

Empirical Analysis of the European Stock Market to the Evolution of Russian Oil and Gas Stock Market Index RTSOG

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Abstract. *This paper analyzes the correlation and evolution of representative European Union stock market indexes from the energy sector, including from the green energy sector against RTS Oil & Gas (RTSOG) a Russian index composed of 11 companies from the oil and gas sector during the double crisis (COVID-19 pandemic and war) and war period. From the impulse response function to RTSOG, high volatility is found present, however with a delayed effect, in the month following the start of the war with BET_NG recording the biggest decrease which could be explained by Romania's proximity to the war. From all the indexes analyzed, ERIX (renewable energy) is the only one that has the most delayed effect and it becomes rather stable starting earlier than the other indexes analyzed. The variance decomposition results of the indexes explained by RTSOG provide proof of a higher variance level during the double crisis period than the war period.*

Keywords: stock market, pandemic, war, VAR model, impulse response, variance decomposition.

Introduction

Energy is one of the variables that is in the center of the economy and one of the main debated topics especially since the start of the war in Ukraine on 22nd of February 2022. According to reports published by the European Commission (2022) in 2020 Europe imported 24,4% of its energy from Russia with Germany importing a little over 30%, France approximately 8% and Romania a little under 20%, on the other hand the natural gas dependency to Russia in the same year was 41,1%. The share of Russia's pipeline gas in EU recorded a decrease from about 40% in 2021 to approximately 8% in 2023 according to the report published by the European Council (2024).

With the latest events that the economy was confronted with, the pandemic and war, the energy market was the main focus of economist analyses. According to Umar et al. (2022) the European renewable industry was the first market to react to the war in Ukraine given the abnormal return increases found present, while Hemrit and Benlagha (2021) find that the uncertainty generated by the pandemic has a positive effect on renewable energy.

Given Russian gas importance for the European market I decided to analyze the evolution of four representative stock market indexes in Europe, including one for renewable energy sector, relative to RTS Oil & Gas (RTSOG) a Russian index currently composed of 15 companies from the oil and gas sector with the objective to observe how much of the evolution of the chosen indexes is explained by RTSOG during the war period as well during the overlap period (COVID-19 and war), respectively if there is contagion from the Russian stock market to the European one and as well if the impact on the European market is different in amplitude in any way between the two time frames analyzed.

The novelty aspects of this article are the fact that it analyzes the two markets from a sectorial perspective, more specific oil and gas, and second, it takes a closer look at the period when the COVID-19 pandemic and war overlap, a time-frame that from the literature that I reviewed wasn't analyzed by researchers, but was rather taken into account as two separate events.

Literature review

The war between Russia and Ukraine has definitely had an impact on the world stock market worldwide and Bounboua and Yatié (2022) find a negative relationship between stock markets return and the war from analyzing stock markets from 94 countries, similar to Ahmed et al. (2023) find negative abnormal returns for the European stock market on 21st February 2022 and also in the post-event period. Also, Yousaf et al. (2022) whom find abnormal returns for the majority of the stock markets analyzed, as a reaction to the war with negative returns in pre-event days for Russia, Hungary, Poland, and Slovakia stock markets and a negative effect in the post-invasion days for France, Germany, India, Italy, Romania, Japan, Spain, Turkey, Australia and South Africa stock markets.

Kumaria et al. (2023) examine the EU stock market index's reaction to Russia's aggression on Ukraine and find that the countries that have a less efficient market and closer to the war zone are considerably more affected by the war and identified these markets as being Austria, Bulgaria, Cyprus, Czech Republic, Croatia, Estonia, France, Finland, Greece, Germany, Hungary, Italy, Ireland, Lithuania, Romania and Slovenia.

When it comes to green energy Umar et al. (2022) find proof of abnormal return increases that were associated with the renewable industry, the first market to react to Russians aggression in Ukraine being Europe, while Hemrit and Benlagha (2021) identify that the renewable energy index has a positive effect due to the uncertainty caused by the pandemic.

Nerlinger and Utz (2022) the results obtained by the authors provide proof of quick changes in the capital market during catastrophic events, such as wars, which trigger changes in the supply chains, similar to the results obtained by Izzeldin et al. (2023) whom find an instantaneous reaction of investors to the news of the war in Ukraine given the evolution of global stock markets, which is different to the GCF and COVID-19 crises when the global stock markets displayed a delay response.

Gaio et al. (2022) findings show that during the COVID-19 pandemic and war a herding effect and irrationality is present in the stock market of six developed countries (Germany, France, Italy, Spain, United Kingdom, United States), while Szczygielski et al. (2022) find that the worst performing energy sectors, during the COVID-19 pandemic, from the 20 countries analyzed covering all continents, were Brazil, Austria, Great Britain, Colombia and Spain, while Ha et al. (2022) find that during the pandemic, the markets that are net volatility shock transmitters to the US energy market volatility are oil, silver and gold markets.

