is used to identify different

structural oil shocks. It includes global crude oil production, as a proxy for oil supply in millions of monthly average barrels per day, the global real economic activity index, as suggested by Kilian (2009), and oil prices, which are represented by the WTI spot price. The world oil supply and the crude oil prices are collected from the Energy Information Administration, while the index of global real economic activity is sourced from the website of Lutz Kilian.⁴

The second set of data includes the stock market indices of the major oil-exporting and oil-exporting countries, based on the net trade balance in crude oil (Table 1). We use monthly stock indices of four selected oil-importing countries (SSE of China, NIKKEI225 of Japan, BSE of India, and KSE of South Korea) and four indices relevant to the oil-exporting countries (RTSI of Russia, OBX of Norway, AAPL of Venezuela, and IPC of Mexico). The real oil price is obtained by deflating the nominal price by U.S. CPI. Similarly, the real stock market index is deflated by the CPI of its respective country.⁵

4.2. Descriptive statistics

Table 2 contains the descriptive statistics of the data. The results show that the mean values are negative for the variation of global oil production and the global economic activity index, while the WTI oil price variations have a positive mean of 0.6544. Regarding standard deviation values, indicating the degree of variability of the variables, we observe that the global economic activity index is the most volatile, followed by the real oil price.

For the stock market returns, we find that the mean returns are positive for all considered markets, showing that in all considered stock markets, the investment activity is beneficial and attractive. For the standard deviation, which informs about the market risk, the highest level is observed for the AAPL index of Venezuela for the oil-exporting countries and the Chinese market for the oil-importing countries. The Jarque–Berra p-values reject the null hypothesis of a normal distribution for all variables, except the oil price returns series, suggesting that the other variables are fat-tail distributed. These results are also confirmed by non-zero Skewness and positive excess kurtosis.

Regarding the unit root test results, the different series are subjected to three unit root tests to determine whether the unit root exists in the first difference of the series: the Dickey and Fuller (1981) (ADF), Phillips and Perron (1988) (PP) and Kwiatkowski et al. (1992) (KPSS) tests. The null hypothesis of the ADF and PP tests is that the time series contains a unit root, while that of the KPSS test is the stationarity. The statistics of the three tests consistently indicate that the hypothesis of the presence of the unit root is rejected at 1% for all of the series.

⁴ The data of this variable can be freely downloaded from Lutz Kilian's website by following this link: <http://www-personal.umich.edu/lkilian/paperlinks.html>.

⁵ We select these countries based on their net trade balance in crude oil, following Aloui et al. (2012), Wang et al. (2013), and, more recently, Tchatoka et al. (2018).

Table 2
Descriptive statistics and preliminary tests of the data.

	Mean	Std.dev	Skewness	Kurtosis	JB p-value	ADF	PP	KPSS
<i>Oil market</i>								
Δprod	−0.1112	1.3685	−0.3344	3.9401	0.0016***	−17.8056***	−18.1604***	0.7980
Rea	−0.0250	15.9039	−0.5015	5.7517	0.0000***	−14.9933***	−14.9817***	0.3257
Roil	0.6544	8.6651	−0.3033	3.4387	0.0666*	−12.4031***	−12.4615***	0.0945
<i>Oil-exporting stock markets</i>								
Russia	0.6788	8.8105	−0.3244	4.7617	0.0000***	−9.3673***	−18.9823***	0.0176
Norway	0.5375	6.0151	−1.3677	7.5310	0.0000***	−13.0469***	−13.1134***	0.0821
Venezuela	0.3339	13.1294	−1.4522	10.8272	0.0000***	−14.2443***	−14.3640***	0.5141
Mexico	0.6675	5.4454	−0.3960	3.9427	0.0000***	−16.6366***	−16.6142***	0.1052
<i>Oil-importing stock markets</i>								
China	0.1980	7.9118	−0.2893	4.9831	0.0000***	−14.3575***	−14.7332***	0.0493
Japan	0.1530	5.5476	−0.8075	4.8922	0.0000***	−14.1028***	−14.1679***	0.2485
India	0.3569	6.6008	−0.4787	4.7619	0.0000***	−15.0969	−15.1556***	0.0614
South Korea	0.3621	6.5775	−0.1921	4.5752	0.0000***	−13.5570***	−13.4941***	0.0488

Note: This table reports the descriptive statistics and preliminary tests for the used data. ADF, PP, and KPSS denote the statistics of Augmented Dickey and Fuller (1981), Phillips and Perron (1988), and Kwiatkowski et al. (1992) unit root test, respectively. Critical values of the different unit root tests at 5% level are −2.8751 for the ADF and PP tests and 0.463 for the KPSS test. *, ** and *** indicate that the null hypothesis is rejected at 10%, 5%, and 1% significance levels, respectively.

Table 3
Descriptive statistics and preliminary tests of oil market structural shocks.

	Mean	Std. Dev.	Skewness	Kurtosis	J-B	ADF	P-P	KPSS
Supply shock	0.0000	0.8305	−0.1700	4.7929	0.0000	−15.0010	−15.0010	0.1104
Aggregate demand shock	0.0000	0.8305	−0.5253	5.5624	0.0000	−14.9103	−14.9103	0.2796
Oil-specific demand shock	0.0000	0.8305	−0.2294	3.5101	0.1018	−14.6070	−14.6070	0.5327

Note: This table reports the descriptive statistics and preliminary tests for the different structural shock provided by the SVR model. J-B is the *p*-value of the Jarque–Berra normality test. ADF, PP, and KPSS denote the statistics of Augmented Dickey and Fuller (1981), Phillips and Perron (1988), and Kwiatkowski et al. (1992) unit root test, respectively. *, ** and *** indicate that the null hypothesis is rejected at 10%, 5%, and 1% significance levels, respectively.

Fig. 1 plots the first part of the data on the global oil production, the global economic activity index, and the real oil price (WTI), while Fig. 2 plots the stock market returns during the study period. Fig. 1 displays an increasing trend for the global oil production, indicating that the demand for oil has increased in recent decades, which is explained mainly by the globalization of the economy in the early 1990s and the development of the transport sector. For the global economic activity index, we observe a random trend, and the index achieves its maximum values during the year 2008 and its minimum values during the beginning of the year 2016. Regarding the oil price graphical evolution, the early 2000s saw a significant increase in the oil price, which continues until halfway through 2008, the year of an important petroleum shock, where the WTI price achieved a value of about \$140 per barrel in June 2008. After that, the oil price goes back to what it was at the end of 2008 and early 2009, reaching a dip of \$40 per barrel, before bouncing back. This shock was mainly due to unbridled speculation. Another dip in the oil price is also noticed during the middle of the year 2016. This event, known as the oil price collapse, started in mid-2014 and finished with a price level of about \$30 per barrel. This crisis is mainly due to the decrease in oil demand by the largest oil-importing countries, such as China and India.

