Does the Conflict-Related News from Donbass Affect the Volatility of the Renewable Energy Market?

Serkan ERYILMAZ[1]
Enes Burak ERGÜNEY[2]
Feyyaz ZEREN[3]
Samet GÜRSOY[4]

DOI: 10.24818/mer/2024.02-09

ABSTRACT

The ongoing war between Russia and Ukraine has deeply affected many countries, mainly EU member states, and has led to an energy crisis. However, this war is also an opportunity for the world to transition from fossil fuels to clean energy because the renewable energy transition has the potential to both reduce Russia's energy revenues and ensure the EU's energy security. For this reason, many countries are planning to invest in the renewable energy sector both to prevent Russia's aggressive behaviour and to overcome the energy crisis. In this context, the study aims to investigate the existence of a dynamic relationship between the intensity of the conflict between Russia and Ukraine and the renewable energy stock market. For this purpose, we adopt a DC-MSV model with the number of conflict news in the Donbass region and ECO and ERIX return series data as proxies of the renewable energy market. As a result, we find that changes in the conflict intensity in the Donbass region do not affect the stock volatility of renewable energy companies, while there is a weak relationship between their returns.

KEYWORDS: *renewable energy, Russia, Ukraine, stock market, war.*

JEL CLASSIFICATION : *G15, H56, Q20.*

1. INTRODUCTION

On February 21, 2022, Russian President Vladimir Putin's announcement that he would recognise Donetsk and Luhansk as autonomous regions elevated the dispute that originated from Russia's invasion of the Crimean Peninsula in 2014 to a critical level. With Putin's announcement, the dispute between Russia and Ukraine transformed into a conflict, resulting in Russia launching a full-scale military operation against Ukraine on February 24, 2022.

Although Russian officials label the operation as a “special military operation”, it is literally a war and events like war, financial crisis, pandemic, terrorist attack, etc., which are referred to as “black swan” events, have had devastating effects on the global economy and stock markets (Yousaf et al., 2022). In this context, the invasion of Ukraine, significantly disrupted the optimistic outlook for the global economy during its recovery phase after the COVID-19 pandemic, as the conflicting parties are major exporters of key commodities such as wheat, corn, sunflower, fertilisers, copper, nickel, gold, natural gas, coal, and oil. As a result, the invasion brought about expectations of declining economic growth on a global scale, rising commodity prices, supply chain disruptions, and reduced global-scale investments (Mbah &

[1] Yalova University, Turkiye, serkaneryilmaz@maltepe.edu.tr
[2] Burdur Mehmet Akif Ersoy University, Turkiye, enesburakergney@gmail.com
[3] Yalova University, Turkiye, feyyaz.zeren@yalova.edu.tr, Corresponding author
[4] Burdur Mehmet Akif Ersoy University, Turkiye, sametgursoy@mehmetakif.edu.tr

Wasum, 2022; Wang et al., 2022). As a result, the beginning of the Russian-Ukrainian war led to a sharp surge in commodity prices. For instance, the price of gold per ounce, which stood at $1,909.20 on February 23, 2022, experienced a 6.85% increase to $2,040.10 on March 8, 2022. Similarly, the price of West Texas Intermediate (WTI) crude oil increased by 34.31% from $92.10 per barrel on February 23, 2022, to $123.70 on March 8, 2022 (Yahoo Finance, 2023a, 2023b). Additionally, the imposition of the United States' (US) embargo on oil, liquefied natural gas, and coal imports from Russia played a pivotal role in contributing to the peak in commodity prices (Deng et al., 2022).

The European Union (EU), having previously enforced various sanctions against Russia in response to the annexation of Crimea and the non-implementation of the Minsk Protocol, adopted new comprehensive sanctions with the explicit aim of destabilising Russia's economy and intensifying its international isolation. The primary objective of these sanctions is to curb Russia's aggressive actions toward Ukraine (Sokhanvar and Bouri, 2023). Consequently, the EU Council introduced ten sanctions packages from February 23, 2022, to February 25, 2023. These packages encompass trade sanctions that restrict Russia's access to EU capital and financial markets, prohibit the export of luxury goods from the EU to Russia, and forbid the import of crude oil, refined oil, and coal from Russia. Furthermore, the sanctions involve individual measures, including travel bans and asset freezes against numerous Russian government officials, businessmen, and oligarchs (Chepeliev et al., 2022). The cumulative effect of these actions resulted in a substantial increase in the number of sanctions imposed on Russia, escalating from 2,695 on February 22, 2022, to 14,153 on February 23, 2023, just prior to the commencement of the invasion (Castellum.AI, 2023).

Russia occupies a critical position as a major global energy supplier, accounting for approximately 12.2% of the world's daily crude oil production and 17.4% of its daily natural gas production. Moreover, it caters to almost one third of Europe's energy demand, thereby rendering many EU nations, particularly those in the eastern region, heavily dependent on Russia's energy exports (BP, 2022). Consequently, this pronounced reliance signifies a notable vulnerability for the EU (Zhou et al., 2023). Exploiting this vulnerability as a “political weapon”, Russia curtailed or halted gas supplies to select EU countries from February 24, 2022. In June of the same year, Russia also took the decision to reduce the capacity of the Nord Stream-1 pipeline, which connects Russia to Germany, by 75%, temporarily closing the pipeline for maintenance in July, and eventually cutting off gas flow indefinitely by the end of August (BBC, 2022). These retaliatory sanctions imposed by Russia have triggered widespread concern among the population and politicians in EU countries due to the looming possibility of energy shortages during the upcoming winter months. Consequently, there was a rapid surge in the sale of firewood and coal in these nations, leading the governments of Austria, Germany, France, and Italy, who had previously shuttered their thermal power plants, to opt for their temporary reopening (Le Monde, 2022). Furthermore, these counter-sanctions by Russia have brought to light two concerning realities. Firstly, fossil fuels continue to dominate the energy mix in the EU, and secondly, the region's high energy dependence on Russia remains a critical issue (Kuzemko et al., 2022).

