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Oil Price Spillover Effects to the Stock Market Sentiment: The Case of Higher vs. Lower Oil Import EU Countries

Stefan Stojkov *, Emilija Beker Pucar, Olgica Glavaški and Marina Beljić

Department of Economic Theory and Policy, Faculty of Economics, University of Novi Sad, 24000 Subotica, Serbia; emilija.beker.pucar@ef.uns.ac.rs (E.B.P.); olgica.glavaski@ef.uns.ac.rs (O.G.); marina.beljic@ef.uns.ac.rs (M.B.)
* Correspondence: stefan.stojkov@ef.uns.ac.rs

Abstract: The process of deepening the economic integration of European economies reached its peak with the formation of a supranational entity for conducting monetary policy. However, the high degree of financial integration of the market also implied the vulnerability of the economic union in terms of prompt reaction to external shocks with divergent effects. Oil price fluctuations are of essential importance for macroeconomic performance, which is particularly reflected in countries more dependent on the import of this raw material. This research aims to apostrophize the asymmetric effects of oil price fluctuations on the stock market indices on a sample of higher (Germany, Italy, France) vs. lower (Croatia, Bulgaria, Ireland) oil importers. The empirical findings are determined based on impulse response functions derived from the VAR model as well as the Granger causality test of the relationship between stock market indices and oil price fluctuations. In order to identify the isolated impact of oil price movements on stock market indices of selected European economies, the VAR (Vector AutoRegression) model is evaluated in the time period 2013M1-2023M1. The results of the research indicate an asymmetric mechanism of the impact of oil shocks on the financial markets of EU member states.

Keywords: oil price shocks; spillover; EU; asymmetric effects

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1. Introduction

From a historical perspective, the world economy has faced different types of global economic crises with transmission effects on national economies. The strength of its influence depends on the character of the crisis itself, as well as the reaction of economic policy to structural breaks or external shocks. One of the crucial external shocks with pronounced transmission to national economies is the jump in oil prices (oil shock). A significant number of countries in the world import large quantities of oil, which, combined with an extremely high degree of financial integration, makes oil shocks a relevant exogenous variable for most countries participating in the global economy (Akinsola and Odhiambo 2020).

The rise in oil prices initiates numerous macroeconomic repercussions and imbalances for oil-importing countries (Wang et al. 2013). Initially, higher oil prices transmit a decrease in economic activities and an increase in inflationary pressures (destabilization of the internal balance). On the other hand, the rise in oil prices raises the value of imports and worsens current accounts as a part of the balance of payments (destabilization of the external balance). In addition to the transmission effects on key aspects of internal and external balance, the rise in oil prices in importing countries also causes financial destabilization, specifically the destabilization of financial markets (Allegret et al. 2018; Morana 2017).

One of the incremental macroeconomic indicators during the previous decades that played a key role in the formation of the movement of stock market indices around the world is the price of oil (Miller and Ratti 2009). Given that Europe leads the global import demand for oil (followed by China, then the USA), this research examines precisely the EU member states from the aspect of the impact of oil shocks on stock market destabilization.

As there is evident heterogeneity among EU member states in key economic parameters (Beker Pucar and Glavaški 2021), among other things from the aspect of dependence on oil imports, European economies are differentiated into a group of smaller (Ireland, Bulgaria, Croatia) and larger oil importers (Germany, Italy, France).

Despite the extensive literature on divergent effects that highlights the heterogeneous nature of the EU, there is still a significant gap in our understanding of financial market reactions to exogeneous shocks. Specifically, the effects of the oil price shock on stock market volatility must be explored. This research contributes to the existing literature in two significant ways: First, it asserts that a common exogeneous shock can have an asymmetrical effect on financial markets in the EU based on import quantities. Second, it emphasizes the relevance of prompt policymakers reactions that can absorb the effects of a shock and hence lower the distinction between higher and lower oil import EU countries stock markets.

The main idea of the research is to identify the asymmetric effects of oil shocks on the financial markets of selected European economies, while confirming the greater exposure and vulnerability of large oil importers. The price of oil represents an inverse signal in the movement of the financial markets of those countries whose economies are highly dependent on oil imports, in contrast to the direct influence in less dependent oil importers. The inverse impact of oil price movements on the financial markets of major oil importers is explained by the mechanism: jump in oil prices $\rightarrow$ increase in production costs $\rightarrow$ disincentive of economic activities and fall in stock market indices, and vice versa. In order to identify the isolated impact of oil price movements on stock market indices of selected European economies, the VAR (*Vector AutoRegression*) model is evaluated in the time period 2013M1–2023M1.

The paper is structured as follows: After the introductory considerations, the first part of the paper presents an overview of the literature; the second part of the paper includes a descriptive analysis of the key research variables, while the third part presents the methodological framework through the VAR model and the Granger causality test. In the fourth part of the paper, the key empirical findings are highlighted through the discussion of the research results, while checking the robustness of the evaluated model. Concluding considerations are made in the last part of the paper.

2. Literature Review

The complexity of the impact of oil price changes on financial markets and stock exchange is also reflected in the uncertainty regarding the conduct of economic policy. Frequent fluctuations in the price of oil can have asymmetric effects on financial markets and the output of the economy, the application of adequate countercyclical economic policy measures can be exponentially difficult (Rahman and Serletis 2010). Taking into account that different causes of oil shocks generate differentiated effects on the economy, the decisions of policymakers become significantly uncertain in terms of expected effects.

Particularly, the issue concerning the source of the oil shock is of great importance. The relationship "supply side vs. demand side" shock determines whether the global price of oil endogenously rises or exogenously falls (Jiang and Liu 2021). In the situation of "*supply side*" shock, when producers are limited by production, there is an increase in oil prices due to a smaller quantity (endogenous increase in oil prices). On the other hand, an example of the "*demand side*" of an oil shock is the COVID-19 pandemic crisis (exogenous drop in oil prices). The rapid decline in consumption resulted in a drastic drop in the price of oil from USD 61 per barrel to USD 12 per barrel (Husain et al. 2019; Prabheesh et al. 2020).

Malik and Umar (2019) distinguish different structural impacts of oil fluctuations based on the fact whether the origin of the shock is on the side of oil supply, aggregate global demand, or oil global demand. The implications of the origin of the distortion indicate that the oil price movement can go in the context of a positive shock (price rise) and in the direction of a negative shock (price fall). The increase in the price of oil directly affects the increase in the production costs of all petroleum products through the increase in transportation costs that lead to an increase in the prices of products and services.

Consequently, cost-push inflation occurs, which worsens the country's competitiveness and leads to a decline in the current account and financial markets (Wesseh and Lin 2018; Basher et al. 2015).

Relevant aspect of alternative views on the sources of potential oil shocks points to the severity of the countercyclical response to such problems (Kilian and Park 2007). Large economies are the biggest importers of oil because their industries rely mostly on this raw material in the production of goods and services. When there is an increase in the price of oil, the real economy suffers a great cost because there is an increase in production costs, a decrease in production, an increase in unemployment, and a weakening of activity in markets and stock exchanges (Arouri and Nguyen 2010). The movement of stock market indices for investors is a reflection of the economic climate, and if the stock market is in decline, there is a high probability of withdrawing funds in order to avoid losses (Joo and Park 2021; Kostin et al. 2021). Even in the case of smaller oil importers, the situation in the economy is also dependent on oil shocks due to the large degree of liberalization and capital flows. However, due to less dependence on oil imports, oil shocks can have the opposite effect on the stock markets of these countries compared to large oil importers.