Li et al. (2022) find that the European stock market fluctuations are better explained during the initial phase of Russia's invasion in 2022 by two commodities that are mainly exported by this country, natural gas and wheat in comparison to the period previous to it, similar to the findings of Li et al. (2024) whom identify a considerable increase in risk at the commodity market level given Ukraine and Russia significant role in exports and energy provider and identify as the largest risk transmitters as being Germany for the stock market, respectively the Eurozone and UK for the foreign exchange market.

The connectedness of the oil with stock markets is found present for Germany, France, Spain, Netherlands, United Kingdom, and European stock index during the war, while prior to the war for non-European countries, specifically the United States, China, Hong Kong, Japan and Australia by Adekoya et al. (2023), which they justify by the stronger economic ties of European countries with Russia, given that it's the largest oil and gas supplier for Europe. Also, Manelli et al. (2024) find

during the war period, a connectedness relationship of Eurostoxx 50 index with TTF Dutch gas futures and wheat prices, with the latest having a more significant effect on Eurostoxx 50.

The energy market volatility based on natural gas was examined by Chen et al. (2023) and observe that volatility-of-volatility of S&P GSCI natural gas index does not decrease to zero and a non-normal distribution of long-term natural gas returns, during the Russia–Ukraine war, a behavior that is opposite to the one prior to the war.

Also, the evolution of the Russian market during the period covering the pre-event and event period (12th September 2021 – 29th April 2022) was analyzed at sector level by Ullah et al. (2023), whom identify a significant impact on the Russian stock market during the war, with sectors such as oil and gas, metals and mining, utilities, financials, consumer goods, and services as transmitters of risk on other sectors, respectively telecoms, transport and chemicals, as risk-receiver sectors. The authors also identified as strong spillover transmitters for the stock market the indexes RTSFN and RTSCR with values of 92,26% and 91,48%, respectively index RTSOG with a value of 90,8%.

Methodology

The research methodology applied to the study of the evolution of the chosen European stock markets indexes relative to RTSOG is in line with the objective of the analysis. Thus, I chose to deploy the model introduced by the macro econometrician Christopher Sims in 1980 named Value Autoregressive Model (VAR) with the purpose of analyzing the dynamics and causal relations among a set of variables, a model often used in the analysis of stock markets.

Further I deployed the impulse response function in order to capture the response of the chosen variables to the impulse represented by RTSOG, followed by the variance decomposition function which represents how much of the evolution of the variance of the indexes can be explained by the evolution of RTSOG.

For the empirical analysis I used EViews 10 program and the data consists of daily observations (5 day week, Monday to Friday) for CAC Oil&Gas (FROG), STOXX Europe 600 Oil & Gas (STOXX Oil&Gas), BET-NG, European Renewable Energy Total Return (ERIX) and RTS Oil & Gas (RTSOG) indexes. In order to assure data uniformity, given the different national days among countries I used the price from the previous working day. The data source of BET-NG is Bucharest Stock Exchange and for the rest of the indexes the data source is the website Investing.com. Given that the price of RTSOG was expressed in USD the European Central Bank daily exchange rate was used to convert the price to EUR.

Table 1. Variable description

Variable	Description
CAC Oil&Gas (FROG)	Index composed of 16 companies from the oil and gas sector traded on the Paris Stock Exchange.
STOXX Europe 600 Oil & Gas (STOXX Oil&Gas)	STOXX Europe 600 Oil & Gas is a index for the European region for the oil and gas sector derived from STOXX Europe Total Market Index that is currently composed of 17 companies.
BET-NG	BET-NG is a sector index that reflects the price changes of all energy and related utilities sector companies with a maximum index weight of 30%, traded on BVB.
European Renewable Energy Total Return (ERIX)	An index that tracks European renewable energy companies' performance (eg: water, solar, wind, geothermal, biofuels and marine).
RTS Oil & Gas (RTSOG)	RTSOG is a sector index for oil and gas that reflects the price changes of top companies (currently 15 in number) traded at the Moscow Stock Exchange.

Source: (Authors' own work based on the information available on the Bucharest Stock Exchange and Investing.com).

For the analysis I chose two-time frames as follows:

- (a) February 2022 - April 2023, representing the overlapping period of the COVID-19 pandemic and the war in Ukraine, given the day when the war began and the date when World Health Organization (2023) declared the pandemic ended (5th May),
- (b) February 2022 – mid December 2024, representing the date since the war in Ukraine started based on UK Parliament (2024) published timeline.

