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iTDAF IETI Transactions on
Data Analysis and Forecasting

iTDAF | eISSN: 2959-0442 | Vol. 1 No. 3 (2023) | OPEN ACCESS

https://doi.org/10.3991/itdaf.v1i3.43419

PAPER

Assessing the Impact of Energy-related Sanctions on Russia and Their Consequences for Europe

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ABSTRACT

This research paper investigates the impact of energy-related sanctions on the European energy sector in light of the Russian-Ukrainian military conflict. The study analyzes the S600ENP index returns using data from June 2018 to July 2023, divided into three distinct periods: pre-invasion, during sanctions, and post-sanctions. Descriptive statistics and distribution analysis reveal distinct market behaviors and volatility clustering during each period. The analysis of variance (ANOVA) test does not show significant differences in mean returns across the periods, indicating relatively consistent index performance. The stationarity test suggests non-stationarity in the index returns. The ARCH model demonstrates the persistence of volatility shocks influenced by geopolitical events like Russian sanctions. The findings underscore the importance of understanding market dynamics during geopolitical uncertainty and its implications for the European energy sector. Though the representation of the S600ENP index limits the research, future studies can explore alternative datasets and periods for more comprehensive insights.

KEYWORDS

energy, consequences for EU and eurozone, sanctions on Russia

1 INTRODUCTION

The topic's relevance is limited, not only at a public level, seeking to evaluate the efficiency of sanctions. It could also interest households and businesses affected by sanctions through different channels. Insights into this topic are relevant at national and international levels. Sanctions against Russia are internationally utilized tools applied to this country to address political, economic, and diplomatic relationships.

In 2014 the EU and the US took decisions related to various sanctions against Russia. The first step of sanctions started in March 2014 and was quite soft. Later, more sanctions appeared, and they became stricter. The main idea of sanctions was to make Russia stop the war against Ukraine and stop international law violations.

Savičius, L., Vasiliauskaite, D. (2023). Assessing the Impact of Energy-related Sanctions on Russia and Their Consequences for Europe. *IETI Transactions on Data Analysis and Forecasting (iTDAF)*, 1(3), pp. 32–45. https://doi.org/10.3991/itdaf.v1i3.43419

Article submitted 2023-07-24. Revision uploaded 2023-08-29. Final acceptance 2023-08-30.

The newest research shows that these sanctions significantly negatively impacted Europe's economy, especially in countries with tight international trading relationships with Russia.

Sanctions that isolated Russia caused a big shock to the global economy, which was still fighting with COVID-19 consequences. Sanctions destroyed global supply chains, increased commodity prices, and had a significant impact on the increase in global inflation and slower economic growth.

Russia tries to lower the effect of sanctions by increasing exports by 50 percent to countries that do not belong to the sanctions coalition, for example, Brazil, China, India, and Turkey.

The policy of sanctions can affect economics and the EU's internal solidarity. Different countries can have different views on sanctions on Russia, and these differences can increase tension and disagreements between EU members. It is essential to pay attention to the fact that the impact of sanctions can vary, and it isn't easy to forecast all the consequences.

The impact of sanctions can be dynamic and depend on political and economic factors, which can impact the application of sanctions and reactions in Russia. This topic must be analyzed continuously because of sanctions' dynamic effect, and the impact results must be monitored. The other essential aspect is Russia's economy, which lately faces many challenges. The budget deficit has reached a record level, and the country faces challenges in attracting funds to its economy.

The economic sanctions on Russia and their impact on different participants in the economic system have been analyzed by various researchers. It is not a new topic, but its relevance has become very important because we can see a significant impact spreading lately. Researchers are actively analyzing this topic ([1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]).

It is also important to point out that this topic is not only relevant among scientists. This topic is very relevant among the most significant financial institutions. The IMF, BIS, Citibank, and the World Bank do research in this area.