The reduction in the EU’s gas and oil imports from Russia has been counterbalanced by the significant surge in energy prices resulting from the ongoing war, which leads to a substantial increase in Russia's energy export revenues. While this increase in revenues may partially mitigate the impact of the EU's economic sanctions against Russia, it simultaneously exacerbates the energy crisis within the EU (Gardner, 2022). Essentially, the sanctions enforced by the European Union (EU) inadvertently have harmful effects on the EU itself. In response to this challenging situation, the International Energy Agency (IEA) took action in

March 2022 by unveiling two strategic plans: the “10-Point Plan to Reduce Oil Use” and the “10-Point Plan to Reduce the European Union's Dependence on Russian Natural Gas”. These plans are designed to alleviate the adverse effects of the energy crisis on European consumers and to curtail Russia's energy revenues. To accomplish these objectives, the IEA recommends the suspension of new energy supply contracts with Russia, the establishment of alternative energy sources to meet the energy demand, the amplification of production from existing low-emission energy sources, the expedited development of wind and solar energy projects, the promotion of decreased fossil fuel utilisation in urban transportation, and the implementation of a speed limit of at least 10 km per hour on motorways, etc. (IEA, 2022a, 2022b).

In conjunction with the IEA's plans, the European Commission announced the REPowerEU plan on March 8, 2022, which seeks to entirely eradicate the EU's energy dependence on Russia and urgently transition the European energy system. This comprehensive roadmap, unveiled on May 18, 2022, encompasses three key aspects: saving energy, producing clean energy, and diversifying its energy supplies. Compared to the 10-point action plans presented by the IEA, REPowerEU stands out with concrete steps, aiming to improve energy efficiency by 13%, increase the share of renewable energy sources to 40-45% by 2030, and secure the necessary budget for the project (European Commission, 2022).

Promoting the share of renewable energy sources and accelerating their implementation constitutes a pivotal element within all action plans. While the EU's alternative suppliers, such as Azerbaijan, Turkmenistan, and Norway, may potentially guarantee adequate gas supply in the medium to long term through new investments, they might not be capable of resolving the energy crisis in the short term due to their limited production and transmission capacities (Ibadoghlu, 2022). Moreover, the EU has committed to becoming carbon neutral by 2050, even if alternative suppliers are secured. Therefore, augmenting the share of renewable energy sources stands as the paramount and most effective option for the EU in terms of sustainable economic development and ensuring energy security (Nerlinger and Utz, 2022). This imperative has been emphasised in a report published by the International Renewable Energy Agency (IRENA) in 2022, which underscores that the transition to renewable energy represents the sole viable means to ensure energy security in the long run (IRENA, 2022).

Consequently, despite numerous countries, particularly the US and the EU, urging an end to the war and implementing sanctions on Russia, the conflict between Russia and Ukraine persists without abatement. As long as the war persists, it is highly likely that the EU and other nations will continue to grapple with energy supply challenges, which in turn will exacerbate the ongoing energy crisis. In response to these pressing challenges, international organisations and policymakers are devising new strategies with a primary focus on rapidly increasing investments in renewable energy. These strategies are set to achieve two main objectives: first, to curb Russia's aggressive actions, and second, to mitigate the adverse effects of the energy crisis. Of course, the implementation of these strategies is also expected to have implications for the renewable energy market.

Hence, the aim of this paper is to provide empirical evidence regarding the impact of the ongoing war on the renewable energy market. Actually, prior studies in the literature have convincingly shown that geopolitical risks and black swan events indeed influence the prices of vital energy resources such as oil and natural gas (Liu et al., 2021; Noguera-Santaella, 2016). However, unlike previous research, our study aims to investigate whether the intensity of the conflict in the Donbass region, which center of the war, exhibits a dynamic relationship with the renewable energy market. Additionally, we seek to establish whether fluctuations in the intensity of the conflict significantly affect market returns and volatility. To achieve this, we employ the DC-MSV model using daily conflict and renewable energy market data.

Our research distinguishes itself from previous studies in the literature by adopting a daily dynamic approach to examine the impact of events on financial markets, rather than focusing solely on pre-event or post-event analyses. By adopting a daily dynamic perspective, our study aims to capture the real-time fluctuations and intricate interconnections between events and financial markets. This approach enables us to gain a deeper understanding of how events unfold over time and how their effects unfold on a daily basis. Furthermore, it allows us to observe how market sentiments and responses evolve as events unfold, offering valuable insights into the temporal dynamics of event-induced market movements.

In essence, our research endeavours to provide a comprehensive and nuanced perspective on the interplay between events and financial markets. By adopting this novel daily dynamic approach, we aim to offer a fresh and insightful contribution to the existing body of literature, ultimately enhancing our understanding of the complex relationship between events and financial market dynamics. Through our meticulous examination of the daily interactions between events and financial markets, we aim to provide policymakers and stakeholders with a more informed basis for decision-making and risk management strategies.

2. PREVIOUS LITERATURE REVIEW

Since the Russian invasion of the Crimean Peninsula in 2014, the history of the crisis between Russia and Ukraine has been extensively discussed by many authors from economic, social, military, and geopolitical perspectives (Davis, 2016; Jonsson and Seely, 2015; Samokhvalov, 2015; Svarin, 2016). However, this crisis, which turned into a war on February 24, 2022, has literally became a human tragedy. In his statement, the US Secretary of State Anthony Blinken pointed out the devastating effects of a possible war, saying, “It’s bigger than a conflict between two countries, and it’s bigger than a clash between Russia and NATO. It’s a crisis with global consequences. And it requires global attention and action” (Deutsche Welle, 2022). Indeed, as the US Secretary of State said, the effects of the war have been profound and devastating in almost every part of the world.

The few studies in the literature that have analysed the impact of the war since the beginning of the Russian invasion have focused on issues such as food, the energy crisis, and the situation of migrants. The main reasons for focusing on these issues are the fact that the war has triggered a large influx of refugees from Ukraine to Europe and the social, economic, and health conditions of these refugees remain uncertain; the food crisis in countries that are highly dependent on grain imports from Russia and Ukraine; and the fact that energy suppliers have not yet been found to replace Russia in energy supply or that the necessary physical infrastructure has not yet been built.