Results obtained and discussions

The log-transformation was applied to all variables in order to normalize the data series. Based on the Augmented Dickey Fuller test (Table 2), for the *Null Hypothesis: Data series has a unit root* and a 5% significance level, applied on the logarithmical form of the data it resulted the need to apply the first difference on the logarithmic form of the data series. Also, I have verified the ADF result for the first difference in order to endure that the series do not have a unit root.

Table 2. Summarized results for the ADF test

Period analyzed	Variable \ ADF	Logarithmical form of data series	First difference of logarithmical form
Overlap February 2022 - April 2023	CAC Oil&Gas	38,13%	0%
	STOXX Oil&Gas	27,28%	0%
	BET-NG	25,36%	0%
	ERIX	6,73%	0%
	RTSOG	35,49%	0%
War February 2022 – mid December 2024	CAC Oil&Gas	30,21%	0%
	STOXX Oil&Gas	74,79%	0%
	BET-NG	81,58%	0%
	ERIX	91,16%	0%
	RTSOG	10,73%	0%

Source: (Authors' own work).

Based on the results obtained for the Lag Order Selection Criteria (Table 3), for both the overlap and war period, Schwarz information criterion and Hannan-Quinn information criterion indicated a zero-lag value, which is not adequate for the analysis, while LR (sequential modified LR test statistic) indicated a lag of eight for the overlap period, respectively seven for the war period. However, Akaike Information Criterion and Final Prediction Error indicated a lag of three, and given that there are two criterions that indicate the same number la lags, greater than zero, for lag selection for the VAR model, I chose to deploy the VAR number for a lag of three for both periods.

Table 3. Lag order selection criteria for VAR model

Overlap	War
VAR Lag Order Selection Criteria	VAR Lag Order Selection Criteria
Endogenous variables: DLOG_CAC_OIL_GAS DLOG_STOXX_OIL_GAS DLOG_BET_NG DLOG_ERIX DLOG_RTSOG	Endogenous variables: DLOG_CAC_OIL_GAS DLOG_STOXX_OIL_GAS DLOG_BET_NG DLOG_ERIX DLOG_RTSOG
Exogenous variables: C	Exogenous variables: C
Date: 12/11/24 Time: 20:03	Date: 12/19/24 Time: 20:40
Sample: 2/01/2022 4/28/2023	Sample: 2/01/2022 12/13/2024
Included observations: 312	Included observations: 737

Lag	LogL	LR	FPE	AIC	SC	HQ
0	4246.758	NA	1.07E-18	-27.19075	-27.13077*	-27.16678*
1	4277.39	60.0861	1.03E-18	-27.22686	-26.86695	-27.08302
2	4302.748	48.92848	1.03E-18	-27.22915	-26.56933	-26.96544
3	4340.285	71.2245	9.49e-19*	-27.30952*	-26.34978	-26.92594
4	4356.777	30.76298	1.00E-18	-27.25498	-25.99532	-26.75153
5	4366.399	17.64013	1.11E-18	-27.1564	-25.59682	-26.53308
6	4386.16	35.59524	1.15E-18	-27.12282	-25.26331	-26.37963
7	4413.645	48.62686	1.13E-18	-27.13875	-24.97932	-26.27569
8	4437.707	41.80082*	1.14E-18	-27.13274	-24.67339	-26.14981
9	4457.351	33.49536	1.18E-18	-27.0984	-24.33914	-25.99561
10	4469.71	20.67814	1.29E-18	-27.01737	-23.95819	-25.79471
11	4490.365	33.89459	1.33E-18	-26.98952	-23.63041	-25.64699
12	4505.937	25.0547	1.42E-18	-26.92908	-23.27006	-25.46668

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	9731.102	NA	2.37E-18	-26.39376	-26.36254*	-26.38172*
1	9772.657	82.43313	2.27E-18	-26.43869	-26.25134	-26.36644
2	9798.641	51.19114	2.26E-18	-26.44136	-26.09788	-26.3089
3	9834.362	69.89083	2.20e-18*	-26.47045*	-25.97085	-26.27779
4	9852.114	34.49245	2.24E-18	-26.45078	-25.79505	-26.19791
5	9864.993	24.85057	2.31E-18	-26.41789	-25.60604	-26.10481
6	9879.106	27.03849	2.38E-18	-26.38835	-25.42037	-26.01506
7	9900.564	40.81864*	2.41E-18	-26.37873	-25.25463	-25.94524
8	9916.596	30.28088	2.47E-18	-26.3544	-25.07417	-25.8607
9	9926.159	17.93249	2.57E-18	-26.31251	-24.87615	-25.7586
10	9945.159	35.37116	2.62E-18	-26.29623	-24.70374	-25.68211
11	9956.964	21.81477	2.71E-18	-26.26042	-24.51181	-25.58609
12	9969.401	22.81564	2.81E-18	-26.22633	-24.32159	-25.49179

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Source: (Authors' own work).