The Russian-Ukrainian military conflict has significant implications for the European Union and the Eurozone, particularly in the energy sector. International sanctions were imposed on various forms of energy, including crude oil, coal, gas, and other related resources.

This paper aims to investigate the impact of these political events on the European energy sector by analyzing the stock returns of the S600ENP index.

To gain insights into the effects of the sanctions, the authors examine three distinct periods, chosen based on hallmark events within each period, using rigorous statistical tools.

The present study contributes to the field by investigating the impact of the Russian-Ukrainian conflict and international sanctions on the European energy sector. The paper analyzes the S600ENP index returns and employs statistical tools. The paper provides valuable insights into market behaviors and volatility clustering during distinct periods marked by key geopolitical events. The study collectively enhances our understanding of the consequences of energy-related sanctions on the European Union.

2 THE IMPACT OF ENERGY-RELATED AND BROAD SANCTIONS

The impact of energy-related sanctions on Russia and their potential consequences for the EU and Eurozone can be analyzed in different aspects. Firstly, we can consider the impact on Russia and then the impact on the EU and Eurozone.

Energy-related sanctions imposed on Russia have significant economic consequences, mainly because energy exports are crucial to the country's fiscal revenue. Many of these sanctions were introduced in response to Russia's actions, such as the annexation of Crimea and its involvement in the conflict in eastern Ukraine. Key consequences for Russia include:

1. **Energy revenue loss**: Russia heavily relies on oil and gas exports, especially to Europe. Sanctions on energy trade can lead to reduced export volumes, which directly impact Russia's revenue and economic growth.
2. **Investment and capital flight**: Sanctions may discourage foreign investment in Russia, leading to capital flight and economic instability.
3. **Currency depreciation**: Sanctions can weaken the Russian ruble, causing inflation and making imports more expensive for Russian citizens and businesses.
4. **Stifling technological advancements**: Energy sanctions may impede Russia's access to advanced technologies and equipment needed for exploration and production in its energy sector.

On the other hand, consequences for the EU and Eurozone can be analyzed. Energy-related sanctions on Russia can also have significant implications for the European Union and the Eurozone, given their strong energy trade and economic ties with Russia.

1. **Energy supply disruptions**: The EU heavily depends on Russia for its energy supplies, especially natural gas. Sanctions could potentially disrupt energy flows and create supply shortages in the EU, leading to higher energy prices.
2. **Economic impact**: Russia is an important trading partner for many EU countries. Reduced trade with Russia due to sanctions could negatively affect European businesses and industries, leading to job losses and economic slowdowns.
3. **Energy diversification**: Sanctions could encourage the EU to seek alternative energy suppliers and reduce its reliance on Russian energy exports. This could increase investments in renewable energy sources and diversification efforts.
4. **Geopolitical tensions**: Energy-related sanctions may escalate geopolitical tensions between the EU and Russia, potentially affecting the region's diplomatic relations and security dynamics.

It's important to note that the consequences of energy-related sanctions are complex and can vary based on the specific nature and extent of the sanctions and the affected parties' responses.

The literature extensively explores the consequences of the Russia-Ukraine conflict on global energy markets, capital markets, and economies. Researchers have analyzed various aspects of the conflict's impact, offering valuable insights. Saad (2023) examined US natural gas futures prices and observed risk-averse behavior during the conflict, leading to significant positive reactions in cumulative abnormal returns (CARs) during pre- and post-event periods [15]. Nerlinger and Utz (2022) focused on energy firms' profitability, particularly in North American firms, and found positive cumulative average abnormal returns around the event date, indicating some sector resilience and positive investor expectations [16]. Chen et al. (2023) employed the GTAP model to assess energy sanctions' effects, revealing negative macroeconomic consequences for both the EU and Russia, including increased inflation rates [17]. Kalogiannidis et al. (2022) investigated the economic impact on EU fuel markets, projecting severe disruptions, price spikes, and implications for European economies [18].