Regarding the graphical evolution of the stock returns, shown in Fig. 2, we generally observe a similar pattern in the global financial crisis. This crisis is graphically characterized by high volatility for all considered stock markets. Therefore, the dotcom crisis of 2001–2002 is also observed in almost all stocks.

5. Empirical findings and discussion

In this section, we implement the two-stage approach, explained above, in order to investigate the time-varying effect of the different structural oil shocks on the stock market returns of a set of oil-related countries. In the first step, the different oil shocks will be identified from the first set of data. Then, we use this results in the second step as explanatory variables of different stock market returns.

5.1. Oil shock identification results

Following the methodology of Kilian (2009) and Kilian and Park (2009), the SVAR model is used to identify the different structural oil shocks, based on the residual series.⁶ Fig. 3 plots the time path of the identified oil market structural shocks. Fig. 3 shows that the real price of oil responds to a multitude of shocks. Graphically, the first abnormal variation during the study period is detected for the supply shock, which presents a remarkable negative value in December 2002, followed by a positive value at the end of the year 2003 and mid-2004. The conflict in the Middle East during 2002–2003, reinforced by the U.S intervention in Iraq in March 2003, could explain this supply crash. In this context, oil-supply shocks are generally caused by geopolitical instabilities in the oil-producing regions.

Moreover, the graphical representation points the petroleum shock of 2008–2009, which is outlined by the aggregate demand and the oil-specific demand shocks. There is no evidence that the petroleum shock of 2008 was a supply shock. Indeed, the evolution of the oil supply shock does not present any particularity during this period. This result is consistent with those of Kilian (2009), Kilian and Park (2009) and Zhu et al. (2016), among others. Additionally, an oil-specific demand disruption is also observed in the year 2016, indicating that the last oil collapse is attributed mainly to oil-specific demand shocks (a decrease in oil demand by most oil-importing countries).

Table 3 reports the descriptive statistics and preliminary tests for the identified structural shocks. The first indication of these statistics of normalized oil-market shocks is the observed zero mean and equal standard deviation. Furthermore, the Jarque–Bera test accepts the null hypothesis of the normality only for the oil-specific demand shock, indicating a fat-tailed distribution for both the supply shock and aggregate demand shock series. Besides, the negative Skewness indicates that the tail is on the left side of the distribution. For the unit root test, the results are similar to

⁶ Following Kilian (2009), the SVAR model is estimated with 24 lags.

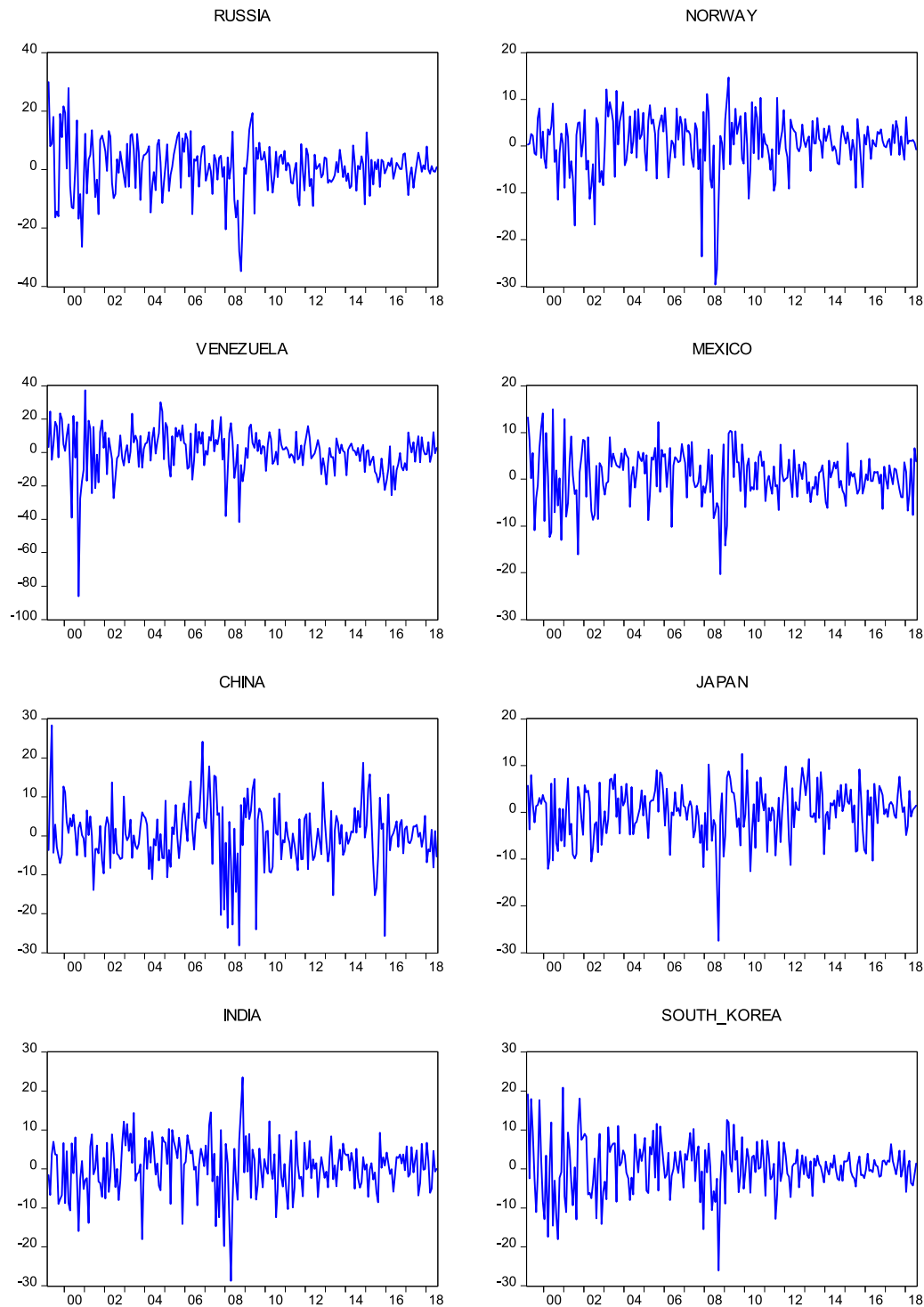


Fig. 2. Monthly stock market returns of oil-importing and oil-exporting countries for the period covering 1999:03 to 2018:07.

those shown in Table 2, in which the hypothesis of the presence of the unit root tests is rejected for all structural shocks series at conventional significance levels.