The stability of the model was checked by deploying the AR root graph which provides proof of stability for both periods, given that all the unit roots are within the unit circle, as it can be seen in the Figure 1 below.

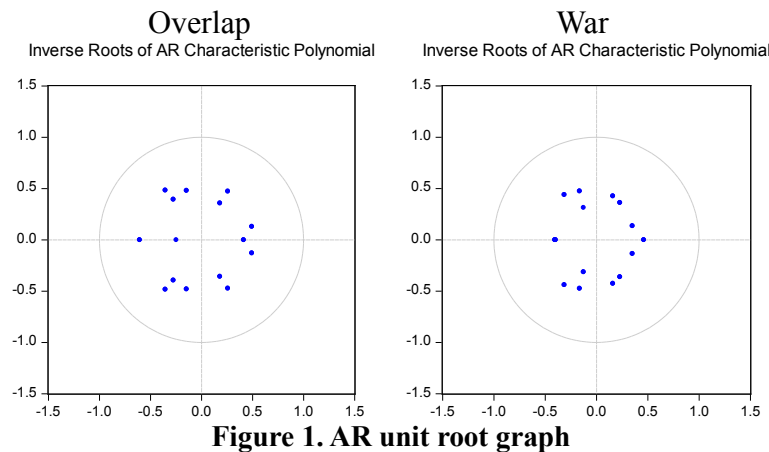


Figure 1. AR unit root graph

Source: (Authors' own work).

The impulse response function was deployed for 15 periods for the overlap period, respectively for 35 periods for the war period in order to better observe the monthly changes of the European indexes relative to the evolution of RTSOG.

The results provide proof of high volatility as a response to RSTOG evolution, especially for the overlap period and all indexes became more stable with the 10th period (both timeframes) which represents January 2023.

Also, when it comes to the first period representing February 2022 the month when the war started, it can be noticed that the stock market indexes that an immediate reaction isn't found present, although two set of sanction packages were applied to Russia for their actions according to the European Consilium (2024), but rather in the post-event period similar to the finding of

Boungou and Yatié (2022) and Ahmed et al. (2023) whom found proof of European stock market being sensitive to the war .

CAC Oil&Gas and STOXX Oil&Gas exhibited a delayed response and record a decrease the following month since the start of the war in Ukraine started. CAC Oil&Gas recorded its most significant decrease related to RTSOG during the fifth period (June 2022) which coincides with several sanctions applied to Russia including the sixth package of sanctions which included with limited exceptions a ban on imports of refined petroleum products and crude oil from Russia EC (2024), while for STOXX Oil&Gas a prolonged decrease is recorded between fifth and seventh period (July-August 2022) which as well coincides with several other sanctions applied to Russia that targeted the finance, energy, technology, dual-use goods, industry, transport and luxury goods EC (2024).

When it comes to BET_NG it can be noticed that from all indexes analyzed, during the second period (March 2022) it records the biggest decrease, matters which coincide with two other sanction packages applied to Russia regarding several aspects including bans on media outlets, SWIFT ban and a ban on transactions with the Russian Central Bank according to EC (2024) and which could also be explained by Romania's proximity to the war, similar to the findings of Kumaria et al. (2023). BET_NG presented a prolonged and significant decrease between fourth and sixth period (May-July 2022).

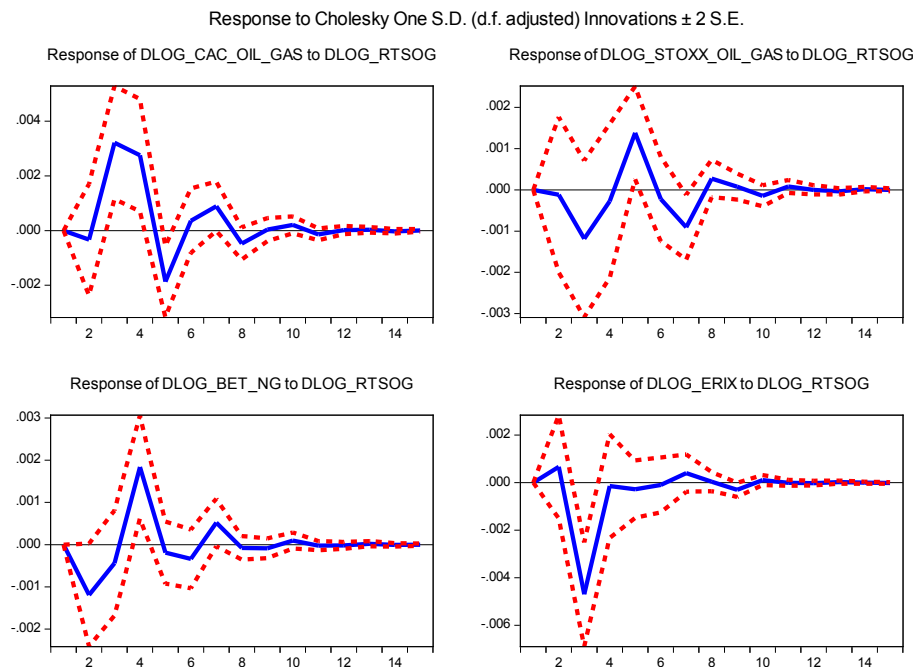


Figure 2. Impulse response to RTSOG during the overlap period

Source: (Authors' own work).