Furthermore, studies by Boungou and Yati (2022), Tajaddini and Gholipour (2023), Ahmed et al. (2022), and Tosun and Eshraghi (2022) found significant negative effects on stock market returns in various countries due to the conflict [19], [20], [21], [22]. Abbassi et al. (2023) and Boubaker et al. (2023) examined the negative impact on financial entities, with Abbassi et al. (2023) focusing on the abnormal returns of G7 countries' firms and Boubaker et al. (2023) analyzing the market returns of banks [23], [24].

The literature also covers the volatility of commodity markets during the Russia–Ukraine war, with studies by Wang et al. (2022), Fang and Shao (2022), and Alam et al. (2023) suggesting a significant increase in commodity market volatility following the conflict [25], [26], [27].

Moreover, researchers explored the economic implications of the war. Studies by Liadze et al. (2022), Maurya et al. (2023), Boubaker et al. (2022), Mottaleb et al. (2022), Hellegers (2022), Arndt et al. (2023), Chortane and Pandey (2022), Qureshi et al. (2022), Bossman et al. (2023), and Desalegn et al. (2022) highlight negative impacts on GDP, inflation, currencies, and economic growth in various regions and countries affected by the conflict [28], [29] [24], [30], [31], [32], [33], [34], [35].

In conclusion, the literature review comprehensively explains the multifaceted impact of the Russia-Ukraine war on energy, capital markets, and global economies. The findings underscore geopolitical events' challenges and economic repercussions, emphasizing the need for flexible policies and sustainable energy strategies to mitigate adverse effects.

3 METHODOLOGY

3.1 Data

The research involved the analysis of daily price data from the S600ENP index, sourced from Bloomberg's database. The index comprises companies categorized into 20 supersectors, 45 sectors, and 173 subsectors using the ICB Industry Classification Benchmark. The data sample spans from June 28, 2018, to July 17, 2023, encompassing a total of 1,299 observations. The selection of the 2018 starting date was purposeful, aimed at including a sufficient pre-invasion period to serve as a control group for comparison.

The dataset is divided into three distinct subgroups for analysis. Period No. 1 spans from June 28, 2018, the beginning of the sample, up to the day immediately preceding the start of the invasion. Period No. 2 covers the period from February 24, 2022, the day of the invasion, until December 31, 2022, marking the conclusion of a significant sanctioning event cluster, including a notable sanctioning packet that enforced a price cap on Russian oil and other oil-based products. Lastly, Period No. 3 encompasses the period from January 1, 2023, to July 17, 2023, representing the latter part of the sample until its conclusion. These three subgroups enable a comprehensive analysis of the impact of events and sanctions on the dataset, providing valuable insights into the energy sector's performance during distinct periods.

3.2 Descriptive statistics

Descriptive statistics were calculated to summarize the basic characteristics of the S600ENP index returns for each of the three sample periods. Table 2 presents the descriptive statistics for Period No. 1, which spans from June 28, 2018, to the day immediately preceding the start of the invasion. Table 3 displays the descriptive statistics for Period No. 2, covering the period from February 24, 2022, the day of the invasion, until December 31, 2022. Lastly, Table 4 provides the descriptive statistics for Period No. 3, encompassing the period from January 1, 2023, to July 17, 2023.

The descriptive statistics for each period include the mean daily return, standard deviation, skewness, and kurtosis values. These metrics offer insights into the return distributions' central tendency, dispersion, and shape during distinct periods. The sample sizes for each period are also reported.

The descriptive statistics for each period are summarized in Tables 1 to 3, which can be found in the Results section for reference.

3.3 Distribution analysis

To assess the distributional characteristics of the S600ENP index returns for each sample period, a distribution analysis was conducted. Figures 1, 2, and 3 present the normal probability plot of the index returns of the three sample periods.

The corresponding normal probability plots for these periods are available in the Results section.