In order to illustrate the impact of the different structural shocks on the global oil price, we use the impulse response function. Fig. 4 plots the impulse response of the global oil price to structural oil shocks. The results show that there is a non-significant impact of oil supply shocks on oil price changes. This result could be explained by the stagnation of global oil production after the price peak of 2005, notably when Saudi Arabia reduced its oil production (Hamilton, 1996; Zhu et al., 2016). For

the aggregate demand and oil-specific demand shocks, we find similar results in Zhu et al. (2016). Indeed, our results highlight a positive and significant response of the global oil price to the aggregate demand and oil-specific demand shocks only when the shock arrives. After that, this reaction becomes rapidly insignificant with time. These results support the dominance of demand shocks, rather than supply shocks, in oil price fluctuations, which is in line with some previous studies, including those of Kilian (2009), Kilian and Park (2009), Hamilton (2009) and Basher et al. (2012), among others.

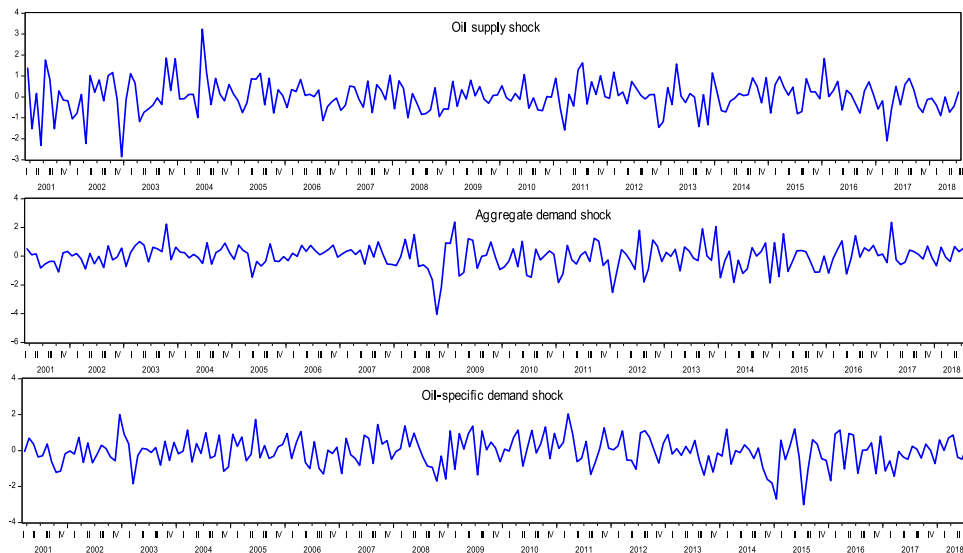


Fig. 3. Oil supply sock, aggregate demand shocks, and oil-specific shocks.

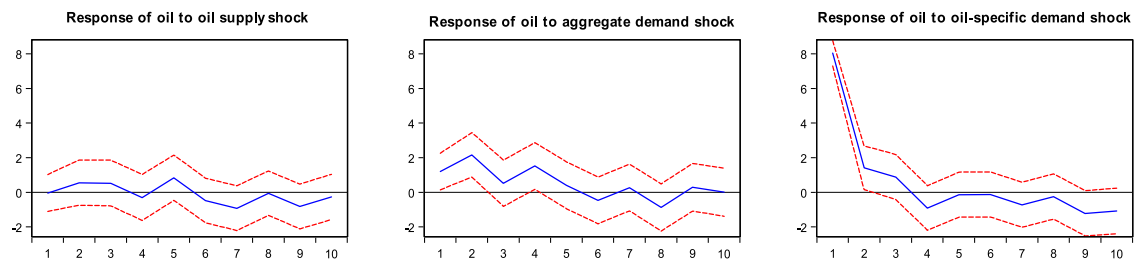


Fig. 4. The impulse response of global oil price to structural oil shocks.

Table 4
Parameters estimation of the constant models.

Variable	Oil-exporting countries				Oil-importing countries			
	Russia	Norway	Venezuela	Mexico	China	Japan	India	S.Korea
<i>Panel A: Global oil price effect</i>								
β_0	0.3648	0.5475	0.1981	0.6066*	−0.1299	0.2279	0.6454	0.5190
(s.e)	(0.5055)	(0.4273)	(0.7433)	(0.3341)	(0.5442)	(0.3824)	(0.4562)	(0.3968)
β_1	0.2490***	0.0012	0.2472***	0.0960***	0.1112*	0.0528	−0.0367	−0.0157
(s.e)	(0.0601)	(0.0508)	(0.0883)	(0.0397)	(0.0647)	(0.0454)	(0.0542)	(0.0472)
<i>Panel B: Effects of different structural shocks</i>								
β_0	0.6001	0.5404	0.4477	0.7052**	−0.0289	0.2819	0.6295	0.5087
(s.e)	(0.5079)	(0.4224)	(0.7424)	(0.3333)	(0.5425)	(0.3835)	(0.4573)	(0.3967)
β_1	0.0642	0.8244	0.2846	0.0182	0.8117	−0.4805	−0.4493	−0.0324
(s.e)	(0.6484)	(0.5393)	(0.9478)	(0.4255)	(0.6926)	(0.4896)	(0.5838)	(0.5065)
β_2	1.7571***	0.9918**	1.4399*	0.7824**	0.5507	0.3571	−0.3823	0.5721
(s.e)	(0.5875)	(0.4887)	(0.8588)	(0.3856)	(0.6275)	(0.4436)	(0.5290)	(0.4589)
β_3	1.7512***	0.0335	2.4219***	0.8533**	1.2766*	0.1532	−0.0032	−0.2217
(s.e)	(0.6237)	(0.5188)	(0.9118)	(0.4093)	(0.6662)	(0.4710)	(0.5616)	(0.4872)

Note: This table provides the parameter estimates of the models defined in Eq. (4) (in panel A) and Eq. (5) (in panel B). Numbers between parentheses are the standard error (s.e) of the estimated parameter. The superscripts (*), (**), and (***) indicate the significance of the parameter at 10%, 5%, and 1% level, respectively.