Most studies in the literature on the threats that the Russia-Ukraine war poses to food security have focused on countries where wheat and its derivatives are the staple food, analysing how the Middle East and North Africa (MENA) countries, which are most vulnerable in this regard, are affected by the crisis and what can be done to mitigate these impacts. Studies have shown that the war between Russia and Ukraine can cause significant hunger crises and social problems, especially in MENA countries whose staple foods are largely based on cereal products such as wheat (Lin et al., 2023). Therefore, to increase food security or mitigate existing impacts, especially in MENA countries, trade restrictions on food and fertiliser trade should be eased or removed altogether (Laborde Debucquet and Mamun, 2022), countries with food security threats should be provided with financial and technical assistance to increase domestic production (Osendarp et al., 2022), farmers should be encouraged to increase cultivation of sunflower, wheat, and derivatives, especially in countries where the climate is favourable and acreage is large (Ben Hassen and El Bilali, 2022), and panic buying by governments that leads to price increases in the commodity market should be avoided (Abay et al., 2023).

Another issue highlighted by researchers is the mass migration movement triggered by the war. Indeed, the Russian-Ukrainian war has triggered the strongest migration wave since the World War II, and millions of Ukrainians, predominantly women and children, have emigrated to various countries in Europe since the beginning of the war. This migration wave, which spread to Eastern European countries and reached 4 million by 30 March 2022 (mainly Poland), is almost twice the size of the wave of Syrian migrants who arrived in Europe from the Syrian civil war since 2015 (Ociepa-Kicińska and Gorzałczyńska-Koczkodaj, 2022).

Studies in the literature have generally focused on these refugees' health and economic problems. Lewtak et al. (2022), one of the studies focusing on the health problems of Ukrainian refugees, analysed the main health problems of Ukrainian refugees treated in Polish hospitals. In the short term, it recommends focusing on strengthening measures to prevent diseases with a high risk of transmission and, in the long term, building responsive health systems to protect refugees and meet their health needs. Similarly, Fatyga et al. (2022) provide recommendations on how Poland can help Ukrainian refugees with their health problems. Bin-Nashwan et al. (2022) evaluated the Russia-Ukraine crisis in relation to the SDG Agenda 2030 and developed recommendations to improve the lives of refugees. It is also stated that UNCHR should work with partner countries to improve the living conditions of refugees, provide incentives to employers who hire refugees, provide support such as financing to refugees to start their own businesses, and create minimum conditions for refugees to live an average life. In fact, Pham et al. (2023) evaluated the impact of Ukrainian refugees on the Polish labour market and suggested that many refugees should be supported with learning programmes that enable them to learn languages and improve their professional skills so that they have the skills to meet employment needs in Poland.

In addition to the food crisis and the wave of refugees, the financial markets were also severely affected by the war, as the warring parties were important suppliers of commodities. Indeed, the sharp fluctuations in the commodity market have led to negative cash flow, profitability, and production expectations for many companies and increased uncertainty. Ahmed et al. (2022) found that the Russia-Ukraine war was different from previous wars (Gulf War, Iraq War) and examined the impact of Russian President Vladimir Putin's autonomous recognition of the Donetsk and Luhansk regions on the STOXX Europe 600 Index. As a result of the study, it was found that the STOXX Europe 600 Index was generally negatively affected by this declaration, with Dutch companies being the most negatively affected and UK companies the least negative. It was also found that more companies in the consumer staples sector were negatively affected than from the energy sector. Based on the study's findings, he suggested that new energy suppliers should be found to reduce energy dependence on Russia and that financial and monetary measures should be taken to boost investor confidence. He also stated that the Russia-Ukraine crisis is an important warning to increase the use of renewable energy. Indeed, Deng et al. (2022) discussed the impact of the Russia-Ukraine crisis on financial markets in their study. When observing the impact of regulations such as REPowerEU in Europe and the Inflation Reduction Act in the US, the authors found that companies more affected by climate transformation regulations in the US performed better. In the EU, on the other hand, they concluded that companies that prioritise renewables perform better due to strong political support for renewables, although this is not entirely obvious. Supporting the findings of the previous study, Liao (2023) concluded in his study that companies with higher renewable energy investments in the EU were less affected by the stock market decline and stated that renewable energy mitigates the negative effects of the crisis by reducing energy dependence in times of increased global risks such as war. On the other hand, Yousaf et al. (2022) examined the impact of the war between Russia and Ukraine on the stock markets of the G20 and other selected countries and how the impact of the war was reflected in the markets of selected countries before the event, on the day of the event, and after the event. The analysis showed that the stock markets of Hungary, Poland, Slovakia, and Russia reacted negatively both before and after the event, while countries such as Australia, India, France, Germany, and Turkey reacted negatively only in the days after the event. It is believed that the least affected markets are North America, Latin America, the Middle East, and African countries. Therefore, the authors recommend that the less affected markets should be considered in investors' portfolio diversification. Similar to the study conducted by Yousaf et al. (2022), Lo et al. (2022) also examined the impact of the Russia-Ukraine conflict on the financial markets of 73 countries, taking into consideration Russia's commodity dependency. Their empirical findings indicate that financial markets perceive dependence on Russian commodities as a risk factor, leading to decreased returns and increased volatility, regardless of the level of dependency.

In short, the Russia-Ukraine crisis seems to have turned into a human tragedy that is much more than a war. The main reason for this is the fact that the warring parties are major suppliers of energy and food. The studies in the literature not only show the devastating effects of war, but also how the effects of war can be reduced with the suggestions they offer. These recommendations are to mitigate the effects of the food crisis giving priority to food and seed production sourced from countries fighting over arable land, introducing legal regulations for this and removing trade barriers in food trade. In terms of migration, improving conditions for Ukrainian refugees such as health, education and employment, developing infrastructure in countries where health infrastructure is inadequate, creating funds to improve their economic situation and establishing educational programmes to ensure integration in the countries they go to. To reduce the financial impact, investors can prioritise markets that are less dependent on warring countries when diversifying their portfolios, develop regulations that accelerate the clean energy transition to prevent the energy crisis, increase investments in renewable energy and prevent a possible energy shortage until the impact of the crisis is mitigated by reducing energy consumption in the short term.