3.4 Mean comparison

The comparison of means aims to examine whether significant differences exist in the mean returns of the S600ENP index across the three sample periods. An analysis of variance (ANOVA) test was conducted to assess the significance of these differences.

The hypothesis testing for the mean comparison is formulated as follows:

- **Null hypothesis (H0)**: The mean returns of the S600ENP index are not significantly different across the three sample periods.
- **Alternative hypothesis (HA)**: The mean returns of the S600ENP index are significantly different across the three sample periods.

A significance level of 0.05 (or 95%) was chosen for the ANOVA test.

3.5 Stationarity test

The Augmented Dickey-Fuller (ADF) test was conducted to investigate the stationarity of the S600ENP index returns for the entire sample period, spanning from June 28, 2018, to July 17, 2023. The ADF test was performed without the inclusion of a constant term (no intercept), assuming a "no drift" model. The results of the ADF test indicate that the S600ENP index returns exhibit a unit root process, suggesting non-stationarity throughout the entire sample period.

3.6 Volatility analysis

This section focuses on investigating the presence of volatility clustering in the S600ENP index returns and its relationship to the impact of Russian sanctions on the energy sector. The autoregressive conditional heteroskedasticity (ARCH) test is employed to assess whether volatility shocks, such as those induced by the implementation of Russian sanctions, exhibit a prolonged effect on the S600ENP index returns.

This study applies the ARCH test to the S600ENP index returns during the three distinct sample periods. By examining volatility clustering across these periods, we aim to gain insights into the persistence of volatility and the prolonged impact of significant events, including the implementation of Russian sanctions.

4 RESULTS AND DISCUSSION

Following the approach of Nerlinger (2022), the first significant event date selected for empirical analysis is February 24, 2022, as this date marks the invasion of Ukraine by Russian armed forces. This event is regarded as an unforeseen exogenous shock in the context of stock market analysis. The second major event date is December 31, 2022, marking the conclusion of a significant period of sanctions. On the other hand, geopolitical events such as sanctions are generally considered planned events for the stock market, as information about the sanctions is available to the public beforehand. Table [1] comprehensively summarizes major sanctions imposed on the Russian Federation during this period.

Table 1. Sanctioning events

Year	Date	Countries Involved	Sanction
2022	March 8	US	Bans imports of Russian oil, gas, and other energy.
2022	March 15	EU	Bans supplies of energy-related equipment, technology, and related services to Russia; Bans new investments in the Russian energy sector.
2022	April 5	EU	Proposes import ban on Russian coal.
2022	June 3	EU	Adopts a sixth package of sanctions. The measures include prohibiting the import of crude oil and certain petroleum products from Russia into the EU.
2022	Oct 6	EU	The European Council proposes banning export of coal, including coking coal.
2022	Nov 4	G7; AU	G7 members and Australia have decided to establish a fixed—rather than a floating—price when they finalize a price cap on Russian oil later this month.
2022	Dec 2	G7; AU	Agrees to cap the price of Russian seaborne crude oil at $60 per barrel.
2022	Dec 3	EU	Sets a $60-per-barrel price cap for crude oil, petroleum oils and oils obtained from bituminous minerals originating from Russia.
2023	Jan 7	EU	Extends sanctions targeting trade, finance, technology and other industries in Russia by six months, until July 31, 2023. The sanctions include a ban on the import of seaborne crude oil from Russia.
2023	Feb 4	G7	Agrees on two price caps for petroleum products originating from Russia. The cap was set at $100 per barrel for oil products that trade above the price of crude oil and at $45 per barrel for products that trade at a discount to crude oil.
2023	Feb 5	EU	Imposes a ban on purchases of Russian gasoline, diesel fuel and other refined petroleum products.