All three indexes, CAC Oil&Gas, Stoxx Oil&Gas and BET NG recorded several periods of high volatility however, starting to the eight-period representing September 2022 they became rather stable with less significant fluctuations and no visible fluctuations starting with the 10th period (January 2023).

From all the indexes analyzed, ERIX is the only one that has the most delayed response and it becomes rather stable starting with the fourth period representing May 2022 and constant, without any significant fluctuations, starting with the 10th period (January 2023), a finding which is expected given that green energy consumption represents an alternative to traditional energy

production and as well similar to the findings of Umar et al. (2022) and Hemrit and Benlagha (2021).

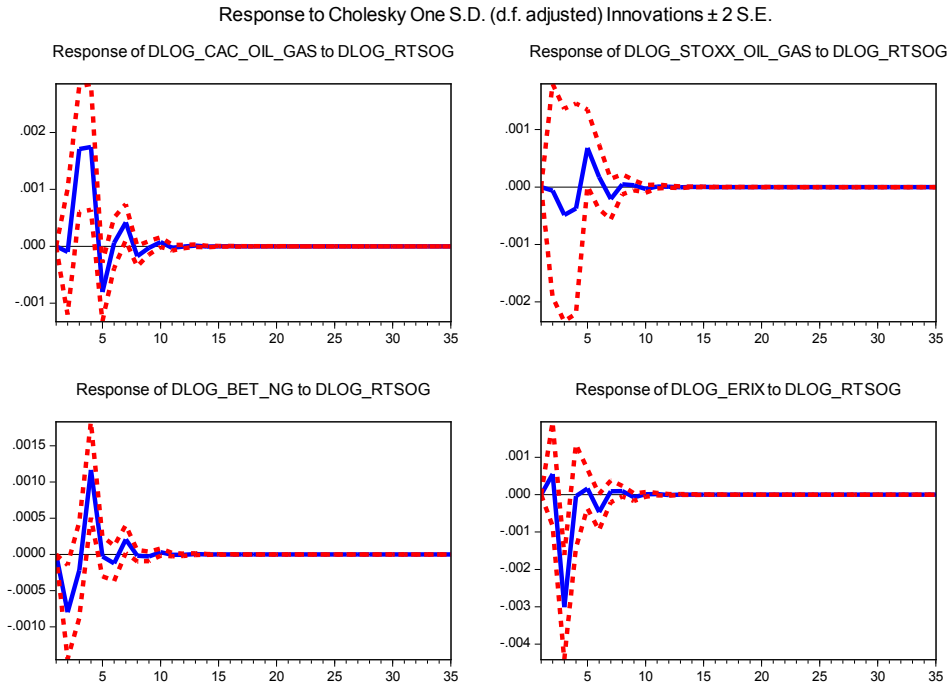


Figure 2. Impulse response to RTSOG during the war period

Source: (Authors' own work).

By comparison of the overlap with the war period, it can be noticed that a significant impact is found present during the period represented by the Covid-19 pandemic and war, a period defined by Paolo Gentiloni as double crisis in an interview for CNBC written by Amaro (2023), while after the economy had time to adapt and react to the crises, especially the one caused by the war in Ukraine and the change the procurement of gas from Russia to other countries as according to the report published by the Consilium (2024), it can be noticed that the effect of RTSOG is significantly diminished. This implies that natural gas is an important measurement for risk for the stock exchange market, particularly during the time frames analyzed, similar to the findings of Li et al. (2022), Chen et al. (2023) and Li et al. (2024).

The findings resulted from the impulse response function address partially both objectives, in the sense that volatility is found present in the European stock market indexes analyzed relative to RTSOG, and second a more significant reaction if found present during the overlap period for all indexes, however the exact dimension will be discussed further based on the variance decomposition.

Similar to the impulse response function, the variance decomposition was deployed for 15 periods for the overlap period, respectively for 35 periods for the war period in order to better observe the monthly changes of European indexes variance explained by the evolution of RTSOG.