2.1 Literature Gap

This study aims to fill a gap in the literature by examining the impact of the Russian-Ukrainian war on renewable energy stock market through an empirical approach based on daily events. Specifically, it investigates whether conflicts occurring in the Donbass region, as a risk indicator, affecting the stocks of renewable energy companies. The necessity of this study can be attributed to three primary reasons: 1) Russia stands as one of the world's most significant energy exporters, creating deep vulnerability for energy-dependent countries and necessitating the exploration of new energy suppliers. 2) The EU is one of the regions with the highest energy dependency on Russia, and it aims to achieve net-zero carbon emissions by 2050. Therefore, an increase in demand for clean energy transition is expected in this region. 3) Clean energy transition has been recognised as the most consistent policy to mitigate the impacts of the energy crisis in the European Union.

There are studies in the literature documenting the impact of wars on financial and commodity markets, leading to fluctuations based on expectations. In particular, wars involving critical commodity-producing countries are known to have more disruptive consequences. For instance, Leigh et al. (2003) noted that even the anticipation of war in Iraq led to a relative increase in oil prices. On the other hand, Mohammed et al. (2022) provided empirical evidence of the impact of the Russia-Ukraine war on the renewable energy stock market. However, our study, unlike the others, investigates whether the effect of the war on the renewable energy market is dynamic. In other words, we examine whether the fluctuations in conflict intensity in the region instantaneously influence returns and volatility in the renewable energy market.

We expect this study to demonstrate the significant effects of conflict reports on the renewable energy stock market. The ongoing conflicts in the Donbass region, shaping the course of the war on a daily basis since February 24, 2022, can lead to positive or negative expectations in the markets, particularly due to Russia's status as major energy exporters, which can influence investors' decisions.

3. DATA AND METHODOLOGY

In this study, we aim to analyse the impact of news about the conflict in the Donbass region on the renewable energy stock market. For this purpose, we use a dataset published by the Armed Conflict Location & Event Data Project (ACLED), which contains independent conflict news from the Donbass region. The data obtained from the ACLED database includes events such as air/drone strikes, armed clashes, missile attacks, sexual violence, suicide bomb, explosions and violence against civilians. These and similar data published by ACLED are frequently used in many studies (Jain et al., 2022; Kunkel and Ellis, 2023; Zanin and Martínez, 2022). The data spanning of this study is from 24 February 2022 to 24 February 2023 and includes a total number of 251 observations. The reason why the number of observations is 251 is that the independent variable is adjusted to the financial markets data.

Conflict news from the Donbass region (EVENTS) is the independent variable of the two models used in the study. The dependent variables are the WillderHill Clean Energy Index (ECO) and the European Renewable Energy Index (ERIX). The ECO Index tracks the clean energy sector through companies that have significant exposure to clean energy or contribute to clean energy development in an environmentally and economically sound manner (Pradhan and Tiwari, 2021). In this context, the ECO index covers energy-related companies in the US, such as renewable energy sources, electricity and energy distribution/storage, clean fuels and greener utilities (Elie et al., 2019). The ERIX is an index that monitors the performance of European renewable energy companies operating in the geothermal, marine, solar, hydro, wind and biofuels sectors (De Blasis and Petroni, 2021).

Stochastic volatility models (SV) were developed as an alternative to Autoregressive Conditional Variance (ARCH) models for the analysis of financial time series with characteristic features. Compared to ARCH /GARCH models, these models provide more successful results in the case of excessive kurtosis that occurs in future forecasts and financial data for a future period (Das et al., 2009). Stochastic volatility models are modelled as a latent variable in cases where inter-series volatility cannot be observed.
The basic stochastic volatility models were introduced to the literature by Taylor (1986) and Harvey et al. (1994) and have evolved into a multivariate structure. These models show the interdependence of market returns, volatility interactions with each other, and volatility spillovers between markets. The fact that the conditional correlation matrix, which is the

weakness of the basic stochastic volatility models, does not have a time-dependent structure proves to be a weakness of these models. As a solution to this problem, the Dynamic Conditional Correlation Stochastic Volatility (DC-MSV) model was developed by Yu and Meyer (2006).

In the DC-MSV model, the time-dependent variation of the correlation coefficient shows a dynamic property. The model DC-MSV proposed by Yu and Meyer (2006) is as follows:

$$
\begin{aligned}
&r_t = a + \beta r_{t-1} + y_t \\
&y_{A,t} = \exp\left(h_{A,t}/2\right)\varepsilon_{A,t} \\
&y_{B,t} = \exp\left(h_{B,t}/2\right)\varepsilon_{B,t} \\
&p_t = cov(\varepsilon_{A,t}, \varepsilon_{B,t}) = \frac{\exp(q_t) - 1}{\exp(q_t) + 1} \qquad (1) \\
&q_{t+1} = \psi_0 + \psi_1(q_t - \psi_0) + \sigma_q v_t \\
&h_{A,t+1} = \mu_A + \phi_A\left(h_{A,t} - \mu_A\right) + \phi_{AB}\left(h_{B,t} - \mu_B\right) + \eta_{A,t} \\
&h_{B,t+1} = \mu_B + \phi_B\left(h_{B,t} - \mu_B\right) + \phi_{BA}\left(h_{A,t} - \mu_A\right) + \eta_{B,t}
\end{aligned}
$$

Equation 1 shows that the model $r_t = a + \beta r_{t-1} + y_t$ is a first-order vector autoregressive process followed by an averaging model that accounts for the bivariate structure, and is defined as$r_t = \left(r_{A,t}, r_{B,t}\right)', y_t = \left(y_{A,t}, y_{B,t}\right)'$. μ_A and μ_B denote constant parameters, p refers to the time-varying dynamic correlation coefficient. $h_{A,t}$, symbolises the volatility of variable A and $h_{B,t}$ symbolises the volatility of variable B. The ϕ_A, is the permanence of the volatility of variable A, ϕ_B is the permanence of the volatility of variable B.