4.1 Descriptive statistics

Period No. 1 (June 2018–February 2022). During period no. 1, the S600ENP index exhibited relatively stable returns, with an average daily return of 0.0014%. The standard deviation of 0.01826 indicated moderate variability, reflecting some fluctuations. However, the high kurtosis value of 18.9838 suggested a distribution with heavy tails and significant peakedness, implying a higher likelihood of extreme values. The slightly left-skewed distribution (skewness = –0.4967) indicated a tendency for negative returns to substantially impact the market during this period. Overall, period no. 1 demonstrated market behavior characterized by stability, high kurtosis, and slight left-skewness (Table 2).

Table 2. Period no. 1

Mean	0.000014
Standard Deviation	0.01826
Kurtosis	18.9838
Skewness	–0.4967
Sample size	941

Period No. 2 (February 2022–December 2022). In period no. 2, the S600ENP index displayed significant changes in its returns. The average daily return increased to 0.0815%, indicating higher returns than period no. 1. The standard deviation remained stable at 0.01828, implying consistent, moderate variability in the index returns. Notably, the kurtosis value decreased to 0.8571, suggesting a more balanced distribution with lighter tails than period no. 1. The skewness value of –0.3428 indicated a slightly left-skewed distribution, though with a less pronounced effect. The observed characteristics of period no. 2 revealed a distinct market behavior characterized by increased returns, reduced kurtosis, and a slight left-skewed distribution compared to period no. 1 (Table 3).

Table 3. Period no. 2

Mean	0.000815
Standard Deviation	0.01828
Kurtosis	0.8571
Skewness	–0.3428
Sample size	219

Period No. 3 (January 2023–July 2023). During period no. 3, the S600ENP index returns exhibited a negative trend, with an average daily return of –0.0292%. The standard deviation decreased to 0.01418, indicating lower variability in the index returns compared to the previous periods. The kurtosis value of 3.6941 suggested a distribution closer to a normal distribution, showing reduced peakness compared to period no. 1 but still exhibiting some degree of non-normality. The negative skewness value of –0.9707 indicated a left-skewed distribution with a longer tail on the left side. These descriptive statistics for period no. 3 revealed distinct market behavior characterized by negative returns, lower variability, and a left-skewed distribution compared to both periods no. 1 and 2 (Table 4).

Table 4. Period no. 3

Mean	–0.000292
Standard Deviation	0.01418
Kurtosis	3.6941
Skewness	–0.9707
Sample size	139

4.2 Distribution analysis

In Figure 1, we observe that on the left side of the plot, the data points deviate significantly below the QQ line when at -3 normal theoretical quantiles. Conversely, on the right side, approximately over the three normal theoretical quantiles, the data points diverge upward from the QQ line. This indicates that during period no. 1 (June 2018–February 2022), the return distribution exhibits heavier tails and an increased likelihood of extreme values, evident by the downward deviation of points on the left and the upward deviation on the right.

Moving to Figure 2, we can see a relatively neat alignment of data points along the QQ line, with only a slight deviation on the left side around the –3 mark on the x-axis. This suggests that during period no. 2 (February 2022–December 2022), the return distribution approaches a more normal-like shape, displaying a closer adherence to the theoretical quantiles with a notable decrease in the heaviness of the tails compared to period no. 1.

Figure 3 presents a QQ plot with data points almost evenly distributed along the middle line, indicating that during period no. 3 (January 2023–July 2023), the return distribution closely follows a normal distribution in the central region. However, on the left side of the plot, data points begin to diverge downward from the QQ line, indicating a left-skewed distribution with a relatively longer tail on the left. On the right side, while there is a slight upward divergence from the line, the distribution remains quite close to the theoretical quantiles. This implies that during this period, the return distribution shows a reduced heaviness in the tails compared to period no. 1, with a slight left-skewed tendency that might be indicative of specific market conditions.

Together, the QQ plots verify the findings from the descriptive statistics, reaffirming the distinct distributional characteristics observed in the S600ENP index returns across the three sample periods.

