

Impact of Macroeconomic Factors on S&P Europe 350 ESG Index During the Russo-Ukrainian War

Muhammad Muddasir^{*} , M. Camino Ramon-Llorens^{**}

Abstract: The Russo-Ukrainian War, which began on February 24, 2022, has introduced significant economic and geopolitical instability. This study aims to investigate the specific impact of key macroeconomic variables - interest rates, exchange rates, inflation, oil, and gas prices—on the S&P Europe 350 ESG Index (SPEESEP) during this conflict. By analyzing daily data spanning 20 months from April 20, 2021, to November 30, 2022, encompassing both pre-war and post-war periods, we employ the Wavelet Coherence Transformation (WCT) method to examine these relationships. Our findings reveal that exchange rates, oil, and gas prices significantly impact the ESG index, while interest rates and inflation exhibit a moderate influence. These results underscore the importance of understanding macroeconomic fluctuations during geopolitical crises for informed investment decisions. The broader significance of this study lies in its potential to guide investors in navigating the complexities introduced by geopolitical conflicts, thereby aiding in better financial decision-making and risk management. By developing appropriate regulations for the ESG industry, this research can contribute to minimizing risks and maximizing profits in volatile environments. As geopolitical risks are a persistent factor in investing, this study emphasizes the necessity for investors to meticulously evaluate these risks when devising investment strategies.

Keywords: Russo-Ukrainian War; S&P Europe 350 ESG index; inflation; exchange rate; oil & gas; EURIBOR; Wavelet Coherence transformation (WCT) method.

JEL classification: F51; N4; G41; O16.

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1. INTRODUCTION

It's doubtful whether the COVID-19 outbreak has totally abated at this point, despite the fact that it began a little more than two years ago. However, the impacts of the crisis in Ukraine must be taken into account as businesses and countries adjust their operations, creating an unexpected new challenge. Corporate executives, entrepreneurs, and government policymakers need to be familiar from the possible consequences of ongoing conflict on the financial system and business in order to achieve this.

The Russo-Ukrainian War, which began on February 24th, 2022, has brought considerable economic and geopolitical instability. As businesses and countries adjust their operations to this unexpected challenge, it is essential for corporate executives, entrepreneurs, and government policymakers to understand the potential consequences of this ongoing conflict on the financial system and business environment.

ESG (Environmental, Social, and Governance) considerations have gained prominence in investment strategies, with research suggesting that ESG-compliant companies may exhibit lower systemic risk exposure (Cerqueti *et al.*, 2021). Studies by Billio *et al.* (2012) and Tobias and Brunnermeier (2016) the importance of identifying key economic players and assessing their systemic risk. Analyzing the impact of sustainability on systemic risk is a crucial extension of this research.

According to Cerqueti *et al.* (2021), ESG investments may help lower systemic risk, with companies adhering to ESG criteria being less vulnerable to systemic shocks. They suggest that firms with higher ESG scores tend to have better stakeholder relations due to more transparent governance. Additionally, investors in ESG assets are less likely to liquidate their investments during market crises, viewing these investments as long-term commitments. However, there is evidence that ESG components might qualify as systemic risk factors (Leterme, 2020). Apergis *et al.* (2022) suggests that the relationship between a company's financial success and ESG scores can be neutral or even negative, while others have identified a positive correlation. This conflicting evidence underscores the need for further research to clarify these relationships.

The Russo-Ukrainian War, as proposed by Lim *et al.* (2022), affects businesses through reduced access to capital, decreased purchasing power, threats to sustained development, increased inflation, and trade restrictions due to economic sanctions. Furthermore, the current COVID-19 crisis has adversely impacted private enterprises, leading to a sudden decline in profitability and issues with timely shifting expenditures (ECB, 2022b). These dual crises highlight the importance of understanding how macroeconomic variables influence financial markets, particularly ESG indices.

This study aims to fill existing gaps by analyzing the impact of macroeconomic factors on the S&P Europe 350 ESG Index (SPEESEP) during the Russo-Ukrainian War. Specifically, we examine the influence of interest rates, exchange rates, inflation, oil, and gas prices on the SPEESEP index returns, utilizing wavelet coherence transformation for data analysis. By elucidating the relationship between these macroeconomic variables and the SPEESEP index, this research seeks to provide valuable insights for investors, analysts, and policymakers.

Understanding the economic ramifications of the conflict in Ukraine and its implications for the ESG sector can inform strategic decision-making and risk management practices, ultimately enhancing the sustainability and competitiveness of businesses in the face of evolving challenges. This study aims to benefit analysts and the general public by providing

comprehensive information on the impact of macroeconomic risk factors on the ESG sector. The insights gained can help investors identify and mitigate the effects of macroeconomic fluctuations on their investments, thereby minimizing risk and maximizing profits through informed policy implementation within the ESG industry.

In conclusion, this research not only addresses the immediate impact of the Russo-Ukrainian War on the SPEESEP index but also contributes to the broader understanding of how geopolitical crises can influence financial markets. By developing appropriate regulations for the ESG industry, this study can help minimize risks and maximize profits, ensuring that businesses remain sustainable and competitive in the face of ongoing and future challenges.

1.1 Background Studies

1.1.1 Russia-Ukraine War

Russia started invading Ukraine on 24, February 2022. In connection with this invasion, there were strikes that caused deaths and destroyed buildings, including homes, schools, and hospitals. The laws of war have been broken by indiscriminate, maybe war crime-level attacks. By the end of the first week of conflict, over a million people had left their homes in Ukraine, many of them were fleeing for safety abroad. Popular independent media outlets in Russia were forced to close as a result of the government limiting access to various independent media websites because of their stories about the conflict. Numerous anti-war protesters were wrongfully imprisoned during the first week of the war all over Russia. The EU and its allied nations ought to grant each refugee from Ukraine a fair shot for travel and treatment.