5.2. The reaction of stock returns to global oil price changes

As a preliminary exercise, we first explore how a stock market of an oil-exporting and oil-importing country reacts to oil price changes from a symmetric and asymmetric perspective. Table 4 contains the OLS estimation results of the regression models, defined by Eqs. (4) and (5). Commencing with the effect of global oil price changes (in panel A), the results suggest that all stock markets of oil-exporting countries react positively and significantly to global oil price changes, except the Norwegian market. However, for the oil-importing countries, the global oil price changes do not have a significant effect on the stock returns. These results

indicate that, globally, in the oil-exporting countries in which oil plays a crucial role in the economy, the stock market is more sensitive to oil price changes than in the oil-importing countries. This finding could be explained by the fact that oil exports affect the main economic variables in oil-exporter countries, such as earnings, revenues, and aggregate demand. Therefore, an increase (decrease) in oil price positively (negatively) affects the corporate output, which positively affects the stock market returns (Aroui and Rault, 2009).

This significant positive reaction is also observed in a time-varying framework. Figs. 5 and 6 plot the time-varying parameter, expressing the reaction of stock market returns in oil-exporting

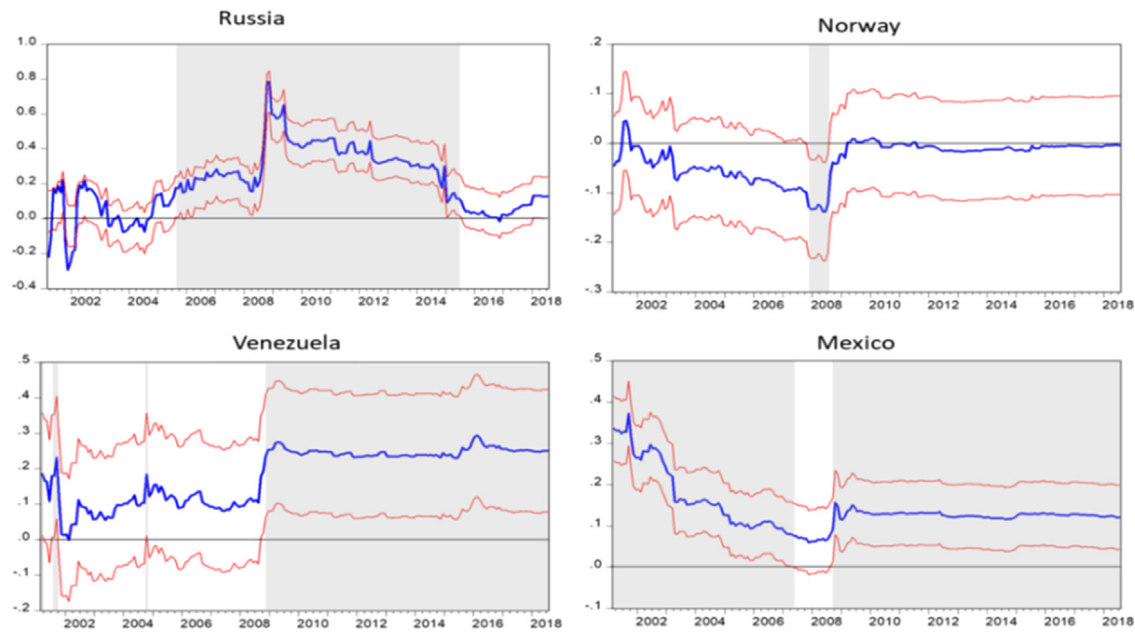


Fig. 5. Estimates of the time-varying coefficient of the effect of WTI returns on the oil-exporting countries' stock market returns. The figure plots the estimates of the time-varying coefficient $\beta_{1,t}$ from the model $r_t = \beta_0 + \beta_{1,t}Oil_t + \epsilon_t$. The red curves represent the lower and upper boundary of the 95% confidence intervals computed using the estimate of the standard error of β_1 reported in Table 4. The estimates for $t = 1, 2, \dots, 24$ are excluded due to convergence of the Kalman filter. The vertical shades (in light green) mark the periods when the parameter is significant at 5% level.

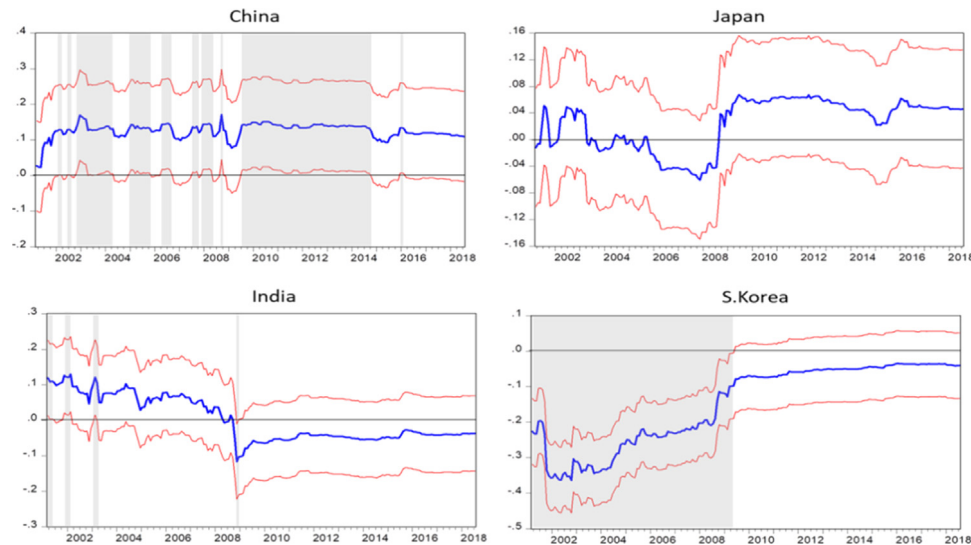


Fig. 6. Estimates of the time-varying coefficient of the effect of WTI returns on the oil-importing countries' stock market returns. The figure plots the estimates of the time-varying coefficient $\beta_{1,t}$ from the model $r_t = \beta_0 + \beta_{1,t}Oil_t + \epsilon_t$. The red curves represent the lower and upper boundary of the 95% confidence intervals computed using the estimate of the standard error of β_1 reported in Table 4. The estimates for $t = 1, 2, \dots, 24$ are excluded due to convergence of the Kalman filter. The vertical shades (in light green) mark the periods when the parameter is significant at 5% level.

and oil-importing countries, respectively. The estimation was realized using the maximum likelihood technique, based on the Kalman filter algorithm. From Fig. 5, we notice that the reaction of oil-exporting countries' stock returns to global oil price changes is positive and statistically significant during most of the study period, except the Norwegian market, in which a significant negative reaction is observed for a very limited period during the global financial crisis. Furthermore, we observe a remarkable peak in the reaction of these stock markets at the onset of the global financial crisis, indicating that the effect of the global oil price changes on stock returns in oil-exporting countries are more pronounced during the global financial crisis. These findings are consistent with the literature that highlights the increase of the

linkage and then the sensitivity of financial markets during crisis periods (Longin and Solnik, 2001; Boldanov et al., 2016).