In the case of statistical significance of these parameters, the fact that they have values close to 1 proves that the volatility in the variable has a permanent effect. The parameters ϕ_{AB} and ϕ_{BA} define the interaction between the volatility of the variables. The statistical significance of the parameter ϕ_{AB} indicates that the volatility in variable B has an effect on the volatility in variable A. On the other hand, the statistical significance of the parameter ϕ_{BA} indicates that the volatility occurring in variable A has an effect on the volatility occurring in variable B. The parameters of the $\sigma^2_{\eta A}$ and $\sigma^2_{\eta B}$ show the variances of the volatility processes in the variables. They measure the uncertainty (predictability) of volatilities in future periods. There is an asymmetric relationship between the parameters ϕ_A and $\sigma^2_{\eta A}$ and the parameters ϕ_B and $\sigma^2_{\eta B}$. When the volatility permanence parameter (ϕ_A or ϕ_B) approaches 1 for the variable in question, the variance parameter ($\sigma^2_{\eta A}$ or $\sigma^2_{\eta B}$) of the volatility process approaches zero. This means that the volatility of the variable is predictable.

4. EMPIRICAL FINDINGS

The variables used in the study consist of daily data for the period between 24/02/2022 and 24/02/2023. The return series of the variables were calculated using the formula $r_t = (\ln {}^{P_t}/_{P_{t-1}})$. The graphs of the estimated return series are shown in Figure 1.

Table 1 presents descriptive statistics for the return series. On examination, skewness was found in the ECO and ERIX series, while kurtosis was found in all series. According to the Jarque-Bera test statistic, the data was found to deviate from the normal distribution. This shows that stochastic models are more appropriate than deterministic models based on the assumption of a normal distribution. This is because stochastic models based on the assumption of randomness can give more accurate results for time series that do not have a normal distribution. In this context, the DC-MSV model, which provides more successful results in kurtosis data compared to ARCH /GARCH models, was evaluated as a suitable option for the dataset.

Table 1. Descriptive Statistics

	EVENTS	ECO	ERIX
Mean	0.001484	-0.001162	0.000625
Median	0.016961	-0.001902	0.000248
Maximum	0.826679	0.096053	0.121717
Minimum	-0.754705	-0.101862	-0.063373
Std. Dev.	0.269853	0.032757	0.018985
Skewness	0.008228	0.121539	1.101699
Kurtosis	2.922128	2.953366	10.19746
Jarque-Bera	0.065989	0.638147	590.1918

In this study, the volatility interaction of the variables was calculated. In addition, the model DC-MSV was used to observe the time-dependent correlation relationship between the returns. The Markov Chain Monte Carlo (MCMC) method was used. The model is based on a Bayesian approach to estimating DC-MSV models. Unlike other estimation methods, the MCMC method does not require numerical optimisation. In addition, the MCMC method offers the possibility of providing latent volatility estimates and distributions of these estimates together with the parameters. This method generates variables from a given multivariate distribution by repeatedly sampling a Markov chain whose invariant distribution is the target of the density function of interest (Yu and Meyer, 2006).

The analysis of the model used in the study DC-MSV was carried out with the package programme WinBUGS 1.4. In the analyses conducted with 100,000 samples, 80,000 samples were considered by excluding the first 20,000 samples as initial values for the estimation method. The results of the estimation are shown in Tables 2 and 3.

Table 2. DC-MSV Model Results of EVENTS and ECO

	Mean	Standard deviation	MC Error	Confidence Interval (95%)	
μ_{EV}	-3.268*	0.1618	0.007968	-3.509	-2.838
μ_{ECO}	-6.869*	0.1417	0.007225	-7.101	-6.533
ϕ_{EV}	0.8533*	0.0967	0.004382	0.6135	0.9854
ϕ_{EVECO}	0.4237	0.4922	0.02714	-0.3074	1.801
ϕ_{ECO}	0.808*	0.1134	0.004967	0.529	0.9747
ϕ_{ECOEV}	-0.1762	0.2722	0.01491	-0.8534	0.2357
$\sigma_{\eta EV}$	0.8802*	0.09817	0.004483	0.6193	0.9883
$\sigma_{\eta ECO}$	0.1295	0.1908	0.008351	-0.3	0.4513
ψ_0	0.1066*	0.03158	0.001425	0.06322	0.1839
ψ_1	0.1135*	0.03674	0.001725	0.06413	0.2024

Note: * denotes statistically significant at the 5% level.

DC-MSV the model results of the returns of EVENTS and ECO are shown in Table 2. Expressing the own volatility of the EVENTS return. The parameter ϕ_{EV} was found to be statistically significant at the 5% level. The value of 0.8533 for this parameter proves that the EVENTS indicator has strong volatility clusters and that the volatility is permanent. The parameter ϕ_{EV} which expresses the volatility of the return of ECO itself, is statistically significant at the 5% level. The fact that the parameter is close to 1 with a value of 0.808 proves that there is a clustering of volatility in the returns of ECO and that a volatility shock in the index itself has a continuous effect.

The parameters ϕ_{EVECO} and ϕ_{ECOEV}, which indicate the interactions between the volatility of the variables EVENTS and ECO, are not statistically significant. Accordingly, there is no transmission between the volatility of the variables, and the volatility of the ECO is not influenced by the developments in the Russian-Ukrainian war.

The fact that the ϕ_{EV} parameter is close to 1 and the $\sigma^2_{\eta EV}$ parameter is different from 1 indicates that the volatility occurring in the EVENTS indicator is lowly predictable. On the other hand, the fact that the $\sigma^2_{\eta ECO}$ parameter is statistically insignificant indicates that the volatility in the ECO variable cannot be predicted. The statistical significance of the ψ_1 parameter indicates a dynamic feature that changes over time. Based on the parameter being significant at the 5% level and the dynamic correlation coefficient obtained as 0.1135, there is a weak and positive correlation between the variables.