1.1.2 S&P Europe 350 ESG Index

Acknowledging the S&P Europe 350 is the first step to understanding the SPEESEP index. The S&P Europe 350 ESG Index is a broad-based, real-world index that consists of stocks from all sectors of the European equity market. It is designed to reflect the performance of the entire stock market with a large number of international companies and consider their sustainability and social characteristics in addition to their financial aspects. The index can be viewed as a European version of the global S&P 500 index.

The SPEESEP Index provides information on a variety of sustainability issues, including governance, the environment, tax strategy, risk culture, human rights, gender diversity, cyber security, and many more, rather than concentrating on just one component of ESG. The index incorporates ESG ratings from each organization's 600 to 1,000 sample points on particular subjects.

1.1.3 ESG Repercussions of the Russo-Ukrainian War

It is difficult to predict the exact effects at this time, but the region will become de facto uninvestable due to the sanctions in place and the fact that, as was already mentioned, Russia is anticipated to be excluded from many policy benchmarks. From the standpoint of foreign investors, this will have disastrous effects on Russian businesses. Although it is still too early to tell, it will be interesting to watch if Russia exposure is ever considered when calculating ESG scores.

We think that one long-term effect of the conflict is the acceptance rate of natural gas and nuclear as long-term bridge fuels. This outlook is not specifically determined by a choice to alter the EU energy taxonomy; rather, it is determined by economic and energy security considerations. Another potential side effect is a loosening of regulations with regard to the timelines for decarbonization.

However, the desire for greater autonomy from fossil fuels may ultimately enhance decarbonization measures. Keep in mind that more than 90% of the world's GDP comes from net energy consumers, and almost 90% more of the world's emissions are already met by zero commitments. These commitments will help the renewable energy sector; thus, this crisis may speed up the geopolitical benefits for renewables. This might allay some concerns about potential excess investment in and potential oversupply of renewable energy sources, which are essential to a net zero pathway.

Particularly in light of the European LNG shock, the US shale sector may emerge as a significant and long-term victor from the crisis. Similar to LNG, non-Russian natural gas is expected to experience a boom period along the full value chain.

A review of the world energy market is necessary. Although Russian production growth has been slowing, the reduction will probably be far more severe now that sanctions are in effect (even accounting for potential Chinese investment). The disagreement might push the floor price for crude oil further higher.

1.1.4 Macroeconomic Risk Factors

A country will take the macroeconomic indices into account when comparing the economies of different Countries. Each macroeconomic component produces important data to promote a nation's development depending on its internal activity and global connections. By allowing us to determine which activities have the greatest potential and which components are the weakest, macroeconomic analysis empowers us to take actions that are advantageous to the citizens of the nation and grow the economy.

Following are the few macroeconomic indicators that are being considered in this study for the EU are: Exchange rates, Interest rates, Inflation, Oil Prices and gas price.

2. LITERATURE REVIEW

Increased access to fossil fuels was made more dubious by the unplanned invasion of Ukraine by Russia, but it also may have opened up new opportunities for developing alternative energy sources and making investments in the green energy sector. In order to diversify the risk associated with financial markets, investors will be urged to shift their investment portfolios toward alternative assets. However, it is still difficult to predict how the war will ultimately affect the entire economy, which is currently reflected in rising energy costs and the response of global financial markets (Lo *et al.*, 2022).

According to Deng *et al.* (2022), stocks are more sensitive to the significant compliance of the shift to a low-carbon society fared better in reaction to the Russia-Ukraine conflict, indicating that investors anticipate a general slowing in this transition. In the US, these effects on stock prices were particularly potent. The impacts were less evident or possibly the opposite in Europe. It may be argued that market participants initially anticipated more aggressive policy measures in favor of renewable energy sources in Europe. Investors

believed that the US Inflation Reduction Act and the REPowerEU approach would boost the worth of companies with prospects in the renewable energy sector. They additionally anticipated a rise in the value of US companies that benefit from a moratorium on the regulation of harmful technologies. Overall, the results indicate that there will likely be differences in decarbonization intensity between countries, putting the accomplishments won so far in the fight against climate change at risk due to geopolitical tensions.

The appeal of sustainable investments, according to [Kick and Rottmann \(2022\)](#), is unwavering and draws both investors and scholars. In their theoretical model for simulating the characteristics of such "green" enterprises, [Pástor et al. \(2021\)](#) take a precaution against climate hazards. Similarly, it might be believed that organizations with high social ratings might provide protection from similar occurrences. One of the largest events imaginable occurred when Russia invaded Ukraine. They examined whether and how the cumulative anomalous returns during various event windows are affected by Refinitiv's ESG ratings in addition to the CO2 intensity. They discover that the pre-and post-event timeframe has a positive impact on the anomalous returns of businesses with high ecological ratings. However, the consequences have no bearing on the economy. They concluded that the data did not entirely support the idea of an "ESG-hedge" against such a rare occurrence. If such a phenomenon exists, additional traits that account for consistency and defensiveness have superimposed it.

[Basdekis et al. \(2022\)](#) try to use daily data to investigate whether there are any relationships between particular crude oil prices, foreign exchange rates, and stock market indexes from January 2021 to July 2022. The COVID-19 post-vaccination phase and the Ukraine War are covered during the time frame we have selected. This makes it easier for us to refer to the time during the Ukraine War and energy crisis as the extent of unstable situation. The research's findings show that there are significant correlations between all of the variables over a range of frequencies and time scales over the study period. The fact that the RTSI strongly influences the American and European stock markets, as well as the development of the Russian ruble, during the crisis is particularly intriguing. Additionally, it appears that the dependency among crude oil and RTSI is influenced by capital restrictions on the Russian stock market as well as rising demand for the commodity. The analysis also discovered an intriguing negative association in low-frequency bands between crude oil and the US stock index as well as the Eurostoxx and RTSI at the time of the pre-war and post-vaccination periods. Investors and asset managers can both use these results to reduce risk and make more certain investment decisions. Additionally, policymakers might utilize these insights to create regulatory strategies for limiting systemic risks in the capital markets.