Regarding the oil-importing countries, the results generally suggest no significant reaction of both Japanese and Indian markets during all of the study period. However, the Chinese markets react positively over most of the period. Indeed, we generally observe a stable level of the impact of global oil price changes on stock returns. This positive reaction, similar to an oil-exporter market, could be due to the large sensitivity of the Chinese economy to oil (as the biggest oil importer in the world). Besides, the negative response of the South Korean stock market is significant only in the period ending in mid-2009, the date of the end of the financial crisis. This negative reaction is caused by the continued

Table 5

Descriptive statistics on the time-varying effect of oil shocks on stock markets.

	Oil-exporting countries				Oil-importing countries			
	Russia	Norway	Venezuela	Mexico	China	Japan	India	S.Korea
<i>Panel A: Global oil effect</i>								
mean	0.2062	−0.0312	0.1841	0.1408	0.1256	0.0245	0.0021	−0.1481
median	0.2051	−0.0146	0.2348	0.1271	0.1300	0.0444	−0.0367	−0.0732
min	0.7840	0.0457	0.2933	0.3723	0.1712	0.0675	0.1301	−0.0342
max	−0.2949	−0.1382	−0.0013	0.0594	0.0230	−0.0608	−0.1167	−0.3637
std. dev	0.1864	0.0366	0.0770	0.0596	0.0210	0.0379	0.0624	0.1135
<i>Panel B: Supply oil effect</i>								
mean	−0.1114	1.0081	−0.1269	−0.9705	0.2020	−0.8437	−0.4384	−1.1877
median	0.1489	0.4553	0.1057	−0.7435	0.1925	−0.7563	−0.3831	−0.9985
min	1.8051	8.7070	0.7924	−0.5153	0.5852	−0.4881	−0.1644	−0.6048
max	−2.2348	−1.8318	−2.5173	−2.9159	−0.3132	−1.4726	−1.4342	−3.7733
std. dev	0.9807	2.1327	0.7625	0.5132	0.1762	0.2488	0.1991	0.5875
<i>Panel C: Aggregate demand shock</i>								
mean	2.0102	1.3433	1.3872	1.1098	0.5418	1.2589	0.0212	1.8933
median	1.8829	1.2163	1.2130	1.1156	0.6102	0.8170	−0.3225	1.3472
min	7.3339	3.0307	4.8018	2.8477	1.8395	6.7137	3.2909	7.5349
max	−0.5970	−1.3639	−4.3223	−0.2888	−2.6419	0.1668	−2.0001	0.5767
std. dev	1.5942	0.7140	1.1738	0.4037	0.6265	1.3106	1.0192	1.4693
<i>Panel D: Oil-specific demand shock</i>								
mean	0.6885	−0.3488	0.3191	0.9720	1.7505	−0.3526	0.0993	−1.4073
median	1.3229	−0.3694	0.7740	0.8690	1.7557	−0.1864	−0.0007	−0.9589
min	1.9145	0.5378	1.9863	2.7089	2.4858	0.2016	0.8525	−0.2752
max	−2.1451	−1.1190	−3.0026	0.3653	0.8103	−1.1400	−0.5584	−3.6164
std. dev	1.2220	0.2801	1.2987	0.4093	0.3409	0.3699	0.3198	1.0273

Note: This table provides descriptive statistics on the time-varying parameter expressing the effect of the structural shock on the stock market returns, including the average (mean) values, the median, the minimum, the maximum, and the standard deviation (std.dev).

increase in oil prices until the end of the global financial crisis. During this period, in the South Korean stock market, investors and analysts predicted low cash flows, based on the continued oil price decrease. This prediction resulted in reduced stock prices and generated negative returns and great volatility during this period (Fig. 2). Furthermore, this finding is related to the fact that South Korea was the country most hit by the financial crisis. Oil price volatility can have a pronounced effect on the time horizon of investment (Masih et al., 2011).

5.3. The reaction of stock markets to structural oil price shocks

The second part of Table 4 (panel B) provides more information about the reaction of the different stock markets to oil price changes. In this case, we investigate the effect of different structural oil shocks on stock returns separately. The results emphasize, firstly, that despite the significant impact of the global oil price on the oil-exporting countries' stock returns, the effect of an oil supply shock is not significant for all stock markets in all oil-exporting and oil-importing countries. However, the aggregate demand and oil-specific demand shocks have a significant positive effect only on the stock returns of oil-exporting countries. This result confirms that stock markets in oil-exporting countries react positively only to the aggregate demand and oil-specific demand shocks. The non-significant effect of the oil supply indicates, again, that oil price changes are mainly due to demand shocks, rather than supply shocks (Kilian, 2009; Kilian and Park, 2009; Hamilton, 2009; Basher et al., 2012; Zhu et al., 2016). Then, the reaction of stock market returns is significant only in relation to demand shocks. This result implies that a positive demand shock leads to an increase in oil prices and to a positive and significant reaction of stock market returns. Besides, the insignificant reaction of oil-importing countries' stock returns may be due to the required assumption of a constant relationship between stock returns and structural oil shocks.

To better investigate the effect of oil price changes on the stock markets in oil-related countries, we estimate a time-varying

parameter regression model, expressed by Eqs. (6) and (7). Compared to the constant parameter models, this model provides more detailed information about the temporal reaction of stock market returns to different structural shocks separately at every time t over the study period. The estimation results of the different time-varying parameters are provided by Figs. 7 and 8 for the oil-exporting and oil-importing countries, respectively. Table 5 contains descriptive statistics on the estimated parameters.

An overview of this table and these two figures allow for the detection of a dynamic feature of each parameter $\beta_{i,t}$; $i = 1, 2, 3$ of the time-varying regression model. Indeed, the descriptive statistics, including the minimum, the maximum, and, especially, the significant standard errors of the different time-varying parameters, indicate precisely that these parameters cannot be assumed to be constant. Additionally, the graphical evolution of these parameters shows that its values switch significantly from one period to another.

Commencing with the oil-exporting countries, the first remark that can be deduced from Fig. 7 is that, globally, stock market returns react to demand shocks more than to supply shocks. Indeed, the parameters indicating the effect of aggregate and oil-specific demand shocks are significant for more extended periods than that of supply shocks. This indicates that the demand channel may be a potential factor in the transmission of oil shocks to oil-exporting countries' stock markets. This result could be explained by the fact that the oil prices are determined by the demand variation more than the supply one (Kilian, 2009).