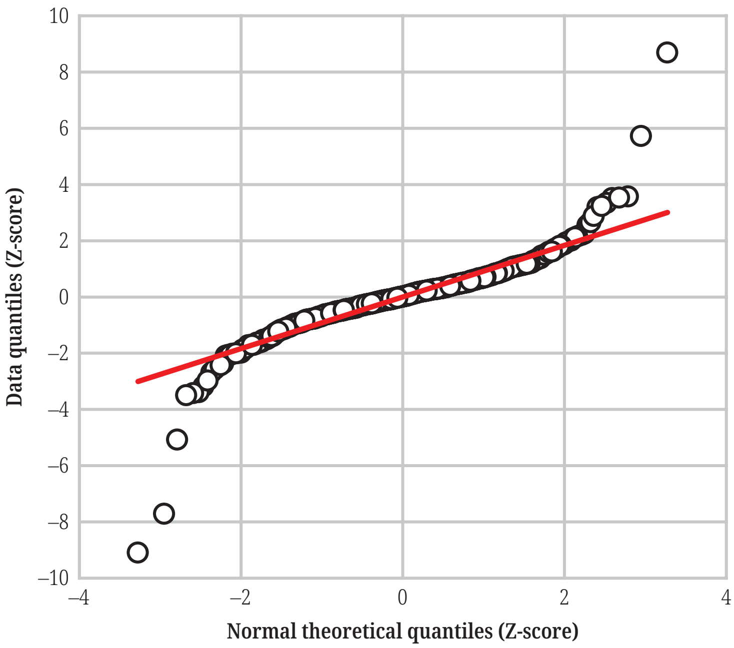

Fig. 1. Normal probability plot of index returns for sample period no. 1

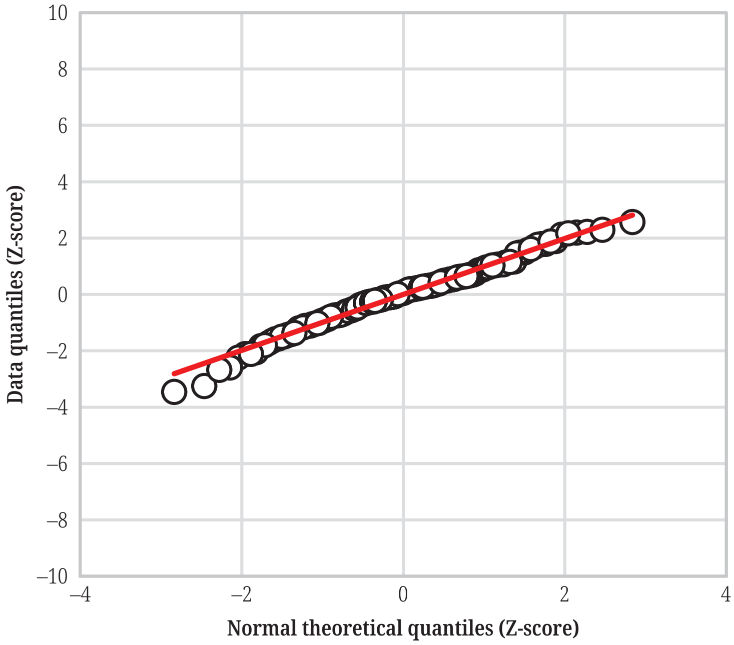

Fig. 2. Normal probability plot of index returns for sample period no. 2

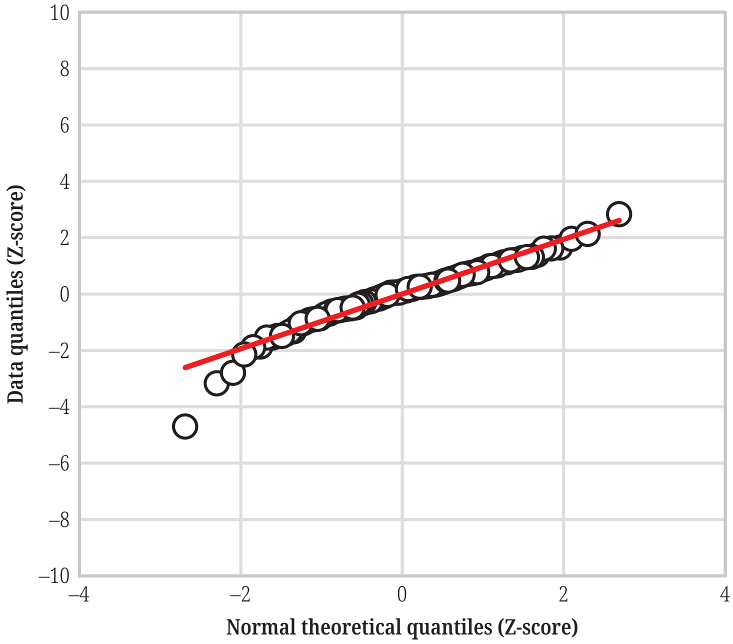

Fig. 3. Normal probability plot of index returns for sample period no. 3

4.3 Mean comparison

The F-statistic of 0.218972726 is smaller than the critical F-value of 3.002667657, and the corresponding P-value of 0.803373344 is greater than the significance level of 0.05. Therefore, we fail to reject the null hypothesis (H0), which states that the mean returns of the S600ENP index are not significantly different across the three sample periods.

In summary, the ANOVA test does not show a statistically significant difference in mean returns between the periods, suggesting that the S600ENP index's average performance remains relatively consistent throughout the different timeframes analyzed.

4.4 Stationarity test

The Augmented Dickey-Fuller (ADF) test results indicated that the S600ENP index returns for the entire sample period (June 28, 2018, to July 17, 2023) exhibit non-stationarity. The highly negative t-statistic (–34.7664) and the coefficient close to –1 provide robust evidence against the null hypothesis of a unit root process. This indicates that the index returns follow a random walk behavior without drift, implying that the mean and variance of the returns are not constant over time.

Non-stationary time series data often exhibit persistent trends and are influenced by past observations, leading to spurious regression results and unreliable statistical inferences.

To address the non-stationarity in the index returns, further analyses were conducted using the autoregressive conditional heteroskedasticity (ARCH) model, which allows for modeling the volatility clustering observed in financial time series data.