How the Russo-Ukrainian dispute impacts the European financial markets is examined by [Ahmed et al. \(2023\)](#). The objective is to ascertain why these markets respond badly to this crisis, given the increased political unpredictability, close proximity, and implications of the new sanctions placed on Russia. They discovered that European stocks saw a large negative anomalous return after Russia designated two Ukrainian territories as independent areas. Additionally, the unfavorable stock price reactions persisted in the days following the occurrence. The severity of the stock market responses to this crisis differs significantly between industries, nations, and firm sizes.

According to [Adekoya et al. \(2023\)](#), Various crises that could happen at the national, regional, or worldwide levels regularly have a negative impact on the stock markets. They are examining the cross-correlation and multifractality between oil prices and top financial markets in world, before and during the most recent Russia-Ukraine conflict. In the oil and

stock markets, their empirical study identifies a strong multifractal behavior. Nevertheless, endurance is typically greater at the lower scales, which correspond to the start of the sampled eras. Additionally, the conflict has a strong explicit impact on how long do stock markets of Europe and oil prices last. On the other hand, it has a bigger implicit effect on the survival of the non-European financial markets over the price of oil. The world's three greatest economies are those of the US, China and Japan. However, during the conflict, all the countries were more affected by oil prices since their stock markets were less effective.

In times of increasing geopolitical risk, the study's main objective is to investigate the spillover effects of the dirty and green energy markets vs the global stock indices. They analyzed structural breaks, volatility interconnectedness indices based on the unique method suggested by [Diebold and Yilmaz \(2012\)](#), and volatility connectedness indices to indicate significant changes in shock transmission during in the period from Aug-2014 to May-2022. They also look into the benefits and drawbacks of using heterogeneous diversity in green energy hedging techniques. Estimated for risk diversification and mitigation are ideal weights and hedge ratios. They discover that while global equity markets generally exhibit more risk than clean energy indices, the expense of hedging in sustainable energy assets is higher. ([Karkowska and Urjasz, 2023](#))

The crisis in Ukraine could have long-term effects with broad-reaching effects on availability and commodity pricing. Manufacturing, demand, and distribution of commodities will change as countries work to become more self-sufficient, creating opportunities for new providers. The likelihood of how long the conflict lasts and exactly how it affects supply chains will have a significant impact on commodity markets. Due to the conflict, trading is becoming increasingly expensive, and the fossil fuels trade has substantially diverged ([Josephs, 2022a](#)).

If Russia and Ukraine start a conflict, the problems with the supply chain will get worse, increasing the price of commodities. The industries with the largest worldwide manufacturing networks and the most reliance on energy and metal resources will face the biggest obstacles ([S&P Global, 2022](#)).

The fuel industries, particularly those engaged in power production and oil refinery, mining, transport services, and chemicals, will collapse first because Russia is a resource supplier to Europe ([S&P Global, 2022](#)). Russian fuel supply restrictions could cause energy shortages and price spikes ([Bundesbank, 2022a](#)).

The best gas and oil analytics company across the globe, Rystad Energy, estimates that 410 Mn. tons of LNG will be produced in 2022, compared to 436 Mn. tons of demand ([GWN, 2022](#)). According to this, demand will increase by 6.3% more than supply, signaling an LNG shortfall. Consider the effects of supply shocks on prices as an illustration.

Approximately 80% of natural gas Austria receives from Russia, has started releasing tenders to replace its reservoirs after announcing that a stoppage from its main supplier would cause a recession across the entire country. Austria built a tactical gas resource before the winter season by first procuring gas at a 45% premium over European base pricing ([Bloomberg, 2022b](#)).

Since the economy started to recover from COVID-19 pandemic, one of the primary causes of inflation [Elbahnasawy and Ellis \(2022\)](#). A shift in the market equilibrium will result in a decrease in GDP and an increase in inflation when the pressure of inflation is too great [Roubini \(2022\)](#). Oil and food prices will rise, further worsening the already unsustainable rate of inflation ([Krugman, 2022](#)).

According to one of the largest financial institutions in the world, BlackRock, the EU countries will invest more on energy in 2022, about 9% of their GDP (Bloomberg, 2022a). Commodity price increases accelerate the already high global inflation rate (Josephs, 2022a). Rising energy prices are responsible for most of the current inflation increase (ECB, 2022a).

Due to a strong increase in the price of commodities, Germany's industrial production price growth index jumped from 30.9% in March to 33.5% in April 2022 (DeStatis, 2022). The inflation rate has risen for two consecutive months at the end of March 2022, reaching 15.6% in Lithuania, 11.5% in Latvia, 14.8% in Estonia, 7.6% in Germany and 7.8% in the EU (Statista, 2022). The price of commodities in Germany increased 2.5% in March 2022 relative to February after being seasonally adjusted. One of the highest inflation in Germany since 1981 (Bundesbank, 2022b).

After reviewing a few research that examined into how the value of various international currencies compared to the USD and likewise. The conflict between Russia and Ukraine had an influence on stock market indices. Given the small number of research that have looked at the effectiveness of the currency exchange market, researchers used the event study approach with market model estimates to analyze the performance of the USD against the other exchange rate during the Russo-Ukrainian war (Dewenter *et al.*, 2005; Hayward, 2018).

The impact of exchange rates on international trade is another justification for studying exchange rates, according to several hypotheses. One of these ideas, the flow-oriented strategy, asserts that exchange rates with weaker signal have less expensive exports, enhancing the ability of companies with an export focus to compete (Bahmani-Oskooee and Saha, 2016).