As an integral aspect of the functioning of production, fluctuations in the price of oil (external shock) can significantly affect the movement of other macroeconomic indicators. The strength of the impact itself depends on whether it is a systemic shock related to structural imbalances in the markets of all countries or is idiosyncratic in the context of the oil market itself (Sato et al. 2013). Regardless of the origin of the shock on the oil market, through different channels, it will have a direct transmission to the real economy (Hong et al. 2022). Depending on whether it is a positive or negative shock, or whether the country is an oil importer or oil exporter, there is an increase or decrease in economic activity in the country.

One of the main reasons for the emergence of world economic crises is the "*spillover*" effects of financially integrated economies (Stojkov et al. 2022). If the negative impact of the oil shock on the financial markets and stock exchanges of more developed countries is strong enough, it can spill over to the markets of less developed economies (Du and He 2015). Considering the transmission of the global crisis to national economies, the identification of causes or negative external shocks is of key interest to economic policymakers. The depth of crisis consequences can be mitigated by prompt, countercyclically directed, and coordinated economic policy reactions (Beljić and Glavaški 2021).

The macroeconomic consequences of oil price volatility make it difficult to conduct economic policies in an already deeply divergent system such as the EU (Cunado and Gracia 2014). Due to the high degree of integration of the member countries of the economic union, an exogenous shock (such as an oil shock) not only destabilizes the internal and external balance of the member countries, but also undermines the financial stability of the entire system, i.e., the economic union. Absorption of the exogenous oil shock of the most exposed member countries of the economic union is a challenge and the primary goal of a highly integrated, but highly heterogeneous system like the EU (Federic and Hubrich 2017).

3. Descriptive Analysis

The degree of transmission of oil shocks to the destabilization of financial markets is directly related to the extent of import dependence. Due to the pronounced dependence of the European region on oil imports, the research refers to the impact of oil shocks on the destabilization of the financial markets of selected EU member states, with the differentiation of member states into larger and smaller oil importers. Figure 1 (left) shows a comparative overview of the largest importers relative to the countries that import the least oil in the EU. The vertical axis shows imports in thousands of barrels, while the horizontal axis shows the movement of imports starting in 2013. In the observed period, Germany, Italy, and France are significantly larger importers of oil compared to Ireland, Bulgaria, and Croatia. Germany stands out as the biggest importer, with the maximum import in 2015 and the smallest in 2020. On the other hand, in the group of the smallest importers, Croatia stands out, importing the least in 2014 and the most in 2015. Due to

the effects of the pandemic crisis, 2020 is the year of relatively least oil imports within the group of large importers. Oil imports are presented in Table A1 in Appendix A.

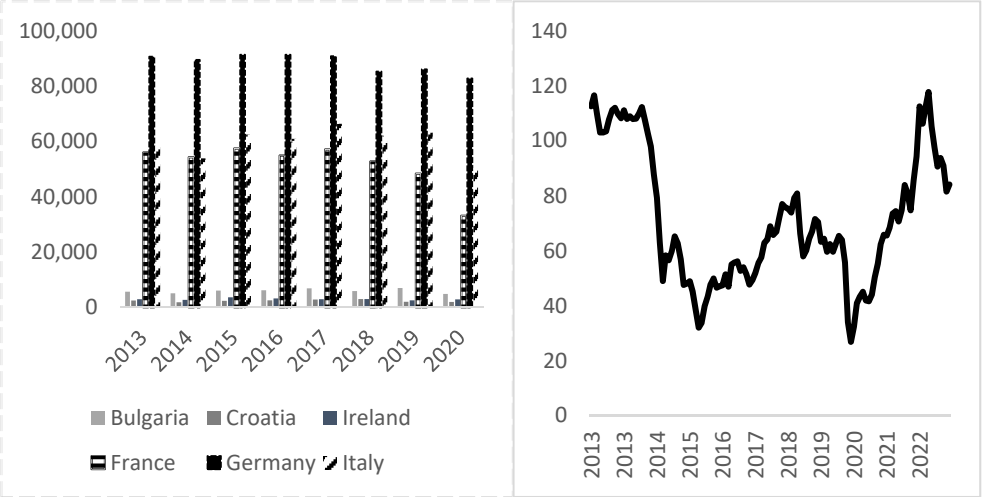

Figure 1. Oil imports of the largest and smallest EU member importers in the period 2013–2020 and oil price fluctuations in the period 2013–2023. Source: Author's research according to Eurostat (2023) and monthly FRED (2023) data.

Bearing in mind the relevance of the oil price movement to the global economy, Figure 1 (right) shows the volatility of its movement during the period 2013–2023. The picture shows how often the price of oil has fluctuated over the past ten years. Initially, the price of oil reached the level of USD 120 per barrel, which caused a sharp drop in its consumption in the following period (Baffes et al. 2015). Combined with the ex-post-effects of the Great Recession, the price of oil continues to fall until 2015, when it stabilizes again. The price of oil stabilized until the onset of the COVID 19 pandemic crisis in 2020 at around USD 60 per barrel of oil. Under the influence of the effects of the pandemic crisis, the price of oil drops to a level close to USD 20 per barrel of oil, after which an exponential growth to the 2013 level of USD 120 per barrel is evident. The end of 2022 and the beginning of 2023 is characterized by a renewed drop in the price of oil to the level of USD 80 per barrel. Oil price fluctuations are presented in Table A2 (Appendix A).

Figure 2 presents a comparative view of the movement of the DAX, CAC40, and FTSE stock market indices of Germany, France, and Italy, respectively, along with the movement of oil prices in the period 2013–2023. The value of the stock market indices is shown on the left primary axis, while the oil price movement is shown on the right secondary axis. Starting in 2013, there is a rapid drop in the price of oil from USD 120 per barrel to USD 60 per barrel in 2015. In this period, the movement of the German DAX index increases from 8000 to 12,000 index points, the French CAC40 from 3700 to 5000 index points, and the Italian FTSE index increases from 18,700 to 25,800. In the following period, from 2016 until the end of 2018. the jump in the price of oil from the initial $40 per barrel to USD 80 per barrel is evident, while the stock market indices of selected countries followed a dominantly stationary path (DAX fluctuates around 12,000 index points, CAC40 around 5500, and FTSE around 40,000).

From the end of 2018 until March 2020, a drop in the price of oil is observed, which coincides with the growth of the stock market indices of all the examined European economies. During the beginning of 2020, there is a "*demand-side*" oil shock in the form of the COVID-19 pandemic crisis, which resulted in bear markets in most European countries along with contractionary repercussions for the real economy. In this period, the stock market moves in parallel with the price of oil for a period of two years. The price of oil rises to USD 120, while the stock market indices tend to fall (DAX from 16,000 to 12,000 index points, CAC40 from 7200 to 5500, and FTSE from 47,000 to 34,700). The price of oil from the

middle of 2022 until the beginning of 2023 tends to fall, while the indices of all countries are growing in this period.