Table 3. DC-MSV Model Results for EVENTS and ERIX

	Mean	Standard deviation	MC Error	Confidence Interval (95%)	
μ_{EV}	-3.17*	0.2728	0.01516	-3.441	-2.106
μ_{ER}	-8.271*	0.4881	0.02703	-8.645	-6.728
ϕ_{EV}	0.7728*	0.1419	0.006367	0.4398	0.972
ϕ_{EVER}	-0.03079	0.1047	0.00546	-0.2204	0.2541
ϕ_{ER}	0.7913*	0.1371	0.006836	0.4412	0.9768
ϕ_{EREV}	1.067	0.9526	0.05236	-0.2506	3.295
$\sigma_{\eta EV}$	0.1985	0.4748	0.02663	-0.2432	2.094
$\sigma_{\eta ER}$	0.8294*	0.1166	0.004959	0.5415	0.9774
ψ_0	0.1096*	0.03441	0.00162	0.06224	0.197
ψ_1	0.1345*	0.06808	0.00342	0.06329	0.3217

Note: * denotes statistically significant at the 5% level.

Table 3: The results of the model DC-MSV for the returns of EVENTS and ERIX show that the parameter ϕ_{EV} which expresses the volatility of the return of EVENTS itself, is statistically significant at the 5% level. The convergence of this parameter with a value of 0.7728 to 1 proves that there is a relative volatility cluster in the EVENTS returns and that the volatility is permanent.

Similarly, ϕ_{ER} parameter of ERIX returns expressing its own volatility is close to 1 with a value of 0.7913, indicating that there is volatility clustering and that a volatility shock occurring in ERIX returns has a continuous effect on its volatility. The parameters ϕ_{EVER} and ϕ_{EREV}, which indicate the interactions between the volatility of the variables EVENTS and ERIX, are not statistically significant. Therefore, there is no transmission between the volatility of the variables and the volatility of the European Renewable Energy Index is not influenced by the developments in the Russian-Ukrainian war.

The fact that the parameter ϕ_{ER} is close to 1 and the parameter $\sigma^2_{\eta ER}$ deviates from 1 suggests that the volatility of ERIX returns is hardly predictable. On the other hand, the fact that the parameter $\sigma^2_{\eta EV}$ is not statistically significant indicates that the volatility of the variable EVENTS cannot be predicted. The statistical significance of the parameter ψ_1 indicates a dynamic property that changes over time. Since the parameter is significant at the 5% level and the dynamic correlation coefficient is 0.1345, there is a weak and positive correlation between the variables.

5. CONCLUSIONS

The longstanding disputes between Ukraine and Russia escalated further after Russia's annexation of the Crimean Peninsula in 2014. However, it was on February 21, 2022, after Russian President Vladimir Putin recognised the Luhansk and Donetsk People's Republics as autonomous regions, that tensions reached a peak. Prior to this event, there had been numerous instances of heightened tensions between Russia and Ukraine, although no one had foreseen it escalating into an armed conflict, or the possibility of conflict was perceived as a nightmare scenario. Regrettably, despite calls from around the world for restraint and a peaceful resolution, on February 24, 2022, Russia launched a full-scale military operation against Ukraine.

The conflict between Russia and Ukraine, referred to as a “special military operation” by Russian officials, has triggered negative expectations worldwide. The significant role of both countries as major exporters of raw materials, food, and energy has contributed to these pessimistic outlooks. In particular, the EU's heavy dependence on Russia as its main energy importer, coupled with Ukraine and Russia's critical roles in the grain and fertiliser trade, has raised concerns about a hunger crisis in MENA countries and an energy crisis in the EU. Despite the proposal of short-term alternatives and suppliers to mitigate the impact of the commodity market crisis, significant challenges remain in implementation. Therefore, investing in renewable energy emerges as a crucial and effective approach, especially in tackling the energy crisis. This study aimed to demonstrate the influence of conflicts between Russia and Ukraine on the renewable energy market over the past year. To achieve this, a dataset of 251 days was compiled, consisting of news from ACLED regarding the Donbass region's conflict and ECO and ERIX index data representing the renewable energy market. Prior research on the war's impact on the renewable energy market has primarily focused on companies heavily invested in renewables or making progress in clean energy transition. However, unlike others, our study aims to fill this literature gap by investigating whether daily conflict-related news triggers investor activity in the renewable energy market as an indicator of geopolitical risk or how existing investments are performing.

The results of the study indicated a relatively weak relationship between conflict news and the renewable energy market. The DC-MSV model reveals dense volatility clustering and permanence in the variables, suggesting unpredictable volatility and a prevailing sense of uncertainty. Bidirectional volatility interaction shows independent effects of conflict news and the renewable energy market. Additionally, a low correlation is found between conflict news and returns on renewable energy markets, indicating a dynamic relationship that evolves over time. The low correlation between conflicts and renewable energy stock prices can be attributed to several factors. Firstly, mutual frictions and sanctions between Russia and the

EU since 2014 have led to shock absorption in both markets, making them resilient to a potential Russia-Ukraine crisis. Secondly, while initial conflict events may have affected investors, they diversified their investments and minimised the potential impact of the conflict going forward. Moreover, investors can base their decisions on government and institutional statements and action plans rather than individual conflicts. In fact, Tosun and Eshraghi (2022) found that corporate decisions strongly influence stock markets during times of political conflict. Therefore, it becomes understandable that daily conflict news has no discernible impact on the renewable energy market, although many clean energy companies have seen significant increases in stock values since February 24, 2022 (Mathis and Wade, 2022).

Furthermore, it is believed that the limitations of the study may also have influenced these results. The inclusion of the geopolitical risk index (GPR) was avoided to prevent multicollinearity issues, as conflict zone events are part of the geopolitical risk measure. Additionally, the study utilized limited data from the evaluation period. Based on the findings, investors are advised not to solely rely on real-time conflict-related information when investing in renewable energy stocks. Instead, it is recommended that energy-importing countries continue to invest in renewable energy markets to reduce supply problems and energy price volatility. Future studies that focus on the impact of conflicts in other sectors and develop policy recommendations to mitigate the effects on financial markets and national economies would be beneficial.