In the short term, Nusair and Olson (2022) supported the flow-oriented strategy. Furthermore, Lyócsa and Plíhal (2022) explained that how the conflict influenced unstable exchange rates, especially the value of the Russian ruble. They also think that other currencies would eventually be impacted by the war's shock.

Chortane and Pandey (2022) investigates how the Russo-Ukrainian conflict impacts the value of several world currencies in comparison to the USD by using market model projections and event analysis techniques. But a region-by-region analysis reveals that the Middle East and African (ME&A) currencies are modest while the Pacific currencies significantly increased, European currencies – mainly the Russian ruble, Polish zloty and Czech koruna depreciated against the US dollar. They illustrate how the Russo-Ukrainian conflict impacted the global currency values. They also demonstrate the steep decline in the value of the Polish zloty and Czech koruna in relation to the US dollar as a consequence of the monetary and financial sanctions placed on Russia.

Notably, swings in energy prices have a significant impact on all parts of the economy, particularly financial markets, through exchange rates (Qiang *et al.*, 2019). In certain research, the important oil or -exporting economies are examined in relation to the oil price and FX rate nexus. One of them, , demonstrates a strong impact of oil rates on real FX rates in Venezuela using the vector error correction model (VECM). In Japan, Uddin *et al.* (2013) find a similar link. According to some analyses, During the 2008 financial crisis, the correlation among oil prices and FX rates grew more interdependent (e.g., Ding and Vo, 2012; Ji *et al.*, 2020). The correlation of currency fluctuations with commodity prices is examined by Salisu *et al.* (2019). Their approach demonstrates that the accuracy of forecasting decreases with lower data frequency and also is enhanced by adding structural breaks and asymmetry. They obtained five important trading currency pairs and disaggregated commodity price indices. Kassouri and Altıntaş (2020) look into how trade shocks affect currency rates in several

African nations. According to their analysis, the impact is particularly noticeable in the nations that export energy.

One of the main sources of energy in the world, oil and natural gas, are being affected by Russia's invasion of Ukraine. In addition, it appears that the war's effects on the oil sector are distinct from those of other crises. Oil prices increased significantly during the Russo-Ukrainian war while falling amid the financial crisis of 2007–2008 and the COVID-19 outbreak. Geopolitical concerns, according to [Gong and Xu \(2022\)](#), have a considerable impact on the interconnection of commodity markets as a whole, but they significantly affect the net spillover of different commodity markets.

[Fahmy \(2022\)](#) emphasizes how concerned investors are about green investments and how their understanding of climate hazards is expanding, particularly in the wake of the Paris Agreement. The author makes the argument that growing public knowledge becomes a factor on how prices of clean energy relate to those of oil and technology companies. The impact of high oil price on green power equities differs across equity investments and quantiles and is asymmetry in the long term, according to [Zhang et al. \(2020\)](#), who used quantile-on-quantile wavelet methodology to make their discoveries. Similar to this, [Yahya et al. \(2021\)](#) examined the link among the renewable energy equities and price of oil, and discovered non-linear, long-term relationships between the two categories of assets. They specifically acknowledged that renewable energy assets have been the main driver of the oil prices in the recent aftermath of the financial crisis. Last but not least, it is yet unknown how well the Russian invasion affects the worldwide movement toward renewable energy.

Using a sizable panel of 73 nations, [Lo et al. \(2022\)](#) determines the effects of the Russian invasion on financial system, which are influenced by the nation's reliance on Russian commodities. The authors noted that as a result of the war, financial markets witnessed an increase in price fluctuations and a fall in asset returns. Their findings demonstrate that, regardless of the degree to which the country is dependent on Russian commodities, the continuous war has a negative influence on stock markets which raises volatility.

According to early evidence of conflict, the government's support for the progressive phase-out of energy resources and the adoption of renewable energy alternatives is provided by [Steffen and Patt \(2022\)](#). The authors found that the Swiss people strongly supported sustainable energy policy; nevertheless, public funding must be converted into political action. The link between the financial market and energy during turbulence has been brought to light by the findings of earlier investigations. Tension between the Russia and Ukraine's effects and the COVID19 epidemic on the framework connecting dirty and clean energy with the financial market, however, has not been the subject of any study. Finding the connections is crucial for governments and regulators to manage potential market volatility in the energy and stock markets, as well as for investors developing an investment strategy.

Investors that concentrate on hedging methods for investments in the stock market and global energy markets can benefit from the knowledge provided by empirical studies. [Managi and Okimoto \(2013\)](#) discover a favorable correlation between the cost of non-renewable energy and the clean energy cost. They also highlight the parallels between the market reactions to the stock prices of IT and clean energy company's stock.

In the [next section](#) of this paper, we discuss the methodology in which we go over the methods employed as well as the datasets and their sources. [Next](#), we apply the techniques and discuss our own research [findings](#) and [conclusions](#). Lastly, we discuss the study's limitations and how they can be overcome in future studies.

3. METHODOLOGY & DATA

Sampling of Data

In our research, we take the sample of daily frequency closing prices of S&P Europe 350 ESG index (SPEESEP) from Thomson Reuters Eikon and the data stream. To check the impact of Macro-economic variables on the mentioned index, we take 5 different variables data sets those are Inflation, exchange rate, interest rate, oil, and gas. All data frequency is daily, and sources are mainly ECB and Eurostat. The sample period contains April 20, 2021, to Nov 30, 2022. Relative returns are calculated for SPEESEP as $(R_t - R_{t-1})/R_{t-1}$.

Variables

For Inflation variable, we selected Harmonized Index of Consumer Prices (HICP) of EU27. The ECB uses the HICP as a gauge for inflation and price stability. It is a consumer price index that was developed using a technique that was standardized among EU member states. For Interest rate, we selected monthly EURIBOR and convert into daily rate. For exchange rate the variable we use in our research is EURO/USD. For oil variable we use Crude Oil Prices: Brent - Europe (MCOILBRENTU) from www.fred.stlouisfed.org and lastly, for gas we choose EU natural gas TTF prices.