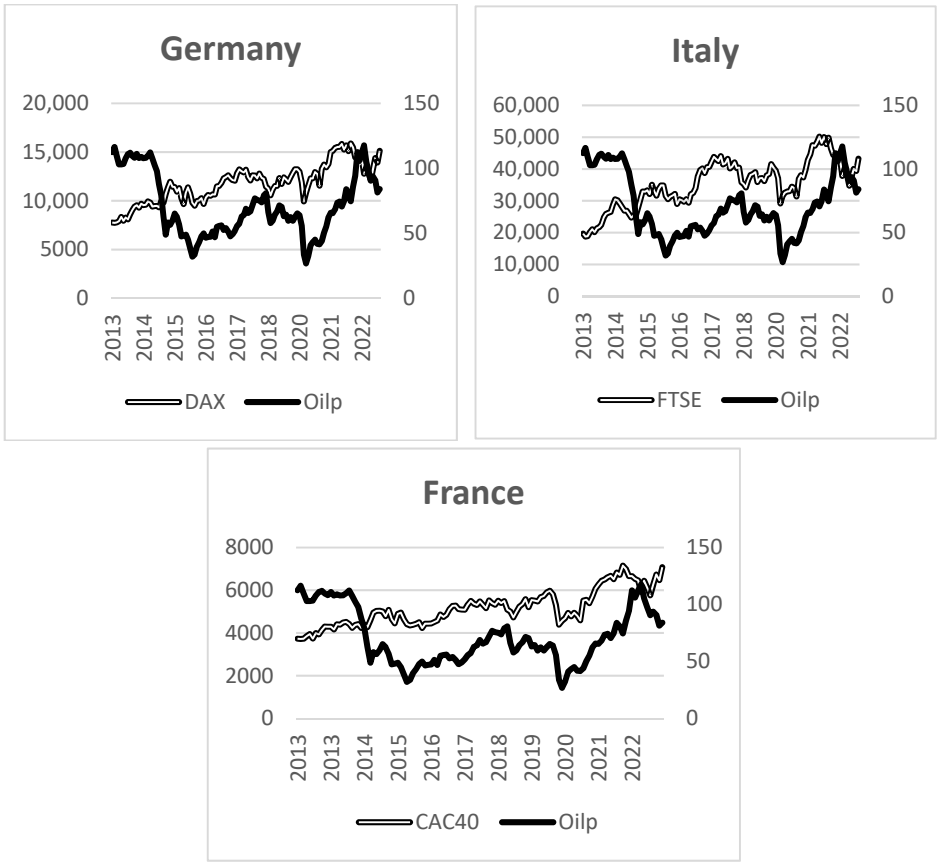

Figure 2. Fluctuation of oil price and movement of stock market indices for the largest oil importers in the EU (Germany, Italy, France) in the period 2013–2023. Source: Author's research according to monthly FRED (2023) data.

Figure 3 shows the comparative movement of stock market indices and oil prices in EU countries that are less oil-dependent. As in the previous case, the value of the stock market indices is shown on the left primary axis, while the oil price movement is shown on the right secondary axis. In contrast to the case of large oil importers, a direct relationship between the value of the stock market indices and the price of oil is now being shown. The table showcasing stock market movements is presented in Table A3 (Appendix A).

Since the end of 2013, a sharp drop in the price of oil has been observed, which continues until 2016, while the indexes in this period show a downward trend: the Croatian CROBEX from 2000 index points to 1600, the Bulgarian SOFIX from 620 to 420, and the Irish ISEQ from 3500 to 2200. After the mentioned drop, oil prices will rise until the end of 2018. In this time interval, the Croatian CROBEX increases from the initial 1600 to 2300 index points but settles at a level of 2000, the Bulgarian SOFIX rises from 420 to 650, and the Irish ISEQ from 2200 to 2700. Throughout the pandemic crisis stock market follows the direction of oil prices. After the rehabilitation period, the price of oil has a rising trend until the middle of 2022, and the stock market indices of the observed countries also follow the rising trend (CROBEX from 1500 to 2000, SOFIX from 400 to 620, and ISEQ from 1900 to 2850 index points). From the middle of 2022, oil prices are falling, which is accompanied by a fall in stock market indices, CROBEX from 2000 to 1800, SOFIX from 620 to 580, and ISEQ from 2850 to 2260.

Descriptive analysis of the relationship between oil prices and stock market indices of selected EU members points to a negative or inverse relationship in the case of major oil importers (Germany, Italy, France), and a positive or direct relationship in smaller oil

importers (Croatia, Bulgaria, Ireland). The analysis of the mentioned relationship is further examined through the VAR model where impulse response functions are derived for each country within the sample in the period 2013M1–2023M1.

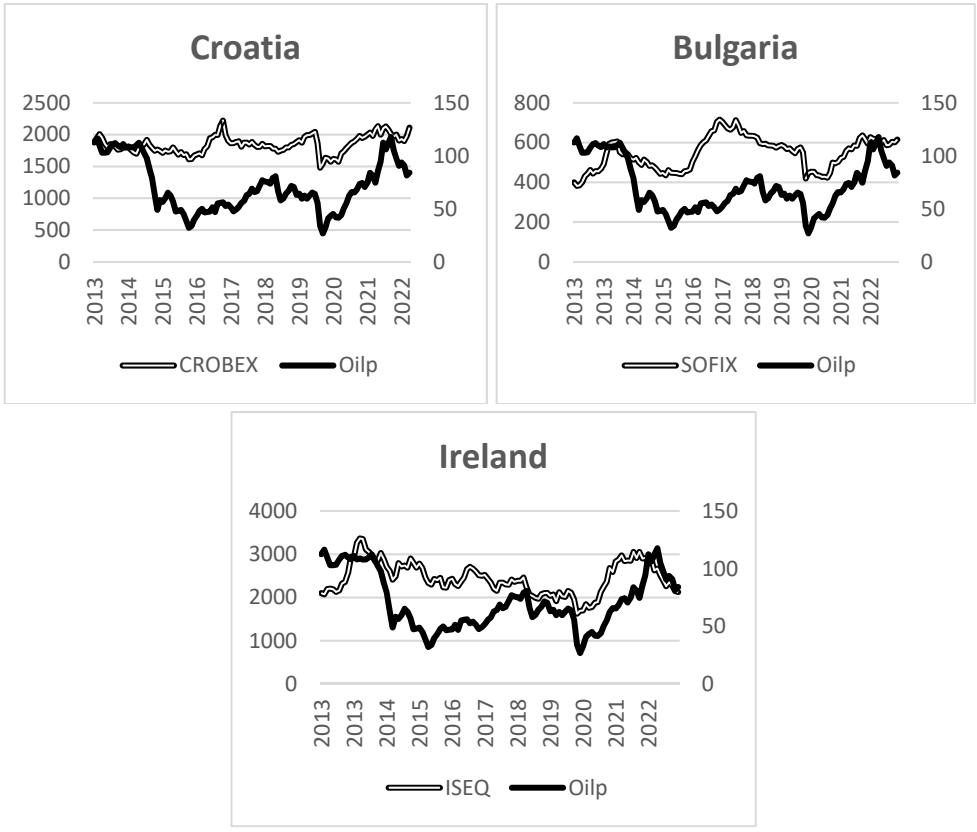

Figure 3. Fluctuation of oil prices and movement of stock market indices for the smallest oil importers in the EU (Croatia, Bulgaria, Ireland) in the period 2013–2023. Source: Author's research according to monthly FRED (2023) data.