REFERENCES

Abay, K.A., Breisinger, C., Glauber, J., Kurdi, S., Laborde, D., & Siddig, K. (2023). The Russia-Ukraine war: Implications for global and regional food security and potential policy responses. *Global Food Security, 36*, 100675. https://doi.org/https://doi.org/10.1016/j.gfs.2023.100675

Ahmed, S., Hasan, M.M., & Kamal, M.R. (2022). Russia–Ukraine crisis: The effects on the European stock market. *European Financial Management*. https://doi.org/10.1111/eufm.12386

BBC. (2022, October 29). Nord Stream 1: How Russia is cutting gas supplies to Europe. BBC. https://www.bbc.com/news/world-europe-60131520

Ben Hassen, T., & El Bilali, H. (2022). Impacts of the Russia-Ukraine War on Global Food Security: Towards More Sustainable and Resilient Food Systems? *Foods*, *11*(15). https://doi.org/10.3390/foods11152301

Bin-Nashwan, S.A., Hassan, M.K., & Muneeza, A. (2022). Russia–Ukraine conflict: 2030 Agenda for SDGs hangs in the balance. *International Journal of Ethics and Systems*. https://doi.org/10.1108/IJOES-06-2022-0136

BP. (2022). Statistical review of world energy. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html

Castellum.AI. (2023, March 28). Russia Sanctions Dashboard. https://www.castellum.ai/russia-sanctions-dashboard

Chepeliev, M., Hertel, T., & van der Mensbrugghe, D. (2022). Cutting Russia's fossil fuel exports: Short-term economic pain for long-term environmental gain. *The World Economy*, *45*(11), 3314-3343. https://doi.org/10.1111/twec.13301

Das, A., Ghoshal, T.K., & Basu, P.N. (2009). A Review on Recent Trends of Stochastic Volatility Models. *International Review of Applied Financial Issues and Economics*, *1*(1), 83.

Davis, C.M. (2016). The Ukraine conflict, economic–military power balances and economic sanctions. *Post-Communist Economies, 28*(2), 167–198. https://doi.org/10.1080/14631377.2016.1139301

De Blasis, R., & Petroni, F. (2021). Price Leadership and Volatility Linkages between Oil and Renewable Energy Firms during the COVID-19 Pandemic. *Energies, 14*(9), 2608. https://doi.org/10.3390/en14092608

Deng, M., Leippold, M., Wagner, A.F., & Wang, Q. (2022). Stock Prices and the Russia-Ukraine War: Sanctions, Energy and ESG. SSRN Electronic Journal.

Deutsche Welle. (2022, January 20). Blinken: Russia risks crisis "with global consequences." DW. https://www.dw.com/en/antony-blinken-says-russia-risks-crisis-with-global-consequences/a-60490736

Elie, B., Naji, J., Dutta, A., & Uddin, G.S. (2019). Gold and crude oil as safe-haven assets for clean energy stock indices: Blended copulas approach. *Energy, 178*, 544-553. https://doi.org/10.1016/j.energy.2019.04.155

European Commission. (2022). REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

Fatyga, E., Dzięgielewska-Gęsiak, S., & Muc-Wierzgoń, M. (2022). Organization of Medical Assistance in Poland for Ukrainian Citizens During the Russia-Ukraine War. *Frontiers in Public Health, 10.* https://doi.org/10.3389/fpubh.2022.904588

Gardner, T. (2022, June 9). Russia's energy revenue higher now than just before Ukraine war, U.S. official says. Reuters.

Harvey, A., Ruiz, E., & Shephard, N. (1994). Multivariate Stochastic Variance Models. *The Review of Economic Studies, 61*(2), 247–264. https://doi.org/10.2307/2297980

Ibadoghlu, G. (2022). Will Azerbaijan Be Able to Become A Reliable Gas Supplier For Europe? Available at SSRN 4236352.

IEA. (2022a). A 10-Point Plan to Cut Oil Use. https://www.iea.org/reports/a-10-point-plan-to-cut-oil-use

IEA. (2022b). A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas. https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas

IRENA. (2022). World Energy Transitions Outlook 2022. https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022

Jain, N., Panag, D. S., Srivastava, M., Mohan, S., Chodnekar, S.Y., Akbari, A.R., Raj, D., Kravarioti, D., Świątek, D., Platos, E., Khetsuriani, K., Gristina, K.L., Evangelou, K., Lica, M., Thirumushi, R.S., Rozani, S., Jain, S., Fedirko, P., Reinis, A., & Pilmane, M. (2022). Fate and future of the medical students in Ukraine: A silently bubbling educational crisis. *Medical Education, 56*(8), 779-782. https://doi.org/10.1111/medu.14818

Jonsson, O., & Seely, R. (2015). Russian Full-Spectrum Conflict: An Appraisal After Ukraine. *The Journal of Slavic Military Studies, 28*(1), 1-22. https://doi.org/10.1080/13518046.2015.998118

Kunkel, S., & Ellis, M. K. (2023). Violence as a Condition: The Threat Posed by Quasi-PMCs.

Kuzemko, C., Blondeel, M., Dupont, C., & Brisbois, M. C. (2022). Russia's war on Ukraine, European energy policy responses & implications for sustainable transformations. *Energy Research & Social Science, 93,* 102842. https://doi.org/https://doi.org/10.1016/j.erss.2022.102842

Laborde Debucquet, D., & Mamun, A. (2022). Documentation for Food and Fertilizers Export Restriction Tracker: Tracking export policy responses affecting global food markets during crisis. https://doi.org/10.2499/p15738coll2.135857

Le Monde. (2022, September 2). Despite climate commitments, the EU is going back to coal. Le Monde. https://www.lemonde.fr/en/economy/article/2022/09/02/despite-climate-commitments-the-eu-is-going-back-to-coal_5995594_19.html

Leigh, A., Wolfers, J., & Zitzewitz, E. (2003). What Do Financial Markets Think of War in Iraq? https://doi.org/10.3386/w9587

Lewtak, K., Kanecki, K., Tyszko, P., Goryński, P., Kosińska, I., Poznańska, A., Rząd, M., & Nitsch-Osuch, A. (2022). Hospitalizations of Ukrainian Migrants and Refugees in Poland in the Time of the Russia-Ukraine Conflict. *International Journal of Environmental Research and Public Health, 19*(20). https://doi.org/10.3390/ijerph192013350

Liao, S. (2023). The Russia–Ukraine outbreak and the value of renewable energy. *Economics Letters, 225*, 111045. https://doi.org/10.1016/j.econlet.2023.111045