Analytical Techniques

We used the wavelet Coherence Transformation (WCT) method as Kuşkaya *et al.* (2021) to analyze the time and frequency dependencies for each pair of variables. The dependent variable in our research is SPEESEP relative return, and independent variables are Inflation, exchange rate, interest rate, oil, and gas.

Rationale for Methodological Choices

Fourier and wavelet transforms come first when discussing time series models for the economics and finance sectors. In spectral decomposition one of the techniques is the Fourier transform, it is a transformation technique that allows analysis. In the Fourier transform, the conversion of the frequency domain into the time domain is a function.

For each frequency, need to determine the Fourier functions' coefficients (Graps, 1995). The Fourier transforms a signal, when it shows the contain frequency, at which time what frequencies are available in the tranche that does not provide information about it. So, the information provides by Fourier transformation is about the whole time period not for just a specific time period. Hence the Fourier transform, analyzing signals whose frequency does not vary over time is a successful approach. Because of this property the scale-based analysis method in the study is the "wavelet analysis method" that we are going to use.

Theoretical Framework

The theoretical framework of this study is based on the application of spectral decomposition techniques to analyze economic and financial time series. Traditional Fourier

transform methods, which analyze signals with constant frequency over time, fall short when dealing with non-stationary data, where frequency content changes dynamically. To address this limitation, we employ the Wavelet Transform (WT), a sophisticated method that simultaneously analyzes data in both time and frequency domains. This allows for the decomposition of a time series into various frequency components and provides detailed insights into each component's behavior over time. The WT, particularly the Continuous Wavelet Transform (CWT), enables us to capture transient features and localize variations within the data, making it ideal for our study's focus on non-stationary economic indicators. Using wavelet analysis, we can discern both high-frequency, fast-changing patterns and low-frequency, slow-changing trends, thus offering a comprehensive understanding of the relationships between the S&P Europe 350 ESG Index and macroeconomic variables. This dual capability of wavelets to examine both the "tree and the forest" simultaneously is crucial for identifying intricate dependencies and temporal dynamics within the data (Graps, 1995; Zhao *et al.*, 2004). A linear combination of the Fourier transform can also be used to define the wavelet function (also known as the mother wavelet function). However, $b \in \mathbb{R}$ and $a \in \mathbb{R}^+$, to be provided, each scaled wavelet function and the transformed $\beta(a, b)(t)$ may be written as follows according to the mother wavelet:

$$\beta(a, b)(t) = \frac{1}{\sqrt{|a|}} \beta\left(\frac{t-b}{a}\right) \quad (1)$$

where the term $1/\sqrt{|a|}$ is the factor representing the normalization that determines the wavelet's unit variance. The mother represents the wavelet $\beta(\cdot)$, which also includes the two control parameters a (scale) and b (position). Parameter ω is the conversion or position parameter. This variable affects the wavelet's position and orientation in the time domain. In equality, a is the parameter that controls the wavelet width. Additionally, it displays where the wavelet is in the frequency domain. Fast-changing features can be caught at lower scales, or high frequencies, when scale is analyzed in terms of frequency, whereas slower-changing patterns can be obtained at higher scales, or low frequencies. This instance demonstrates the adverse correlation between scale and frequency. Continuous Wavelet Transform (CWT), wavelet $\beta(a, b)(t)$ with respect to $\ddot{x}(t) \in L^2(\mathbb{R})$'s examined the time series of a particular wavelet, $\beta(\cdot)$, as can be described as follows:

$$W_{\ddot{x}}(a, b) = \int_{-\infty}^{\infty} \ddot{x}(t) \frac{1}{\sqrt{|a|}} \beta^*\left(\frac{t-b}{a}\right) dt \quad (2)$$

where $W_{\ddot{x}}(a, \omega)$ represents WCT. The $*$ in the equation shows the complex conjugation. On the other hand, small waves are referred to as wavelets, which differ from larger waves in many ways. In this sense, wavelets are categorized into various classes based on their traits. These wavelets can be classified into the following types: Mexican hat, Morlet, Meyer, Shannon, Biorthogonal, Daubechies, Symlets, Coiflets, and Haar. The Morlet wavelet transform can be used to assess both the amplitude and the phase because it has both real and imaginary portions. For time-frequency analysis, Morlet wavelet analysis has various benefits. The most important of these advantages is the Gaussian curve of the Morlet wavelet in the frequency domain. This characteristic reduces ripple effects that could be mistaken for oscillations by eliminating sharp edges (Cohen, 2019). The wavelet function, as described by Grossmann and Morlet (1984), is written as:

$$\lambda_{\varphi}(t) = \pi^{-1/4}(\exp^{i\varphi t} - \exp^{-\varphi^2/2})\exp^{-t^2/2} \quad (3)$$

Here the symbol φ indicates the central frequency parameter $\lambda\varphi(t)$ of the Morlet wavelet. In addition, φ determines how many oscillations there are in the Gaussian envelope. Thus, it is possible to provide better frequency location by increasing φ (Addison, 2017). The term $\exp^{-\varphi^2/2}$ is the complex sine wave's non-zero average is corrected by the correction parameter in the equation. However, when $\varphi > 5$, this situation can be neglected.

Cross-wavelet power, two time series, $Wxy(a, b)$ time-series can be defined as the correlation among the local covariance and the scale (frequency band) at each instant. Hudgins *et al.* (1993) were the first to identify the cross-wavelet power of $x(t)$ and $y(t)$ of two time series, it is as follows:

$$W_{xy}(a, b) = W_x(a, b) \overline{W_y(a, b)} \quad (4)$$

where, $Wx(a, b)$ and $Wy(a, b)$, $Wxy(a, b)$ as is the WCT of the time-series of $x(t)$ and $y(t)$. So, the cross is the wavelet power. Cross-wavelet transformations, both in time series, each time series that represents the covariance between the local areas with high joint strength scale shows (Vacha and Barunik, 2012).