4. Methodology

Examining the transmission of exogenous shocks to the variations of selected variables in empirical analyses inevitably implies the evaluation of the VAR model. The VAR model enables the execution of the impulse response function, which specifies the dynamism, direction, and degree of shock transmission from one variable to another (Beker Pucar and Glavaški 2020a). Optimal lag length selection is determined based on common information criteria. The evaluation of the VAR model is preceded by testing the stationarity of selected variables through formal unit root tests. Stationarity was tested using the augmented Dickey–Fuller (ADF) test and the Phillips–Perron unit root test. In the case of variables where the alternative hypothesis of stationarity is rejected, the variable needs to be differentiated to obtain its stationary variant (Ben Cheikh and Louhichi 2013). Due to pronounced fluctuations of the observed time series (oil price and stock market indices of selected countries), each variable in the model is differentiated to obtain a stationary representation. The presence of non-stationarity indicates that there is a long-term effect on the variable, which means a slower return to the equilibrium path (Beker Pucar and Glavaški 2020b).

The next step is to investigate the presence of the long-run relationship between variables of the same order of integration (Jin and Nadal De Simone 2020). The presence of cointegration was tested using the "*Johansen*" test. The cointegration test indicates the absence of a long-run relationship in each observed country, and the VAR model with stationary (initially differentiated) variables is evaluated in the further procedure. Diagnostic checks of the estimated model include checking the stability of the VAR model

and the absence of autocorrelation of the model residuals. Stationarity and cointegration tests are shown in Table A4 in Appendix A.

The stability of the estimated VAR model and the absence of autocorrelation have been confirmed, the analysis continues with the application of the "*Wald*" test to check the "*Granger*" causal relationship. Granger causality indicates whether one variable can cause the future movements of another (Dias et al. 2021; Peng et al. 2020). At the end of the empirical procedure, impulse response functions are constructed in the form of the reaction of stock market indices to oil price fluctuations in selected EU member states.

The model includes two groups of EU member states. The first group represents countries which are large EU importers (Germany, Italy, France), and on the other hand, the EU members who import oil the least (Croatia, Bulgaria, and Ireland). The VAR (*Vector AutoRegression*) model was evaluated individually for each of the selected countries. The main idea is to generate individual impulse response functions that are mutually comparable within the sample of examined economies.

All variables within the research have a monthly frequency. Data on oil price movements were taken from *Federal Reserve Economic Data* (FRED 2023), while data on stock market indices of each country were taken from Investing (2023) for the period 2013M1–2023M1. The period of the empirical analysis 2013M1–2023M1 avoids the impact of the global economic crisis of 2008 (Great Recession) and includes the oil shock of the COVID-19 crisis (pandemic crisis). The variables included in the model are: (i) oil price (oilp); (ii) stock market indices of selected countries: DAX (Germany), CAC40 (France), FTSE (Italy), ISEQ (Ireland), SOFIX (Bulgaria), and CROBEX (Croatia).

The VAR model with endogenous and non-stationary variables (order of integration 1) of stock market indices and oil prices can be written as follows:

Germany: $\Delta DAX_t = \sigma + \sum_{i=1}^{k} \beta_i \, \Delta DAX_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{1t}$

France: $\Delta CAC40_t = \alpha + \sum_{i=1}^{k} \beta_i \Delta CAC40_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{2t}$

Italy: $\Delta FTSE_t = \delta + \sum_{i=1}^{k} \beta_i \Delta FTSE_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{3t}$

Ireland: $\Delta ISEQ_t = \mu + \sum_{i=1}^{k} \beta_i \Delta ISEQ_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{4t}$

Bulgaria: $\Delta SOFIX_t = \gamma + \sum_{i=1}^{k} \beta_i \Delta SOFIX_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{5t}$

Croatia: $\Delta CROBEX_t = \rho + \sum_{i=1}^{k} \beta_i \Delta CROBEX_{t-i} + \sum_{j=1}^{k} \phi_j \Delta oilp_{t-j} + u_{6t}$

where

k—optimal number of lags in the model; i
$\sigma, \alpha, \delta, \mu, \gamma, \rho$—intercepts;
β_i, ϕ_j—short-run dynamic coefficients of the model;
u_{it}—residuals of the VAR model.

The endogenous Granger causality model with non-stationary variables can be written as follows:

$$Yt = \sum_{i=1}^{n} \alpha i Yt - i + \sum_{j=1}^{n} \beta j Xt - 1 + u_{1t}$$

$$Xt = \sum_{i=1}^{n} \lambda i Yt - i + \sum_{j=1}^{n} \sigma j Xt - 1 + u_{2t}$$

where

$\alpha, \beta, \lambda, \sigma$—intercepts;
u_{it}—residuals of the model.

5. Results and Discussions

5.1. VAR Model

The impulse response function is best suited to showcase the magnitude, as well as the direction, of the impact of the oil shock on the stock market indices of the selected countries. The inverse movement of the stock market and the price of oil is expected in the case of major oil importers in which oil is one of the key economic resources. The aforementioned

implies that the price of oil is a signal of the future movement of financial markets and stock exchanges, which is of vital interest to economic policymakers. On the other hand, the direct relationship between oil price movements and stock market indices in the case of lower oil-dependent economies implies that the oil price cannot serve as a signal of the future movement of stock market indices. At the same time, oil shocks do not represent a key source of macroeconomic destabilization in countries less dependent on oil resources.

Figure 4 shows how the unexpected change in the price of oil is reflected on the key stock market indices of selected EU member countries in the period 2013M1–2023M1. Figure 4 (left) indicates that all major oil importers (Italy, France, Germany) have inverse relationship between oil price and stock market indices. The highlighted finding indicates that an unexpected rise in the price of oil leads to a fall in stock market indices in major importing countries, which corresponds to the findings of Filis et al. (2011). It is important to point out that the oil price shock has a distinct and strongest impact in the third month for each country, with Italy being the most pronounced. After the third month, the impact of the unexpected change in the price of oil on stock market indices in all selected countries weakens.

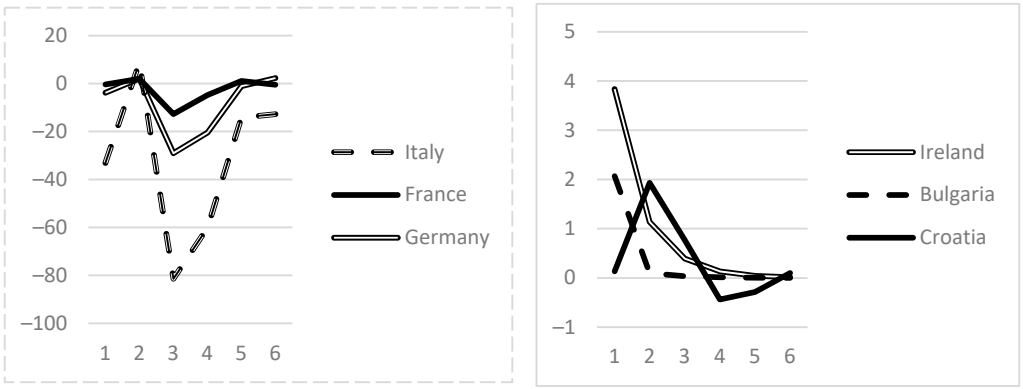

Figure 4. The impulse response function of large oil importers (Italy, France, Germany) and the impulse response function of small oil importers (Ireland, Bulgaria, Croatia). Source: Author's estimation.