As it can be seen from the variance decomposition summarized results, in Table 4 (representation of the quarterly average values for each period), during the overlap period the variance of the indexes that is explained by RTSOG is greater than the period representing the war, meaning that while the economy faced a double crisis the evolution of BET NG, CAC Oil&Gas, STOXX Oil&Gas and ERIX was more dependable on the evolution of RTSOG, which can be explained also by the fact that Ha et al. (2022) during the pandemic for the US market energy

market and Ullah et al. (2023) during the war for the Russian stock market, as response to several commodities including oil. Also, the results are emphasized by Adekoya et al. (2023) who find during the war a connectedness relationship with oil and Germany, France, Spain, Netherlands, United Kingdom, and European stock indexes, while Li et al. (2022) find that the European stock market fluctuations are better explained during the initial phase of Russia's invasion in 2022., corroborated as well with those of Li et al. (2022) and Li et al. (2024) the pandemic put a pressure on energy prices and the war exacerbated this pressure. Similar results were obtained for other world markets by who find proof of European stock market fluctuations to natural gas.

Table 4. Summarized results of Variance decomposition

Period	overlap period				war period			
	CAC OIL&GAS	STOXX OIL&GAS	BET NG	ERIX	CAC OIL&GAS	STOXX OIL&GAS	BET NG	ERIX
February-March 2022	0.0160	0.0024	0.5766	0.0607	0.0021	0.0003	0.3853	0.0427
2022 Q2	4.5984	0.7018	2.9960	5.5975	2.1700	0.0756	1.8885	2.5232
2022 Q3	6.0341	1.3264	4.0663	5.6068	2.8078	0.1395	2.4696	2.5831
2022 Q4	6.1462	1.4384	4.1448	5.6421	2.8412	0.1422	2.4881	2.5866
2023 Q1	6.1533	1.4424	4.1478	5.6431	2.8422	0.1423	2.4885	2.5866
2023 Q2*	6.1535	1.4427	4.1479	5.6432	2.8422	0.1423	2.4885	2.5866
2023 Q3					2.8422	0.1423	2.4885	2.5866
2023 Q4					2.8422	0.1423	2.4885	2.5866
2024 Q1					2.8422	0.1423	2.4885	2.5866
2024 Q2					2.8422	0.1423	2.4885	2.5866
2024 Q3					2.8422	0.1423	2.4885	2.5866
2024 Q4					2.8422	0.1423	2.4885	2.5866

*the average value of 2023 Q2 for the overlap period reflect only on the values for April.

All values are percentage values.

Source: (Authors' own work).

The variance decomposition of the European stock market indexes to RTSOG was explained, on average, by less than 1% in February-March 2022 and starting with 2022 Q2 it recorded a significant increase for both time frames, reaching its highest values towards the end for the overlap period, while for the war period it recorded constant values starting with 2023 Q1. This evolution can be explained by the fact that during the overlap period surprises the remaining pressure on the energy sector as a result of the pandemic and the short-term response of the indexes to the war, response which is more quantifiable in variance explained. Given that during the war period the variance of all European stock market indexes analyzed explained by RTSOG became constants, it can be assumed that the relationship among these indexes reached an equilibrium state and can be justified also by the significant reduction in gas imports from Russia in Europe in 2023 by approximately 32 percentage points compared to 2021, according to the report published by the European Council (2024).

Also, given the constancy of the variance of the analyzed indexes relative to RTSOG, it can be assumed that a certain connectedness will remain between European and Russian stock markets will remain in the gas and oil sector, with more expected decoupling over time as Europe's continues to diminish even more its dependency to Russian energy.