Moreover, the estimation results show a negative reaction of the Russian and the Mexican markets to a supply shock, which is generally observed in the first part of the study period. The Middle East conflict and the second Gulf war, which started in March 2003, could explain this finding. Indeed, during this period, the oil supply decreases significantly, leading to the beginning of a long period of prices rising, which causes a continued degradation of some oil-exporting countries' stock indices. Additionally, the supply shock is also the consequence of the stagnation of oil production since 2005, when Saudi Arabia, which is among the biggest oil producers, reduced its oil production (Hamilton,

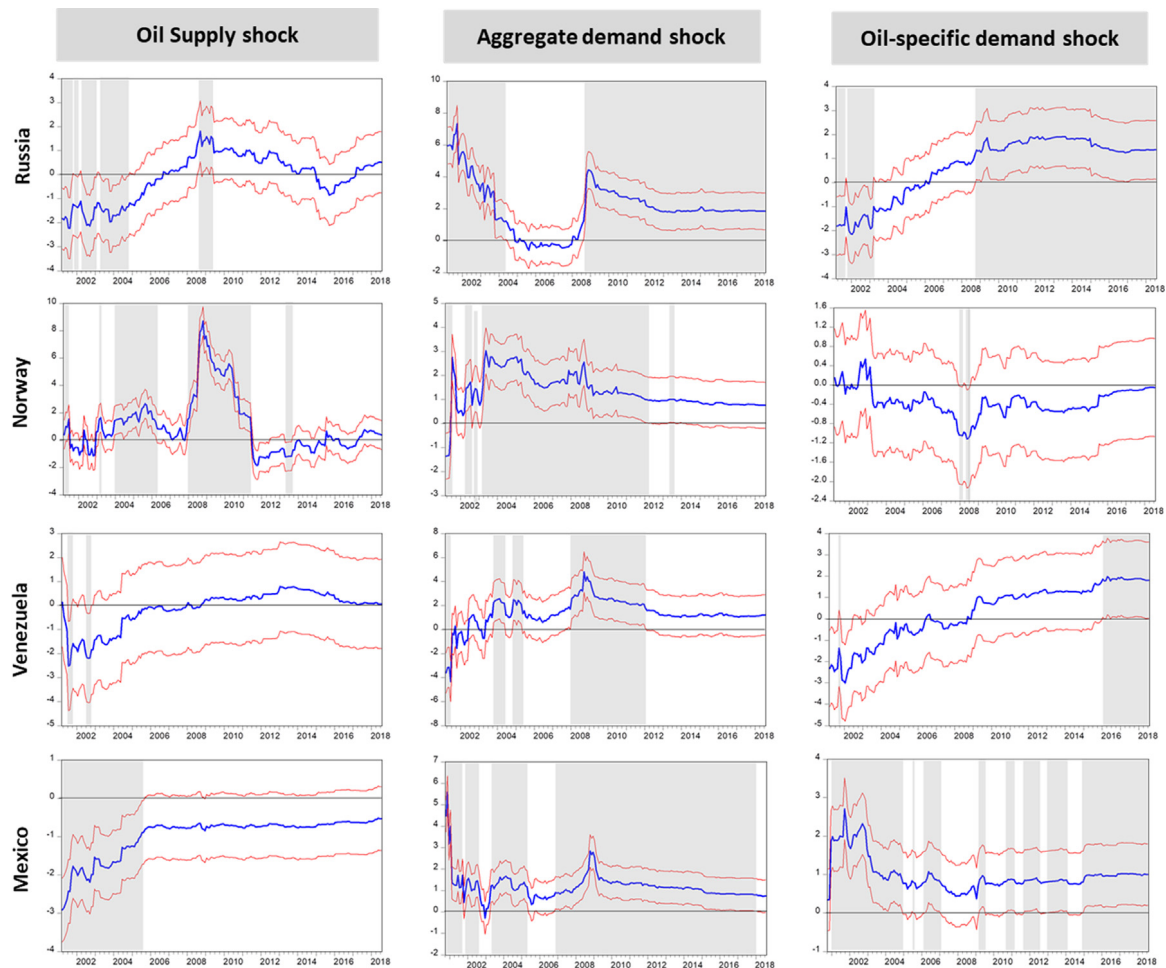


Fig. 7. Estimates of the time-varying coefficients of the effect of different structural oil shocks on the oil-exporting countries' stock market returns. The figure plots the estimates of the time-varying coefficient $\beta_{1,t}$, $\beta_{2,t}$ and $\beta_{3,t}$ from the model defined in Eqs. (6) and (7). The red curves represent the lower and upper boundary of the 95% confidence interval computed using the estimate of the standard errors of β_1 , β_2 and β_3 reported in Table 4. The estimates for $t = 1, 2, \dots, 24$ are excluded due to convergence of the Kalman filter. The vertical shades (in light grey) mark the periods when the parameter is significant at 5% level.

1996). In contrast, similar to the findings of Park and Ratti (2008), the Norwegian market presents a positive reaction to the supply shock. This response peaked during the global financial crisis, which implies a negative oil supply shock, and despite its effect in decreasing the oil price, the OBX index rose significantly. The intervention of policymakers in this country during crisis periods could be the source of this reaction. In fact, Norway has the largest sovereign funds in the world, amounting to US\$860 billion, and the money saved in the funds is invested in bonds and shares.

Turning to the aggregate demand shocks' effect on the oil-exporter countries' stock markets, it appears to be the most important shock affecting the stock market returns in these countries. Indeed, the associated time-varying parameter is positive and significant for all markets during almost all of the study period. Explaining this result, an increase in the aggregate demand (positive shock) is an indicator of an economic recovery, driven by increased national revenues. This could be the main factor leading to an increase in firm benefits and financial performance. Hence, the stock market index rises as a result of firms expecting great cash flows. Furthermore, it appears from Fig. 7 and Table 5 that the Russian and the Mexican markets react more intensively to the aggregate demand shocks than the others. Indeed, the mean values of the estimated time-varying parameter are around 2.0102 and 1.1098 for the Russian and the Mexican markets, respectively. Additionally, we generally observe a peak in the

level of the estimated parameters during the 2008 period for all oil-exporting countries' stock markets, indicating that the global financial crisis intensified the reaction of stock returns to the aggregate demand shocks. Then, during stress periods, the stock market's volatility increases, leading to a situation of augmented market sensitivity to oil shocks. Further, during these augmented volatility periods, speculation deepens, leading to a stock market boom.