Figure 4 (right) shows a comparison of individual impulse response functions for the countries that import the least oil in the EU (Ireland, Bulgaria, Croatia). It can be seen that in Ireland and Bulgaria, the reactions of the stock market index to the oil price shock are most pronounced in the first month, after which the impact of the oil shock weakens. On the other hand, in Croatia, the impact of the oil shock grows exponentially during the first month and reaches its peak during the second month. After the second month, the reaction of the stock market weakens until the end of the observed period. Unlike the previous group of countries, for which the inverse relationship between the two variables was determined, now their direct relationship is observed. An unexpected change in the price of oil leads to the growth of stock market indices in the observed countries. The mentioned finding indicates that there is a weak connection between the movement of oil prices and stock market indices and that stock exchange fluctuations are influenced by other variables not covered by the model. The above conclusion coincides with the initial assumption that the financial markets of countries less dependent on oil imports are not sensitive to oil price fluctuations or oil shocks.

Different impacts of global external shocks on the macroeconomic indicators of the member countries of the economic union create the need for coordination of national levers of economic policy. In this research, the asymmetry of the impact of oil shocks on stock market indices in different members of the economic union, i.e., EU. Asymmetric "*spillover*" effects within European countries with a deep level of economic integration can lead to the destabilization of individual member countries, as well as the monetary union *per se* (Glavaški et al. 2023). The table showcasing VAR coefficients is presented in Table A5 in Appendix A.

5.2. Granger Causality Test

Table 1 shows the results of Granger causality through the *Wald* test for the group of the largest oil-importing countries in the EU. The table shows the causal relationship between the price of oil (*doilp*) and the stock market indices of France (*dCAC40*), Germany (*dDAX*), and Italy (*dFTSE*). The results of the *Granger* causality test indicate that changes in oil prices (first difference of oil prices—*doilp*) cause changes in stock market indices of France, Germany, and Italy (first difference of stock market index values—dCAC40, dDAX, dFTSE). The aforementioned is confirmed by the fact that the *p*-value for each of the observed countries is less than 0.05, and the null hypothesis that *doilp* does not cause dCAC40, dDAX, and dFTSE is rejected. An alternative hypothesis of the existence of a cause-and-effect relationship is accepted, that is, the change in oil prices affects the movement of the stock market indices of Germany, France and Italy in the observed time period. Examining the inverse relationship in the sense of testing whether stock market indices significantly affect the movement of oil prices, we find a *p*-value below 0.05. The aforementioned finding indicates that the null hypothesis is rejected, that is, stock market indexes cause the change in oil prices according to *Granger*.

Table 1. Granger causality of major oil-importing countries (Germany, France, Italy) in the period 2013M1–2023M1.

Country	Direction of Causality	*p*-Value	Direction of Causality	*p*-Value
France	doilp → dCAC40	0.031	dCAC40 → doilp	0.004
Germany	doilp → dDAX	0.006	dDAX → doilp	0.022
Italy	doilp → dFTSE	0.044	dFTSE → doilp	0.003

We can conclude that in countries whose economies are highly dependent on oil, fluctuations in oil prices cause future changes in stock market indices. Given that they are important oil importers and factors in the world demand for oil, changes in their demand affect the world price of oil. And the import demand within large oil importers is made by companies that are included in the stock market indices, *hence* the significant influence of the stock market on the oil market (Filis and Chatziantoniou 2014).

Table 2 shows different results for the group of EU members that are small oil importers. Namely, the cause-and-effect relationship between the price of oil (the cause) and the stock market indices (the effect) of Bulgaria (dSOFIX), Croatia (dCROBEX), and Ireland (dISEQ) has not been confirmed. In every observed small oil importer, the change in the price of oil (*doilp*) does not cause a change in the stock market indices according to *Granger*, because the *p*-value for each country is greater than 0.05, and the null hypothesis of the absence of a cause-and-effect relationship is accepted. In the same grouping of European economies, the causal relationship between the stock market indices (the cause) and the price of oil (the effect) has not been confirmed either. We can conclude that in countries whose industries are not significantly dependent on oil imports, fluctuations in oil prices will not cause a future change in the movement of stock indices, and vice versa.

Table 2. Granger causality of smaller oil-importing countries (Ireland, Bulgaria, and Croatia) in the period 2013M1–2023M1.

Country	Direction of Causality	*p*-Value	Direction of Causality	*p*-Value
Ireland	doilp → dISEQ	0.068	dISEQ → doilp	0.168
Bulgaria	doilp → dSOFIX	0.554	dSOFIX → doilp	0.559
Croatia	doilp → dCROBEX	0.233	dCROBEX → doilp	0.437

5.3. Robustness of the Evaluated Model

In order to confirm the robustness of the evaluated model, two more countries are included, that is, one representative of large oil importers (Netherlands) and one repre-

sentative of smaller oil importers (Romania) of EU member states. The robustness of the model confirms the existence of a direct impact of the oil shock on the movement of the stock index of Romania (BET), while it shows an inverse relationship in the case of the Netherlands (AEX). The observation period is identical and refers to 2013M1–2023M1.

Figure 5 (left) shows a comparative overview of oil imports of two selected countries to confirm the robustness of the estimated VAR model. In each observed year, the Netherlands has significantly higher oil imports compared to Romania. Netherlands recorded the highest oil imports in 2019 before the pandemic crisis, and the lowest imports during 2013. On the other hand, Romania achieved the smallest import during 2013, and the largest in 2019.

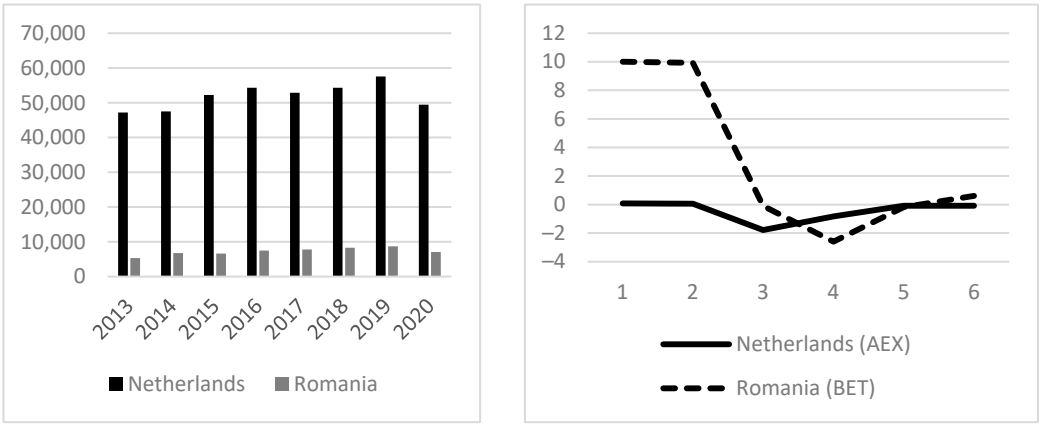

Figure 5. Oil imports of the Netherlands and Romania in the period 2013–2020 and impulse response function of the Netherlands and Romania in the period 2013M1–2023M1. Source: Eurostat (2023) and author's estimation.