Corresponding to Aguiar-Conraria *et al.* (2013), $Wx(a, b)$ and $Wy(a, b)$ are two of the time series of Harmony wavelet (wavelet coherency) is defined as follows:

$$R_{xy}(a, b) = \frac{|\mathcal{S}(W_{xy}(a, b))|}{\mathcal{S}(|W_{xx}(a, b)|)^{1/2} \mathcal{S}(|W_{yy}(a, b)|)^{1/2}} \quad (5)$$

In the equation R_{xy} represents the correlation. This value is a parameter that Decays between 0-1. If there is strong consistency among the frequency and time domain, the correlation will be equal to "1", if there is no consistency, the correlation will be equal to "0". Additionally, $\mathcal{S}$ denotes the smoothing parameter. If this correction does not happen, the consistency will always be strong, that is, "1". The analysis of the phase difference, for example, the correlation's direction (positive and negative correlation) also, the premise behind it (lead or lag) the remaining components such as the relationship between the phase gives the opportunity to identify relationships. The difference between the phase $x(t)$ and $y(t)$ time series is between (ξx , $y \in [-\pi, \pi]$) with the relationship can be defined as in equation (6):

$$\xi_{xy}(a, b) = \arctan\left(\frac{\mathcal{I}(W_{xy}(a, b))}{\mathcal{R}(W_{xy}(a, b))}\right) \quad (6)$$

In the equation, $\mathcal{I}(W_{xy})$ and $\mathcal{R}(W_{xy})$ represent real and imaginary sections, correspondingly. If, $\xi_{xy} \in (0, \pi/2)$ if it is, the series will move in phase and $x(t) \rightarrow y(t)$ ye will lead. If $\xi_{xy} \in (0, -\pi/2)$ if, then the series will move in phase again, and in this case $y(t)$ is in the leading state. If $\xi_{xy} \in (\pi/2, \pi)$ then, the anti-phase decoupling between the variables is there, the series will move out of phase in this instance, and $y(t)$ is in the leading state. When the phase difference is π or $-\pi$, this shows that there is an anti-phase relationship. If $\xi_{xy} \in (-\pi, -\pi/2)$ on contrary, there is an anti-phase relationship and $x(t)$ is in the leading position. Finally, if the phase difference is at zero, in this case, $y(t)$ and $x(t)$ will move together.

4. RESULTS

The continuous wavelet spectrum is seen as having a vertical axis that represents frequencies and a horizontal axis that represents time (the higher the scale, the lower the frequency). The wavelet coherence determines the covariance between the two-time series in time-frequency space. Warmer colors (red) depict regions with robust connections, whereas cooler colors (blue) suggest lesser series reliance. Cold zones represent time and frequency without any series dependency outside of the noted areas.

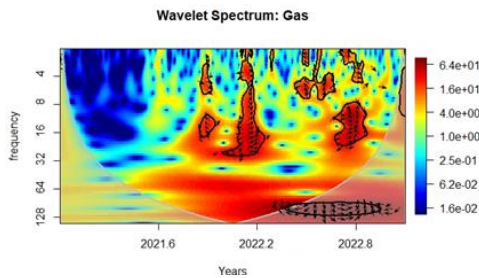


Figure no. 1 – Wavelet Spectrum (Gas) from 20, April 2021 to 30, Nov 2022

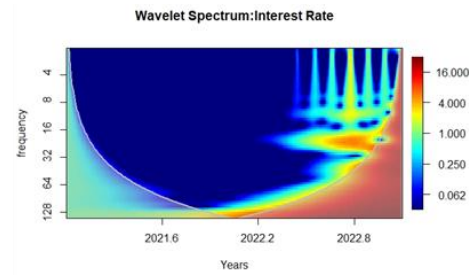


Figure no. 2 – Wavelet Spectrum (Interest Rate) from 20, April 2021 to 30, Nov 2022

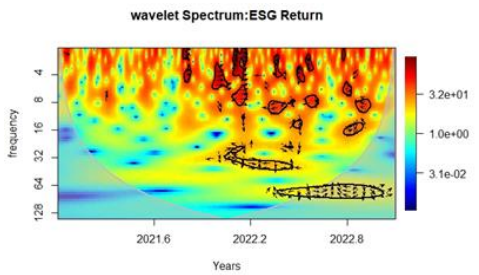


Figure no. 3 – Wavelet Spectrum (ESG Return) from 20, April 2021 to 30, Nov 2022

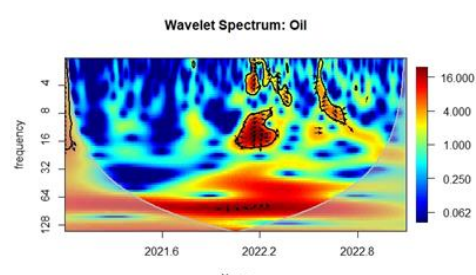


Figure no. 4 – Wavelet Spectrum (Oil) from 20, April 2021 to 30, Nov 2022

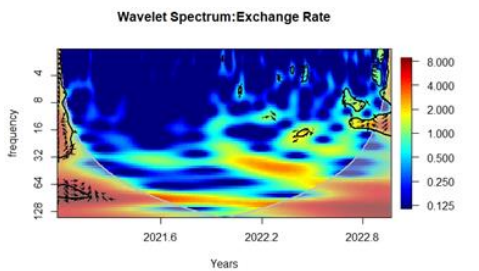


Figure no. 5 – Wavelet Spectrum (Exchange Rate) from 20, April 2021 to 30, Nov 2022

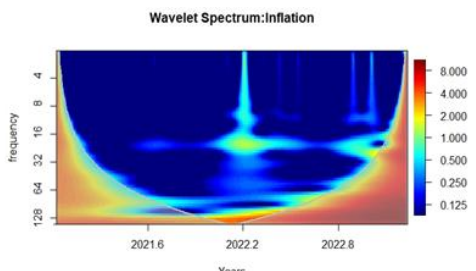


Figure no. 6 – Wavelet Spectrum (Inflation) from 20, April 2021 to 30, Nov 2022

The lag period relationships between the studied series are shown as an arrow in the wavelet coherence graphs. Two different time series move simultaneously on a specific scale when there is no phase difference between them. If the time series are in phase, arrows point

to the right (left) which we call (anti-phase). These series move in the same direction when they are in phase; when they are out of phase, they move in the other way. While the second indication is most important when an arrow points in a right-up or left-down direction, the first variable is leading when an arrow points in either a right-down or left-up direction.