Regarding the oil-specific demand shocks and their effect on the oil-exporting countries' stock markets, we also observe the dominance of the Russian and the Mexican markets in response to this type of shock. Indeed, a negative reaction during the first part of the period (period of supply shock) is outlined, followed by a positive reaction after the global financial crisis. Focusing on the second part of the study period, a positive reaction to oil demand implies that when oil demand increases, it is beneficial for oil-exporting countries in the sense that oil price rises. Then, the national revenue increases, allowing for an increase in firms' performance and predicted cash flows, resulting in increased returns.

Overall, by comparing the effect of the different oil price shocks on the oil-exporting countries' stock returns, the results suggest evidence of a significant asymmetric response of these stock market returns to oil supply and demand shocks. This result can also be drawn from Table 5, in which the mean of the time-varying parameter series varies between negative and positive

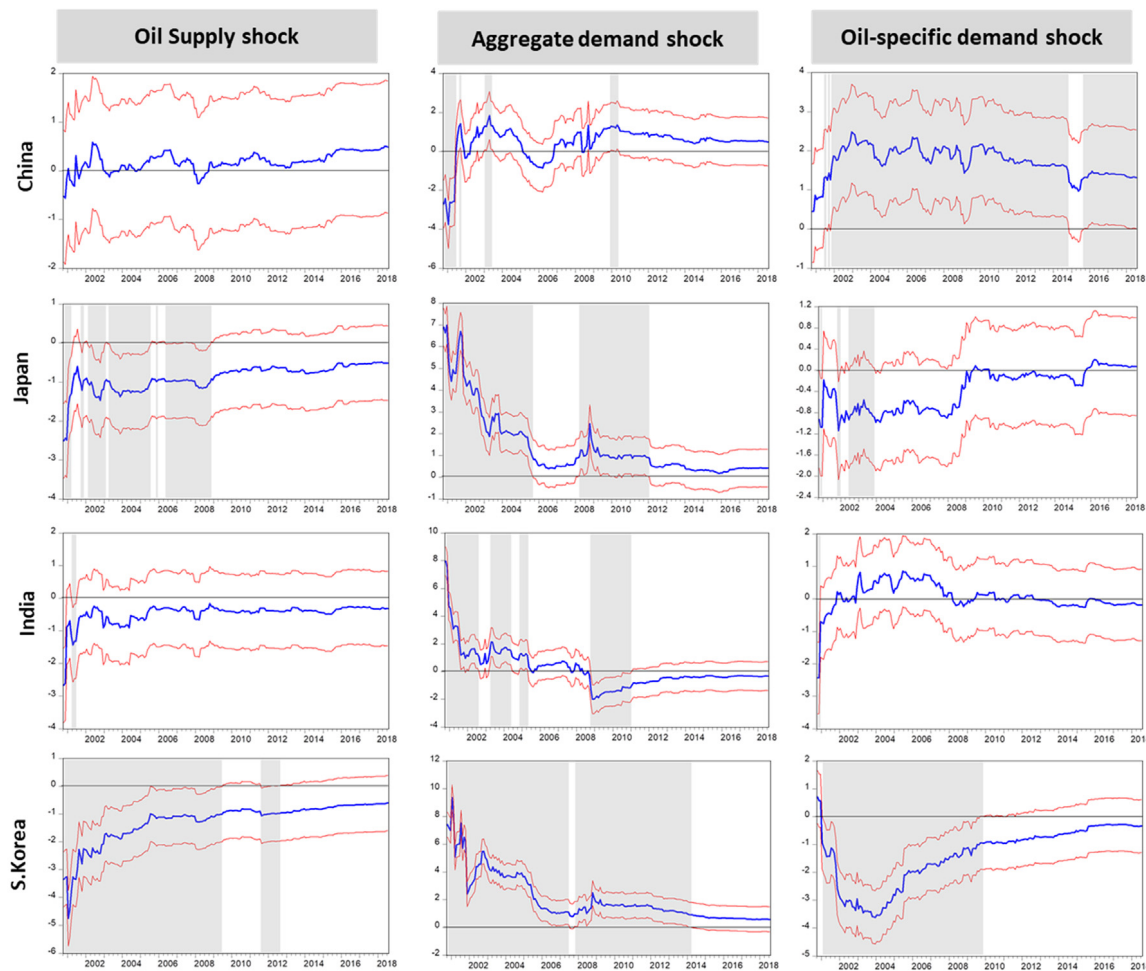


Fig. 8. Estimates of the time-varying coefficients of the effect of different structural oil shocks on the oil-importing countries' stock market returns. The figure plots the estimates of the time-varying coefficient $\beta_{1,t}$, $\beta_{2,t}$ and $\beta_{3,t}$ from the model defined in Eqs. (6) and (7). The red curves represent the lower and upper boundary of the 95% confidence interval computed using the estimate of the standard errors of β_1 , β_2 and β_3 reported in Table 4. The estimates for $t = 1, 2, \dots, 24$ are excluded due to convergence of the Kalman filter. The vertical shades (in light grey) mark the periods when the parameter is significant at 5% level.

numbers for most of the oil-exporter countries. Moreover, the dynamic feature of the reaction of stock returns differs according to the type of oil shock. These findings are similar to those of [Zhu et al. \(2016\)](#) and [Basher et al. \(2018\)](#) in the context of a switching-regime model, as well as with those of [Bouoiyour et al. \(2017\)](#), in the context of a quantile regression approach.

[Fig. 8](#) plots the time-varying effect of the different exogenous oil price shocks on the stock market returns of the oil-importing countries. Examining this figure globally, the first indication is that the oil-importing countries' stock markets react less intensively to the three oil shocks than those of oil-exporting countries. For example, the Chinese market does not react to supply shock, and the Indian market reacts neither to a supply shock nor a demand-shock. Then, we deduce from these results that, generally, stock markets in oil-exporting countries are more sensitive to oil shocks than those of oil-importing countries. These results, which are consistent with the literature ([Zhu et al., 2016](#); [Bouoiyour et al., 2017](#)), could be explained by the fact that during the study period, most oil shocks are related to demand (the shocks of 2008 and 2016). This can explain the dominance of the reaction of the stock returns in oil-exporting countries, in which an increasing oil demand results in higher oil prices, which induces stock market depreciation.