The same result can be observed in the case of the previously analyzed European economies, for Netherlands and Romania, both variables (oil price and stock market indices) were differentiated to achieve stationarity. The absence of a long-term cointegrating relationship was confirmed using the "*Johansen*" test. Accordingly, the VAR model with the first difference of oil prices and stock market indices was evaluated. The tests show that the VAR model is stable and there is no autocorrelation of the residuals. This is the basis for the final performance of the impulse response function.

The results shown in Figure 5 (right) confirm that the price of oil has an inverse effect on the stock market of those countries whose industry is highly dependent on oil imports. Namely, the rise in oil prices leads to a fall in the stock market index of the Netherlands. In the case of Romania, whose economy is not dependent on oil, a direct influence of oil price movements and stock market indices can be observed in the same period of time. In the Netherlands, the impact of the oil shock is greatest in the third month, after which the impact of the shock gradually weakens. In the case of Romania, the shock was prolonged from the first to the second month, followed by a relaxation of its impact.

The robustness of the previously evaluated model is confirmed by the highlighted results for the Netherlands and Romania, which correspond to the already detected and expected relations of oil shocks and financial markets. In order to clearly see the distinction in the transmission of the oil shock to the stock market, Figure 6 shows the averaged impulse response functions for all large (France, Germany, Italy, Netherlands) and small (Ireland, Bulgaria, Croatia, Romania) European oil importers included in this study.

In the group of large oil importers, the impact of the oil shock has a negative effect on the stock market indices, with a clear destabilization during the observed six months since the outbreak of the shock. On the other hand, within the framework of small oil importers, the impact of the oil shock has a positive, weaker, and short-term effect on the stock market indices. The research results indicate a greater exposure or sensitivity of the stock market to

oil shocks in the case of European countries more dependent on oil imports, while the stock market is less sensitive to oil shocks in the case of less dependent European economies.

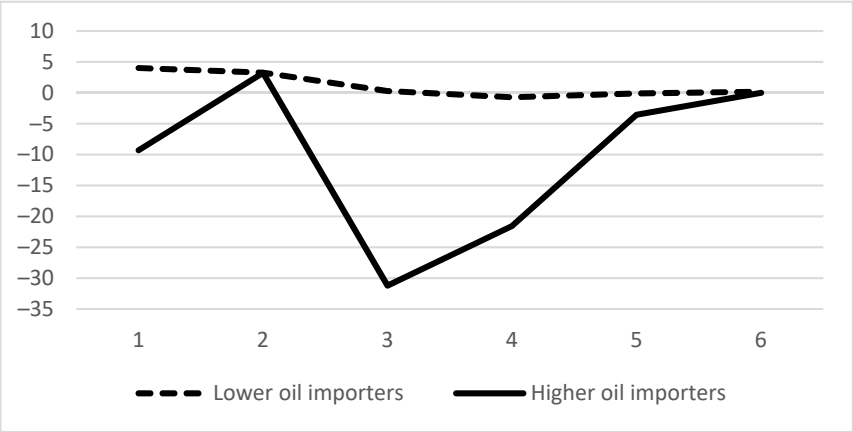

Figure 6. Averaged impulse response function of large and small European oil importers. Source: Author's estimation.

Table 3 shows the results of Granger causality through the *Wald* test for the selected representatives of large oil importers (Netherlands) and small oil importers (Romania). The table shows the causal relationship between the price of oil (*doilp*) and the stock market indices of the Netherlands (dAEX) and Romania (dBET). The results of the *Granger* causality test indicate that changes in oil prices (first difference of oil prices—*doilp*) cause changes in stock market indices in the Netherlands (first difference of stock market index values—dAEX). The is confirmed by the fact that the *p*-value for the observed country is less than 0.05, and the null hypothesis that *doilp* does not cause dAEX is rejected. An alternative hypothesis of the existence of a cause-and-effect relationship is accepted, that is, the change in oil prices affects the movement of the stock market indices of the Netherlands in the observed time period. Examining the inverse relationship in the sense of testing whether stock market indices significantly affect the movement of oil prices, we find a *p*-value below 0.05. The aforementioned finding indicates that the null hypothesis is rejected, that is, stock market indexes cause the change in oil prices according to *Granger*. On the other hand, the cause-and-effect relationship between the price of oil (the cause) and the stock market indices (the effect) of Romania has not been confirmed. In the observed country, the change in the price of oil (*doilp*) does not cause a change in the stock market indices according to *Granger*, because the *p*-value is greater than 0.05, and the null hypothesis of the absence of a cause-and-effect relationship is accepted. We can conclude that the findings correspond to the initial results in the model.

Table 3. Granger causality of larger (Netherlands) and smaller (Romania) oil importers in the period 2013M1–2023M1.

Country	Direction of Causality	*p*-Value	Direction of Causality	*p*-Value
Netherlands	doilp → dAEX	0.014	dAEX → doilp	0.015
Romania	doilp → dBET	0.133	dBET → doilp	0.847

The results correspond to the vast literature examining EU heterogeneity. Peersman and Robays (2009), while investigating the effects of oil price shock on inflation, determined the existence of EU dualism in terms of asymmetrical inflationary responses to the oil shocks. Also, the vulnerability of heterogeneous structures is proven with the VAR model when examining effects on output (Evgenidis 2018). Financial market's asymetrical volatility is confirmed in the Euro Area in terms of "core vs. periphery" dualism (Lombardo and McAdam 2012; Demirer et al. 2020).

6. Conclusions

Fluctuations in oil prices are of essential importance for the macroeconomic performance of most countries in the world, which is particularly reflected in countries more dependent on the import of this raw material. Oil is an indispensable resource of the production process, with direct repercussions on the real economy, inflation, and the balance of payment positions of the importing countries. Historically, the global economy has faced several oil shocks with negative real and monetary consequences for the world economy. Each of the previous oil crises had a specific character and differed in terms of their origin. The last crisis caused by the COVID 19 pandemic had the character of a "*demand side*" shock with the consequent drop in oil prices.

Recent empirical studies related to the topic of oil price fluctuations are dominantly related to the issue of its uncertainty (Kocaaslan 2019; Cunado et al. 2015; Jo 2014; Elder and Serletis 2010; Salisu et al. 2022). This paper expands the existing literature by identifying the asymmetric effects of oil shocks on stock market indices of selected EU member states depending on the degree of import dependence on oil resources. The focus of the research is highlighting the asymmetric effects of oil price fluctuations depending on the level of oil imports on a sample of selected EU members. The transmission of oil shocks to stock market indices was examined using the VAR model in the period from 2013M1–2023M1. The derived individual impulse response functions indicate the degree of strength of oil shocks, as well as the direction of their influence.

Causality tests confirm a causal relationship between oil prices and stock market indices in major oil importers. On the other hand, the causal relationship does not exist in the case of small oil-importing countries, thus detecting the absence of influence on the stock markets of the observed countries. Empirical findings confirm two effects of oil shocks on the stock market indices of the observed economies: inverse effects in countries that are significant oil importers (Germany, France, Italy and Netherlands) and direct effects in countries that are smaller oil importers (Ireland, Bulgaria, Croatia, and Romania). The identified asymmetric impact of the oil shock on the stock market indices of selected EU members significantly complicates the conduct of economic policy at the supranational and national levels. The situation at the level of the economic union is further complicated by the fact that such deep economic integration is difficult to maintain in the circumstances of the asymmetric effect of external (in this case oil) shocks.