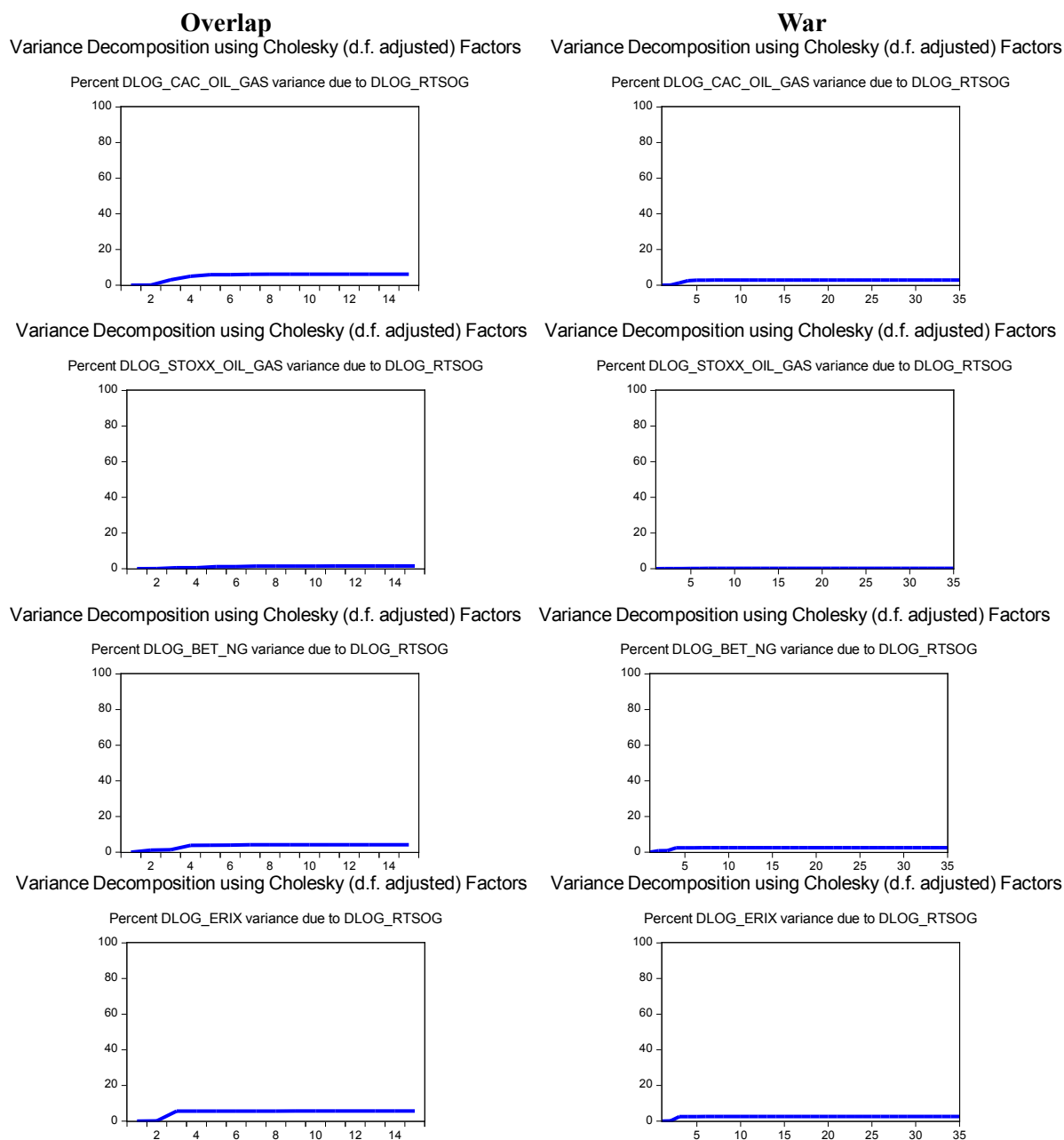


Figure 3. Variance decomposition to RTSOG

Source: (Authors' own work).

Although, according to the impulse response function to RTSOG the greatest volatility is recorded, in general, up to the eight period, as it can be seen from Figure 3 above a higher level of variance explained by RTSOG is explained towards the end of the two frames analyzed and it became stable, in general, starting with the 10th period, similar to the graphic representation of the impulse response function (Figure 2).

For the overlap period the results are as follows:

- 11th period (December 2022) for CAC Oil&Gas with a level of 6,15%,
- 11th period (December 2022) for STOXX Oil&Gas with a level of 1,44%,

- c) 10th period (November 2022) for BET_NG with a level of 4,14%,
- d) 9th period (October 2022) for ERIX with a level of 5,64%.

For the war period the results are as follows:

- e) 13th period (February 2023) for CAC Oil&Gas with a level of 2,8422%,
- f) 10th period (November 2022) for STOXX Oil&Gas with a level of 0,1422%,
- g) 10th period (November 2022) for BET_NG with a level of 2,4884%,
- h) 9th period (October 2022) for ERIX with a level of 2,5865%.

Taking a closer look at each index, during both time frames France stock market index for oil and gas records the greatest value of variance explained by RTSOG, followed by the renewable energy index sector (ERIX) ERIX and Romanian stock market index for oil and gas, which can be explained by the cumulated dependance of France and Romania of approximately 38% on Russian energy in 2020 according to the European Commission (2022), respectively by their renewable energy consumption in 2020 of 19,1% for France, respectively 24,5% for Romania according to Eurostat (2022) and as well the countries proximity to the war zone, especially Romania's. Similar findings were confirmed, during the war, for European countries, including France and Romania by Yousaf et al. (2022), Kumaria et al. (2023), and separately for European countries, including France by Adekoya et al. (2023). Although, I expected to find a higher level of dependency for Romanian stock market, than France's with Russia stock market in the oil and gas sector, given its borders with the war zone, the lower level of variance could be explained by BET_NG company compenence, which according to the Romanian Stock Exchange information, 31,89% companies shares in the stock index are owned, on average by 61%, by foreign capital (Austria, Netherlands' and Cyprus).