Focusing on the impact of supply shocks on the stock market returns in different oil-importing countries, we generally observe the same pattern, but both the Chinese and Indian markets do not

have any reaction to this type of shock. In fact, these countries, which are the biggest oil consumers in the world, are generally far from international conflicts (that have been produced by oil supply shocks). This factor allowed the behavior of the investors in financial markets to be unaffected by this type of shock. More precisely, even if oil prices rise as a result of international conflicts, this is not taken into consideration by the players in these markets. Furthermore, the Japanese and South Korean markets react significantly and negatively to oil shock during the first half of the study period. These countries, which are allies of some parties to the conflict in the Middle East, make their markets more sensitive to supply oil shocks than to demand shocks ([Fig. 8](#)).

For the aggregate demand shock, the estimation results indicate that the Korean stock market is the most sensitive to this type of shock, while the Chinese market is the least sensitive. Additionally, we observe a significant positive reaction of almost all stock returns during the global financial crisis, indicating that during turmoil periods, an increase in the aggregate demand leads to stock market appreciation.

Finally, it is interesting to note that the Chinese market appears to be the most significantly influenced by oil-specific demand shocks. Indeed, for this market, the impact of the oil-specific demand is statistically significant during most of the period, indicating that an increase of oil-specific demand by 1% leads to an increase of the stock index by around 2% during most of the study period. On the other hand, the results suggest that,

globally, the reaction of both the Japanese and Indian markets is very limited, while we observe a significant negative reaction of the South Korean market only during the first half of the period. These various types of responses can be related to the relative price elasticity of the demand and supply of the oil market faced by the countries (Marashdeh and Afandi, 2017).

6. Conclusion and policy implications

This paper analyzes the dynamic reaction of oil-related countries' stock markets to structural oil shocks. For this, we implement a two-stage methodology, in which we first identify the different oil shocks, such as the supply, aggregate demand, and oil-specific demand shocks, based on the SVAR procedure developed by Kilian (2009) and Kilian and Park (2009). Second, we use the time-varying parameter regression model, based on the Kalman filter, to investigate the dynamic feature of the effect of different oil shocks on the stock market returns.

The estimation results of the SVAR model, allowing for the identification of the different structural oil price shocks, shows the existence of three oil events; one is a supply shock, which is related the conflict in the Middle East and the Gulf war of 2003, while the second (petroleum shock of 2008) and the third (2014–2016) are consists of two demand shocks.

The findings of our investigation of the reaction of stock returns to different oil shocks are numerous. Firstly, the estimation of the time-varying regression model shows that the reaction of all stock markets to different oil shocks exhibit a dynamic feature. Indeed, the evolution of the parameter expressing the effect of the structural shocks on the stock return varies significantly from one period to another. Second, we find that the reaction of all the considered stock market returns is more intensive for a demand shock than for a supply shock. Then, a significant asymmetric response of stock returns to structural oil price shocks is detected. Indeed, in the case of oil-exporting countries, the estimation results of the time-varying regression model suggest a negative reaction to oil supply shocks during the period of the Middle East conflict and an insignificant reaction during the rest of the period. However, a positive reaction of these stock returns to oil demand shocks is globally observed during most of the period. Additionally, the results suggest a particular pattern during the global financial crisis, which is expressed by an increase in the impact of the different oil price shocks on stock returns.

For oil-importing countries, the effect of the supply shock is non-significant for the Chinese and the Indian markets throughout the study period. However, for the two other markets (Japan and South Korea), the reaction is negative and significant only during the first half of the study period. The results also suggest that the reaction of the stock market returns of the oil-importing countries to the aggregate demand shock switches between positive and negative for the Japanese and the South Korean markets, respectively. The response of the oil-importing countries' stock returns to oil-specific demand shocks presents various results. Thus, there is no reaction of the Japanese market to this type of shock. The Chinese market reacts positively during the study period. However, South Korea reacts negatively only before the global financial crisis. Finally, the Indian stock market does not react significantly to the oil-specific demand shock.

The results of this study have many implications for oil-related countries' policymakers. First, the financial control system in these countries needs to pay more attention to the time-varying feature in the reaction of stock returns, given that the effect of oil shocks is not constant but can change in every time period. In fact, in their decisions, authorities should make more effort to consider the changes in the reaction of the stock market returns to oil shocks. Furthermore, the intense reaction of stock returns to oil

demand shocks, compared to supply shocks, and the asymmetric reaction to different oil price shocks require authorities to treat the sources of oil price shocks differently. They should also be more cautious regarding demand shocks than supply shocks.

Moreover, it is necessary to diagnose the events occurring in the oil market successively in order to identify the type of shock and intervene in the stock market with suitable decisions. In this context, the intervention should be focused on the major determinants of stock market returns, including the interest rate, exchange rate, industrial production, and inflation (Al-hajj et al., 2018). For example, since the literature highlights a negative relationship between stock returns and oil prices, policymakers' decisions tend in the direction of interest rate reduction (rise) when an oil supply (demand) shock occurs. Additionally, during a financial crash, policymakers must take into account that stock market returns become more sensitive to different oil shocks in both oil-importing and oil-exporting countries. This requires intervention with appropriate policies to fight against the effects of oil shocks. Therefore, in order to reduce oil price fluctuations, governments in oil-importing countries can, for example, create an independent wealth fund to manage their venues during the oil price hikes (Al-hajj et al., 2018). Furthermore, some other strategies could also be adopted, like the implementation of alternative energy sources to reduce the dependency of their stock markets on oil shocks.

Besides, to understand the impact of oil price shocks on stock market returns and whether this impact differs depending on the type of shock, investors in oil and stock markets, particularly in oil-related countries, should be aware that the oil-stock relationship may change in different time horizons and under different market circumstances. For this, our results are very crucial for investors to make appropriate investment decisions. In fact, the time-varying effects of different oil price shocks on stock returns offer investors the possibility to appreciate the degree of the linkage between oil and stock returns. Thus, this finding suggests to investors interested in international investment that asset allocation and risk management strategies should be conducted dynamically. Furthermore, the negative impact of supply shocks implies that investors in oil-exporting and oil-importing countries' stock markets should anticipate an increase (decrease) of their portfolios' returns in the case of negative (positive) oil supply shocks. However, during the periods of positive oil demand shocks, investors are not willing to invest in these markets, given that the reaction to an oil-demand shock is generally positive in oil-exporting countries. On the other hand, our results are important for risk management purposes. Indeed, given that oil price shocks appear as a risk factor for oil returns, the proposed time-varying specification allows for a suitable framework to quantify and manage risk.

An interesting question that future studies could examine is whether oil price shocks have a dynamic effect on the stock market volatility. Finally, another avenue for further research would be the examination of the time-varying effect of different oil price shocks on stock markets under different market conditions. In this case, quantile regression from a dynamic perspective could be adopted.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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