Lin, F., Li, X., Jia, N., Feng, F., Huang, H., Huang, J., Fan, S., Ciais, P., & Song, X.-P. (2023). The impact of Russia-Ukraine conflict on global food security. *Global Food Security, 36*, 100661. https://doi.org/https://doi.org/10.1016/j.gfs.2022.100661

Liu, Y., Han, L., & Xu, Y. (2021). The impact of geopolitical uncertainty on energy volatility. International *Review of Financial Analysis, 75*, 101743. https://doi.org/10.1016/j.irfa.2021.101743

Lo, G.-D., Marcelin, I., Bassène, T., & Sène, B. (2022). The Russo-Ukrainian war and financial markets: the role of dependence on Russian commodities. *Finance Research Letters, 50*, 103194. https://doi.org/10.1016/j.frl.2022.103194

Mathis, W., & Wade, W. (2022, March 1). Green energy stocks surge as war spurs push away from Russia and fossil fuels. The Japan Times.

Mbah, R.E., & Wasum, D.F. (2022). Russian-Ukraine 2022 War: A review of the economic impact of Russian-Ukraine crisis on the USA, UK, Canada, and Europe. *Advances in Social Sciences Research Journal, 9*(3), 144-153.

Mohammed, K.S., Usman, M., Ahmad, P., & Bulgamaa, U. (2022). Do all renewable energy stocks react to the war in Ukraine? Russo-Ukrainian conflict perspective. *Environmental Science and Pollution Research, 30*(13), 36782-36793. https://doi.org/10.1007/s11356-022-24833-5

Nerlinger, M., & Utz, S. (2022). The impact of the Russia-Ukraine conflict on energy firms: A capital market perspective. *Finance Research Letters, 50*, 103243. https://doi.org/https://doi.org/10.1016/j.frl.2022.103243

Noguera-Santaella, J. (2016). Geopolitics and the oil price. *Economic Modelling, 52*, 301-309. https://doi.org/10.1016/j.econmod.2015.08.018

Ociepa-Kicińska, E., & Gorzałczyńska-Koczkodaj, M. (2022). Forms of Aid Provided to Refugees of the 2022 Russia– Ukraine War: The Case of Poland. *International Journal of Environmental Research and Public Health, 19*(12). https://doi.org/10.3390/ijerph19127085

Osendarp, S., Verburg, G., Bhutta, Z., Black, R. E., de Pee, S., Fabrizio, C., Headey, D., Heidkamp, R., Laborde, D., & Ruel, M. T. (2022). Act now before Ukraine war plunges millions into malnutrition. *Nature, 604*(7907), 620-624. https://doi.org/10.1038/d41586-022-01076-5

Pham, T., Talavera, O., & Wu, Z. (2023). Labor Markets during War Time: Evidence from Online Job Ads (Issues 23–03). https://ideas.repec.org/p/bir/birmec/23-03.html

Pradhan, A.K., & Tiwari, A.K. (2021). Estimating the market risk of clean energy technologies companies using the expected shortfall approach. *Renewable Energy, 177*, 95–100. https://doi.org/10.1016/j.renene.2021.05.134

Samokhvalov, V. (2015). Ukraine between Russia and the European Union: Triangle Revisited. *Europe-Asia Studies, 67*(9), 1371-1393. https://doi.org/10.1080/09668136.2015.1088513

Sokhanvar, A., & Bouri, E. (2023). Commodity price shocks related to the war in Ukraine and exchange rates of commodity exporters and importers. Borsa Istanbul Review, 23(1), 44-54. https://doi.org/https://doi.org/10.1016/j.bir.2022.09.001

Svarin, D. (2016). The construction of ‘geopolitical spaces’ in Russian foreign policy discourse before and after the Ukraine crisis. Journal of Eurasian Studies, 7(2), 129-140. https://doi.org/10.1016/j.euras.2015.11.002

Taylor, S.J. (1986). Modelling Financial Time Series. Wiley: Chichester.

Tosun, O.K., & Eshraghi, A. (2022). Corporate decisions in times of war: Evidence from the Russia-Ukraine conflict. *Finance Research Letters, 48*, 102920. https://doi.org/10.1016/j.frl.2022.102920

Wang, Y., Bouri, E., Fareed, Z., & Dai, Y. (2022). Geopolitical risk and the systemic risk in the commodity markets under the war in Ukraine. *Finance Research Letters, 49*, 103066. https://doi.org/https://doi.org/10.1016/j.frl.2022.103066

Yahoo Finance. (2023a, March 25). Crude Oil May 23 (CL=F). https://finance.yahoo.com/quote/CL%3DF/history?period1=1643587200&period2=1656547200&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true

Yahoo Finance. (2023b, March 26). Gold Apr 23 (GC=F). https://finance.yahoo.com/quote/GC%3DF/history?period1=1640995200&period2=1672531200&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true

Yousaf, I., Patel, R., & Yarovaya, L. (2022). The reaction of G20+ stock markets to the Russia–Ukraine conflict “black-swan” event: Evidence from event study approach. *Journal of Behavioral and Experimental Finance, 35*, 100723. https://doi.org/10.1016/j.jbef.2022.100723

Yu, J., & Meyer, R. (2006). Multivariate Stochastic Volatility Models: Bayesian Estimation and Model Comparison. *Econometric Reviews*, *25*(2-3), 361-384. https://doi.org/10.1080/07474930600713465

Zanin, M., & Martínez, J.H. (2022). Analyzing international events through the lens of statistical physics: The case of Ukraine. *Chaos: An Interdisciplinary Journal of Nonlinear Science, 32*(5), 051103. https://doi.org/10.1063/5.0091628

Zhou, C., Zhu, B., Davis, S.J., Liu, Z., Halff, A., Arous, S. B., de Almeida Rodrigues, H., & Ciais, P. (2023). Natural gas supply from Russia derived from daily pipeline flow data and potential solutions for filling a shortage of Russian supply in the European Union (EU). *Earth System Science Data, 15*(2), 949-961. https://doi.org/10.5194/essd-15-949-2023