In this spectrum the timelines we choose are actually divided into 2 scenarios which is before War and after War. From April 20, 2021, to Feb 20, 2022, is the time span before War and after onwards till Nov 30, 2022, the time span is after war. As you can see in [Figure no. 3](#), SPEESEP ESG index return shows that before war the index is moving with normal fluctuations but after war you can see that the spectrum shows more red color and with arrow which shows that the index prices are volatile, and we can conclude that there are effects of war on SPEESEP index.

In [Figures no. 2, no. 5 and no. 6](#) the variables exchange rate, EURIBOR and Inflation which shows almost similar pattern that in pre-war time period there is almost blue color which means there are not many fluctuations in the rates but after war you can clearly see the color changes into waves of yellow which shows that war have effects on these variables.

At last, [Figures no. 1 and no. 4](#) the oil and gas variables are the independent variables which shows significance shift into wavelet that the color turns from blue to blood red and it's also logically appropriate according to GEP report that After conflict, the price of crude oil on the global market soared, rising from roughly \$76 per barrel at the beginning of Jan 2022 to \$110 per barrel by March 2022. Even the other larger markets, such as the stock exchanges in France, Germany and London (FTSE 100), as well as the S&P 500 and Dow Jones in the United States, all saw drops in the price of their stocks. The Russia-Ukraine conflict caused a global supply disruption that had an effect on hydrocarbon-dependent industries worldwide, including oil and gas prices.

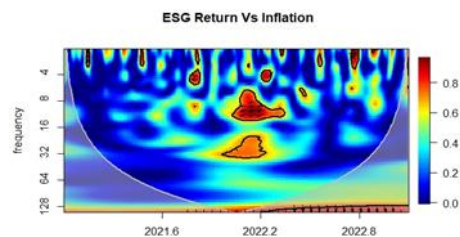


Figure no. 7 – Wavelet Spectrum between the SPEESEP Index with Inflation from 20, April 2021 to 30, Nov 2022

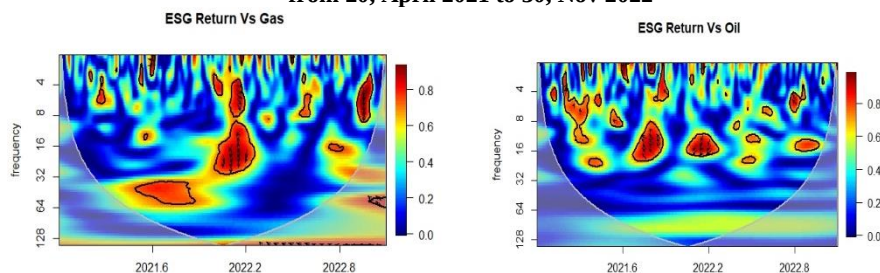


Figure no. 8 – Wavelet Spectrum between the SPEESEP Index with Gas from 20, April 2021 to 30, Nov 2022

Figure no. 9 – Wavelet Spectrum between the SPEESEP Index with Oil from 20, April 2021 to 30, Nov 2022

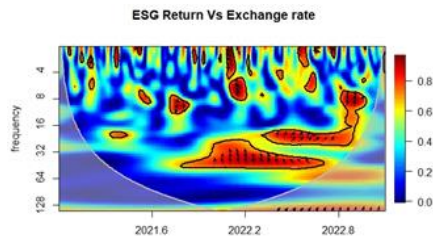


Figure no. 10 – Wavelet Spectrum between the SPEESEP Index with Exchange rate from 20, April 2021 to 30, Nov 2022

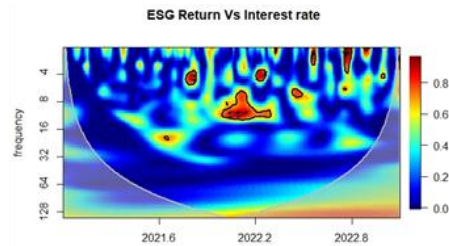


Figure no. 11 – Wavelet Spectrum between the SPEESEP Index with Interest rate from 20, April 2021 to 30, Nov 2022

We can see how the market was affected before and during the War and how macro-economic variables influenced markets from the plot. The intensity of cross-correlation is vigorous for exchange rate, oil, and gas, moderate for inflation and interest rate, according to the heat-map (color of the spectra).

The heat map shows an increase in market connection from blue to red, according to [Gencay et al. \(2002\)](#). Blueish is weak, red is strong. Similar comparisons can be made between wavelet coherence plots and wavelet spectrum (WPS).

5. FINDINGS

The relationship between SPEESEP ESG return and inflation doesn't show much at the beginning of the study period till Jan 2022 but after when the insights of war confirmed and later on war started it exhibits high levels of volatility at the beginning of February 2022 till August 2022 we found same result as [Lo et al. \(2022\)](#) and from August it was getting normal use to high inflation. According to The Guardians ([Partington, 2022](#)) as food costs rise and oil prices rise because to Russia's invasion, the ECB aims to raise interest rates for the first time since 2011. The most recent survey revealed In June, energy prices jumped at an annual rate of roughly 42% as opposed to 39% in May.