It is important to note that the effects of oil prices on financial markets can vary depending on many factors, including global economic conditions, political factors and the dynamics of energy supply and demand markets. Specifically, the model can be enhanced by including another control variable that would represent systemic shock. Future research directions refer to additional investigations of the transmission effects of oil shocks in terms of (de)stabilization of financial markets, inflationary pressures, economic activity, and balance of payments imbalance as crucial parameters of macroeconomic stability. In addition to additional variables, the research can be extended to a larger sample of EU member states with a different methodological framework of non-stationary and dynamic macro-panel analysis techniques.

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Data Availability Statement: The original data presented in the study are included in the article.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Oil price fluctuations in the period 2013M1–2023M1.

Variable	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
oilp	112.52	107.93	48.93	32.05	55.71	68.89	59.94	63.90	55.22	85.62	84.08
	116.48	108.84	58.25	33.76	56.10	65.70	64.38	55.69	62.36	94.27	
	109.58	107.87	56.52	39.79	52.66	66.89	66.94	33.95	65.80	112.44	
	102.96	108.00	59.83	43.33	53.98	71.93	71.48	26.85	65.53	106.16	
	102.98	109.83	65.19	47.73	51.37	76.93	70.39	32.42	68.37	112.11	
	103.35	112.24	62.62	49.88	47.65	75.80	63.21	40.86	73.51	117.69	
	107.77	107.46	56.83	46.60	49.25	75.23	64.32	43.30	74.40	105.25	
	111.05	102.40	47.53	47.05	51.93	73.85	59.61	45.08	70.59	97.64	
	111.96	97.85	48.03	47.38	55.56	79.16	62.43	41.93	74.75	90.61	
	109.62	87.58	48.90	51.41	57.54	80.78	59.63	41.61	83.87	93.72	
	108.15	79.23	45.09	46.94	62.84	66.23	62.69	44.05	80.89	90.94	
	111.07	62.90	38.52	55.02	64.06	57.95	65.35	50.38	74.68	81.50	

Table A2. Annual oil imports by country.

Country	2013	2014	2015	2016	2017	2018	2019	2020
Germany	90,567.000	89,397.000	91,275.0000	91,244.000	90,738.000	85,209.000	85,991.000	82,724.000
France	55,961.000	54,220.000	57,452.000	54,894.000	57,053.000	52,726.505	48,335.000	33,121.000
Italy	58,357.000	53,843.000	62,457.000	60,878.000	66,348.350	62,052.875	63,139.508	50,363.074
Croatia	2462.000	1851.000	2328.000	2513.000	2818.000	2965.500	20,006.000	1943.000
Bulgaria	5641.000	5103.000	6068.000	6195.000	6859.089	5857.628	6984.887	4858.519
Ireland	2933.000	2701.000	3642.000	3197.000	2915.418	2985.991	2552.814	2903.736

Table A3. Stock market fluctuations in the period 2013M1–2023M1.

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CAC40	3732.60	4165.72	4604.25	4417.02	4748.90	5481.93	4992.72	5806.34	5399.21	6999.20	7082.42
	3723.00	4408.08	4951.48	4353.55	4858.58	5320.49	5240.53	5309.90	5703.22	6658.83	
	3731.42	4391.50	5033.64	4385.06	5122.51	5167.30	5350.53	4396.12	6067.23	6659.87	
	3856.75	4487.39	5046.49	4428.96	5267.33	5520.50	5586.41	4572.18	6269.48	6533.77	
	3948.59	4519.57	5007.89	4505.62	5283.63	5398.40	5207.63	4695.44	6447.17	6468.80	
	3738.91	4422.84	4790.20	4237.48	5120.68	5323.53	5538.97	4935.99	6507.83	5922.86	
	3992.69	4246.14	5082.61	4439.81	5093.77	5511.30	5518.90	4783.69	6612.76	6448.50	
	3933.78	4381.04	4652.95	4438.22	5085.59	5406.85	5480.48	4947.22	6680.18	6125.10	
	4143.44	4416.24	4455.29	4448.26	5329.81	5493.49	5677.79	4803.44	6520.01	5762.34	
	4299.89	4233.09	4897.66	4509.26	5503.29	5093.44	5729.86	4594.24	6830.34	6266.77	
	4295.21	4390.18	4957.60	4578.34	5372.79	5003.92	5905.17	5518.55	6721.16	6738.55	
	4295.95	4272.75	4637.06	4862.31	5312.56	4730.69	5978.06	5551.41	7153.03	6473.76	
DAX	7776.05	9306.48	10,694.32	9798.11	11,535.31	13,189.48	11,173.1	12,981.97	13,432.87	15,471.2	15,128.27
	7741.7	9692.08	11,401.66	9495.4	11,834.41	12,435.85	11,515.64	11,890.35	13,786.29	14,461.02	
	7795.31	9555.91	11,966.17	9965.51	12,312.87	12,096.73	11,526.04	9935.84	15,008.34	14,414.75	
	7913.71	9603.23	11,454.38	10,038.97	12,438.01	12,612.11	12,344.08	10,861.64	15,135.91	14,097.88	
	8348.84	9943.27	11,413.82	10,262.74	12,615.06	12,604.89	11,726.84	11,586.85	15,421.13	14,388.35	
	7959.22	9833.07	10,944.97	9680.09	12,325.12	12,306	12,398.8	12,310.93	15,531.04	12,783.77	
	8275.97	9407.48	11,308.99	10,337.5	12,118.25	12,805.5	12,189.04	12,313.36	15,544.39	13,484.05	
	8103.15	9470.17	10,259.46	10,592.69	12,055.84	12,364.06	11,939.28	12,945.38	15,835.09	12,834.96	
	8594.4	9474.3	9660.44	10,511.02	12,828.86	12,246.73	12,428.08	12,760.73	15,260.69	12,114.36	
	9033.92	9326.87	10,850.14	10,665.01	13,229.57	11,447.51	12,866.79	11,556.48	15,688.77	13,253.74	
	9405.3	9980.85	11,382.23	10,640.3	13,023.98	11,257.24	13,236.38	13,291.16	15,100.13	14,397.04	
	9552.16	9805.55	10,743.01	11,481.06	12,917.64	10,558.96	13,249.01	13,718.78	15,884.86	13,923.59	