When examining the European stock market, represented by STOXX Oil&Gas it can be seen from the variance decomposition that its values relative to RTSOG are under 1,5% for the overlap period, respectively 0,15% during the war period the lowest and less significant among all indexes analyzed, and even though this index is a sub-index of Eurostoxx 50, for which Manelli et al. (2024) found during the war period, a connectedness relationship with TTF Dutch, the fact that the imports of natural gas from Russia dropped in 2023 to 9,31% from 20,67% in 2022 according to Eurostat (2025), could explain the decoupling of EU sector market for oil and gas, as a whole from the Russian one. This finding, implies that a better understanding of connectedness among different regions will be obtain by analyzing at country level, index compenence, and respectively dependence of that said country to energy sources by importing country.

Overall, it can be noticed that during the overlap period compared to the war period, the amount of variance of all indexes explained by RTSOG is a little over double in value which could be explained by the fact that during the overlap period the economy was still recovering from the COVID-19 and faced a new shock generated by the war in Ukraine.

The results obtained from the variance decomposition, address the objectives of the paper and provide proof of connectedness of the European stock market with RTSOG, an oil and gas index, and corroborated with the proof of extensive worldwide relationship of energy commodities with stock markets during both the COVID-19 pandemic and war, emphasize on the importance of oil and gas as risk transmitters for the stock market, which for Europe in particular can be justified by its economic ties with Russia regarding energy, but also by its proximity to the war. These implications are important and should be taken into consideration by investors and by policy makers regarding fiscal, monetary decisions and as well energy sustainability.

Conclusions

The results of the impulse response function provide proof of high volatility as a response to RSTOG evolution, especially during the overlap period, results reinforced also by the variance decomposition results as to a lower level of variance is recorded during the war period compared to the overlap one, a period defined by Paolo Gentiloni as double crisis in an interview for CNBC written by Amaro (2023).

All indexes analyzed present a delayed response to the war, however they present a post-event reaction firstly starting with March 2022, similar to the finding of Ahmed et al. (2023) and Yousaf et al. (2022), followed by several fluctuation till 10th (January 2023) period for both time frames when all the indexes become rather stable.

The results obtained from the variance decomposition, address the objectives of the paper and provide proof of connectedness of the European stock market with RTSOG, an oil and gas index, with a more pronounced impact for the overlap period, and corroborated with the proof of extensive worldwide relationship of energy commodities with stock markets during both the COVID-19 pandemic and war (European Commission (2022), Ha et al. (2022), Li et al. (2022), Ullah et al. (2023), Adekoya et al. (2023), European Council (2024) and Li et al. (2024)), emphasize on the importance of oil and gas as risk transmitters for the stock market, which for Europe in particular can be justified by its economic ties with Russia regarding energy, but also by its proximity to the war.

Although the results obtained provide proof contagion from RTSOG to European stock market indexes analyzed from the energy sector further analysis is needed in order to determine in more detail how much catastrophic, events such as pandemics and war, have an effect on the economy, however investors need to take into consideration this kind of events, similar to the findings of Gaio et al. (2022) and Izzeldin et al. (2023).

Commodities that hold a significant level of importance, such as oil and natural gas, for daily life, as well companies, given their main contribution in the production process of goods and service offering, and governments, and also the dependency to a certain country as providers for it, should be taken into consideration by policy makers as to it can have implications on the supply and demand side which imply a shift in price, employment, development of that market and also political implication as alliances change.

Policy makers should direct their attention towards commodities of strict necessities to economic development and take measures regarding fiscal and monetary regime in order to increase investors and population confidence. As well, actions regarding the continuance of decreasing the dependance on Russian energy should continue and attention should be turned to long-term energy sustainability, which could come from a growth in renewable energy production and consumption. The limitation of this current study might derive from the fact that it analyzes the impact of the war in Ukraine, through a sector index traded at the Moscow Stock Exchange, at European Union level and it does not differentiate among countries that are predominantly importing or exporting energy and their particular dependence on Russian energy, this differentiation among EU countries could lead to different results in regard to the correlation with RTSOG. Also, how sanctions applied to Russia did in turn affect the energy supply could have significant implications for the analysis of contagion among stock markets.

The current analysis does not reflect the whole picture, just a part of it, so further analysis is needed in order to capture the perspective at country level and as well how price fluctuation from the energy sector affect other economic variables, such as inflation. Also, a comparison to recent

crisis, such as the Global Financial Crisis could provide insight of a certain patterns on how the energy sector affects economies and the contagion level among them, even though their source is different, the GFC had its roots in the financial sector, the COVID-19 pandemic a sanitary one and the war in Ukraine in the energy sector itself.

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