4.5 Volatility analysis

The ARCH test results were examined for each sample period to assess the persistence of volatility and its potential impact on the S600ENP index returns.

The ARCH (alpha) value of 0.386856203 for Period 1 suggests moderate persistence in the volatility of the S600ENP index returns. The F-statistic of 9.3839 with a corresponding p-value of 0.0023 indicates that the ARCH effect is statistically significant during this period (Table 5). Volatility clustering is present, implying that periods of high volatility tend to cluster together.

Table 5. ARCH test results for period 1

F-stat	9.384	T-stat	3.0633	Chi-sq stat	9.3108
p-value	0.00225	p-value	0.00225	p-value	0.00228

For period 2, the ARCH (alpha) value of 0.9500 indicates a higher degree of persistence in volatility compared to period 1. The significantly larger F-statistic of 113.4350 with an extremely small p-value of 4.3921E-25 confirms that the ARCH effect is highly significant during this period (Table 6). Volatility clustering is pronounced, suggesting that events impacting volatility have a prolonged impact on the S600ENP index returns.

Table 6. ARCH test results for period 2

F-stat	113.4350016	T-stat	10.6505869	Chi-sq stat	101.412737
p-value	4.3921E-25	p-value	4.3921E-25	p-value	7.4682E-24

In period 3, the ARCH (alpha) value of 0.9988 suggests a high persistence in volatility. The F-statistic of 11.0074 with a p-value of 0.0009 indicates that the ARCH effect is statistically significant during this period, although to a lesser extent than in period 2 (Table 7). Volatility clustering is still present, indicating a tendency for volatility shocks to linger in the S600ENP index returns.