Table A3. *Cont.*

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
FTSE	19,714.68	26,521.81	27,842.87	31,512.27	32,550.91	44,054.26	36,552.87	39,458.85	37,359.19	46,484.54	43,263.71
	18,771.75	28,758.83	30,545.78	30,541.38	33,920.36	41,453.53	38,136.55	37,144.16	39,723.93	44,461.08	
	18,929.97	30,481.30	32,961.31	31,294.68	37,714.90	41,794.68	38,406.84	29,149.95	42,866.33	43,676.97	
	20,219.34	30,149.73	32,876.11	31,676.04	39,665.83	43,208.11	39,000.45	31,593.57	44,585.62	43,097.59	
	21,067.48	29,189.06	33,298.91	32,193.95	40,186.51	40,194.05	35,913.60	32,590.67	47,479.51	42,929.23	
	20,178.15	28,060.76	32,151.48	29,023.99	38,716.27	40,782.02	37,036.57	32,942.35	47,275.72	37,798.21	
	21,394.15	26,878.36	35,042.65	30,466.52	40,573.93	42,102.82	37,151.46	33,050.87	48,517.60	40,282.55	
	21,709.11	26,891.90	33,052.41	30,170.50	40,658.68	40,263.58	36,200.90	34,446.30	50,171.48	38,065.01	
	22,525.62	25,881.94	31,648.83	29,711.32	42,241.63	40,424.64	37,984.19	34,039.71	48,233.16	34,757.44	
	24,789.90	24,741.78	33,786.98	30,542.13	43,812.45	35,868.06	38,407.41	31,360.71	50,023.35	37,638.37	
	25,902.32	25,455.24	34,848.53	29,402.63	43,080.59	35,240.38	41,553.22	36,836.63	47,841.92	40,012.34	
	26,242.64	25,228.74	34,872.26	32,098.78	42,473.97	34,170.17	40,422.20	38,091.63	49,841.71	39,374.15	
CROBEX	1887.81	1803.53	1764.75	1612.19	2142.69	1884.79	1761.79	2041.52	1786.24	2132.61	2110.79
	1945.38	1795.09	1745.56	1614.28	2221.02	1839.46	1798.98	1863.40	1830.19	1999.68	
	2008.78	1758.44	1712.82	1669.68	1989.27	1804.97	1797.81	1480.51	1872.22	2098.47	
	1948.39	1721.39	1751.67	1688.48	1901.87	1809.60	1837.98	1544.30	1893.51	2129.32	
	1853.97	1701.51	1729.44	1704.64	1864.17	1854.02	1851.20	1635.37	1932.84	2078.38	
	1804.69	1791.48	1737.55	1675.95	1865.57	1816.49	1883.11	1621.55	1980.49	2012.13	
	1848.55	1815.30	1798.44	1773.97	1885.31	1820.01	1911.58	1573.77	1948.31	1968.96	
	1841.41	1850.73	1738.18	1818.39	1893.01	1822.24	1873.36	1617.09	1967.54	2000.79	
	1810.54	1918.06	1685.63	1941.32	1811.12	1782.15	1963.54	1608.54	1999.24	1906.28	
	1764.41	1838.75	1725.10	1958.94	1874.49	1779.13	1991.98	1574.68	2032.51	1928.91	
	1772.11	1792.02	1680.19	1997.81	1875.01	1729.38	1995.61	1702.37	1981.00	1898.60	
	1794.28	1745.44	1689.63	1994.84	1842.87	1748.81	2017.43	1739.29	2079.35	1979.88	
SOFIX	399.59	546.83	500.49	448.44	602.28	712.73	585.76	575.87	499.38	618.53	614.89
	382.04	594.42	487.79	447.42	611.12	686.43	585.37	550.25	495.58	595.22	
	384.29	600.32	514.09	446.35	633.99	649.17	583.87	419.35	502.28	626.76	
	400.19	601.98	502.7	442.59	657.29	658.11	575.06	447.45	522.39	619.03	
	430.15	605.22	482.92	441.34	661.23	636.55	582.48	452.71	527.61	617.97	
	443.77	551.41	485.25	455.55	703.46	634.26	587.81	453.26	557.69	613.21	
	462.04	540.73	473.64	458.18	715.21	634.03	580.68	436.45	570.44	599.72	
	444.17	549.39	459.44	464.66	705.44	631.83	567.45	434.21	566.1	612.34	
	456.2	539.96	442.34	504.58	688.11	624.39	570.58	427.55	585.36	587.15	
	455.86	520.31	446.91	531.82	671.41	596.81	556.84	427.94	583.95	589.52	
	468.47	514.42	435.56	562.82	665.03	592.12	546.57	423.33	622.72	603.44	
	491.52	522.1	460.9	586.43	677.45	594.46	568.14	447.53	635.68	601.49	
ISEQ	2101.41	3264.72	2412.30	2335.05	2460.56	2341.99	1991.70	2110.66	2370.06	2902.20	2124.27
	2074.54	3366.62	2494.64	2299.54	2658.70	2343.05	1970.61	1950.42	2680.45	2914.72	
	2193.28	3348.20	2793.10	2428.41	2711.15	2301.67	2076.01	1625.69	2589.58	2779.90	
	2205.88	3112.94	2716.19	2403.82	2663.63	2293.79	2102.43	1692.36	2832.74	2878.00	
	2186.06	3053.16	2739.47	2455.08	2601.86	2413.00	2107.73	1697.50	2876.75	2628.50	
	2126.79	2981.27	2689.97	2235.37	2512.24	2360.50	2038.62	1842.66	2973.08	2668.09	
	2162.19	2844.66	2902.02	2229.94	2503.97	2387.05	2070.59	1762.98	2844.57	2516.56	
	2322.43	2849.29	2801.00	2403.27	2519.39	2385.81	1918.43	1779.25	2853.83	2392.91	
	2360.43	3027.33	2692.11	2431.01	2432.82	2461.16	2119.03	1876.42	2851.51	2262.52	
	2568.77	2887.86	2782.69	2309.92	2345.94	2242.66	2028.38	1895.87	3053.22	2350.45	
	2942.17	2711.47	2679.29	2267.02	2205.39	2066.17	2012.90	2132.14	2911.44	2267.13	
	2952.07	2615.06	2457.89	2369.08	2153.71	2034.48	2151.71	2251.51	3052.08	2147.01	

Table A4. Stationarity and cointegration tests.

Country	Variable	ADF in the Level	ADF at the First Differences	PP in the Level	PP at the First Differences	Johansen Test for Cointegration *
France	CAC40 oilp	0.6823 0.2789	0.0000 0.0000	0.6690 0.2762	0.0000 0.0000	9.0001
Germany	DAX oilp	0.3904 0.2789	0.0000 0.0000	0.3970 0.2762	0.0000 0.0000	12.4205
Italy	FTSE oilp	0.2164 0.2789	0.0000 0.0000	0.2701 0.2762	0.0000 0.0000	14.6427
Netherlands	AEX oilp	0.8036 0.2789	0.0000 0.0000	0.8229 0.2762	0.0000 0.0000	7.3685
Croatia	CROBEX oilp	0.1198 0.2789	0.0000 0.0000	0.0889 0.2762	0.0000 0.0000	11.3153
Bulgaria	SOFIX oilp	0.1793 0.2789	0.0000 0.0000	0.2802 0.2762	0.0000 0.0000	13.3737
Ireland	ISEQ oilp	0.1541 0.2789	0.0000 0.0000	0.2001 0.2762	0.0000 0.0000	12.1746
Romania	BET oilp	0.8058 0.2789	0.0000 0.0000	0.8228 0.2762	0.0000 0.0000	6.5703

* Notes: Absence of cointegration for values below critical value (15.41).

Table A5. VAR model coefficients.

Country	VAR Coefficients	*p*-Value
Germany	0.0010167 −0.0003078 0.0016881 −0.002205	0.265 0.726 0.060 0.015
France	0.0040739 0.0002539 0.0047316 −0.005628	0.059 0.904 0.029 0.011
Italy	0.0005117 0.0000621 0.0005471 −0.0007337	0.050 0.806 0.032 0.005
Netherlands	0.0227263 0.005675 0.0454672 −0.0550179	0.315 0.799 0.046 0.017
Croatia	0.0092084 0.0041872	0.249 0.606
Bulgaria	0.0138877	0.559
Ireland	0.0056523	0.168
Romania	0.000472 0.0005957	0.720 0.651

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