Table 7. ARCH test results for period 3

F-stat	11.007	T-stat	3.318	Chi-sq stat	10.903
p-value	0.00094	p-value	0.00094	p-value	0.00096

The results from the ARCH test (Table 7) provide evidence of volatility clustering across all three sample periods. The increasing alpha values from period 1 to period 3 suggest a trend of more remarkable persistence in volatility over time, potentially influenced by geopolitical events, including Russian sanctions and other market drivers. These findings support the notion that periods of high volatility in the energy market tend to be followed by other periods with similar volatility levels, indicating the presence of clustered volatility shocks.

5 CONCLUSION AND LIMITATIONS

Overall, the results indicate notable changes in the S600ENP index returns during different sample periods, reflecting the impact of significant events, such as sanctions on Russia, regarding the energy sector's performance. Descriptive statistics revealed distinct market behaviors in each period. Period no. 1 showed relatively stable returns with a high kurtosis value, suggesting a distribution with heavy tails and significant peakedness. In period no. 2, there was an increase in returns, reduced kurtosis, and a closer adherence to a normal distribution. Period no. 3 demonstrated negative returns, reduced variability, and a left-skewed distribution.

The distribution analysis using QQ plots supported these findings, visually confirming the distinct characteristics of the return distributions in each period. QQ plots for period no. 1 displayed heavier tails, while plots for period no. 2 and no. 3 showed closer adherence to normal distributions, albeit with slight deviations.

The ANOVA test did not show a statistically significant difference in mean returns across the three periods, indicating that the average performance of the S600ENP index remained relatively consistent throughout the analyzed timeframes.

The stationarity test using the ADF test revealed that the index returns exhibit non-stationarity. The results indicated a random walk behavior without drift, implying that the mean and variance of returns were not constant over time. To address this, further analyses were conducted using the ARCH model to model volatility clustering.

The ARCH test analysis showed evidence of volatility clustering in all three sample periods. As alpha values increased from periods 1 to 3, the persistence in volatility also grew, indicating that periods of high volatility tend to be followed by other periods with similar volatility levels. These results suggest that significant events, including Russian sanctions, may contribute to the clustering of volatility shocks in the energy sector.

In conclusion, the analysis highlights the impact of the aforementioned geopolitical events. The S600ENP index returns exhibited distinct market behaviors and volatility clustering during different periods, providing valuable insights into the consequences of energy-related sanctions on the EU. The findings emphasize the importance of understanding market dynamics during times of geopolitical uncertainty and its implications for investors and policymakers in the energy sector.

Our research had some limitations. It is important to note that the index is weighted according to free-float market capitalization, meaning that larger companies significantly impact its performance more than smaller companies. This can result in the index being dominated by a few large companies, which may not fully represent the diversity of the European energy sector. Additionally, the internal operations of the companies within the index may vary and not be uniform, further limiting the index's ability to accurately represent the European energy sector as a whole. As such, while the S600ENP index can provide valuable insights into the performance of the European energy sector, it may not be a perfect representation of the real view of the EU and the Eurozone energy sectors performance. This implies that a better research design can be suggested for further research, such as considering using alternative datasets or proxies for the variables. Future endeavors in this area should prioritize evaluating the impact of different time periods to enhance the reliability of findings. Dividing the data into distinct and relevant sub-periods and rigorously assessing whether the observed patterns and conclusions remain consistent over time will bolster the credibility of the results. Additionally, employing diverse statistical models and methodologies and conducting sensitivity tests to assess the influence of key parameters and assumptions will further strengthen the robustness and validity of the conclusions. Addressing these critical aspects will lead to a more comprehensive and accurate understanding of the consequences of energy-related sanctions on the European Union, making a significant contribution to the field.

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