The relationship between SPEESEP ESG return and interest rate doesn't show much at the beginning of the study period till Jan 2022 but after when the insights of war confirmed and later on war started it exhibits high levels of volatility at the beginning of February 2022 till September 2022 and after onwards it was expecting to be higher, according to Euronews ([Liboreiro, 2022](#)) ECB has announced a further significant increase in interest rates in an effort to reduce the record-high inflation in the eurozone. As it did in September all of the bank's three basic interest rates was increased by 0.3 percentage points. Interest rates offered by commercial banks to people and companies in the eurozone are directly impacted by the ECB's interest rate decisions.

The relationship between SPEESEP ESG return and exchange rate is the most volatile one as compared to inflation and interest rate. We find similar outcomes as [Chortane and Pandey \(2022\)](#) that in the beginning its doesn't show much but after when the insights of war confirmed and later on war started it exhibits high levels of volatility at the beginning of February 2022 till November 2022 but from December it is in recovery stage. According to the ([DW news, 2022](#)) the Euro has hit an all-time low against the US dollar as a consequence of surging inflation, the situation in Ukraine soared food and oil prices.

The relationship between SPEESEP ESG return and Oil is one of the most depending factor. [Zhang et al. \(2020\)](#); [Yahya et al. \(2021\)](#); [Fahmy \(2022\)](#); [Adekoya et al. \(2023\)](#) stated

the identical outcome as our findings that at beginning of April 2021 its show that there is volatility but after when the insights of war confirmed and later on war started it exhibits high levels of volatility at the end of February 2022 till April 2022 but later on it is stabilized. According to the Reuters (Lawler, 2022), the price of oil has stabilized around \$110 per barrel in April, after rising to \$139 per barrel in March which is the highest of 14-year price.

The relationship between SPEESEP ESG return and gas is one of the most depending on factor in Russo-Ukrainian War. According to a statistic from the BBC (Horton and Palumbo, 2023) Germany was the leading importer of natural gas last year, followed by Italy and the Netherlands. 40% of the natural gas used in EU countries came from Russia. Zhang *et al.* (2020); Yahya *et al.* (2021); Gong and Xu (2022) found same effects that from beginning its show that there is volatility but after when the insights of war confirmed and later on war started it exhibits high levels of volatility at the end of February 2022 till Nov 2022. According to Eurostat (2024), the cost of natural gas for residential consumers increased considerably from the previous year to €0.0861 per kWh in the 1st quarter of 2022, achieving the highest point since the data gathering began. Each of the 25 EU nations that reported non-household gas prices saw an increase in such costs during the first half of 2022. The increase ranged from 67% to 271%.

Discussion

Based on our results, independent variables (Inflation, Interest rate, exchange rate, Oil, and gas) show impact on SPEESEP ESG index as many researchers found same negative relationship like (Zhang *et al.*, 2020; Yahya *et al.*, 2021; Basdekis *et al.*, 2022; Chortane and Pandey, 2022; Fahmy, 2022; Gong and Xu, 2022; Lo *et al.*, 2022; Adekoya *et al.*, 2023). Exchange rate, oil and gas have the strong correlation with ESG index while Interest rate and inflation have moderate affects. we can conclude that Russo-Ukrainian war have a direct relation with macro-economic factors which we used in our research and accordingly these macro-economic factors are highly impacted ESG index.

6. CONCLUSION

The motive of this study is to examine how such macroeconomic variables influence the SPEESEP Index during the Russo-Ukrainian War. Interest rates, exchange rates, inflation, oil, and gas prices are among the macroeconomic data that were considered in this study. The interest rate is calculated using the EUIBOR rate, and inflation is calculated using the HICP. These factors were chosen in accordance with market views as observed in numerous research on the impact investing sector. The Wavelet Coherence transformation method has been used to process and evaluate the data for this investigation. The macroeconomic variables in this study serve as explanatory variables, with the return on the SPEESEP index serving as a dependent variable. In conclusion, the initiative intends to assess how macroeconomic variables affected the SPEESEP Index during the Russo-Ukrainian War.

Our findings indicate that while interest rates and inflation have limited impact on the ESG index, exchange rates, oil, and gas show a substantial association. The Russo-Ukrainian War directly correlates with these macroeconomic parameters, significantly impacting the SPEESEP index.

The purpose of this study is to give analysts and the general public more reliable and understandable information about the relationship between macroeconomic risk variables and

the sustainability of the ESG industry. It helps investors make better decisions by providing them with baseline knowledge on identifying and reducing the impact of these variables on their assets. Furthermore, reducing risk and maximizing profitability can be achieved by implementing rules inside the ESG business that are based on these findings. For investors who care about the environment, the outperformance of shares in the energy sector has presented a big problem since the advent of the environmental, social, and governance (ESG) investment phenomenon. The performance of ethical investors, who generally underweight oil and gas companies in their portfolios, has abruptly declined in contrast to traditional funds.

On 23, March 2022 in Financial Times, John Kerry, a US climate envoy, has cautioned states against switching to coal in order to wean themselves off Russian gas. But despite these calls, Europe is moving away from Russian gas and toward alternative fossil fuels. According to the European Commission, the bloc can replace its reliance on imported Russian energy over the next five to ten years by using 5% more coal than initially anticipated. According to a recent analysis from financial data provider MSCI, under the worst-case scenario, emissions might increase by up to 0.8 gigatons of CO₂ equivalent in the first year if Europe substitutes all of its imports of Russian gas with coal.

On the way to achieving energy independence, renewables are a crucial element. The urgency of switching to sources of renewable energy, such as wind and solar power. Which are more difficult for climate laggards like Russia to disrupt and also ensure energy independence, is made more urgent by the ongoing war in Europe. The case for expanding green energy in the short term is strengthened by the fact that shares of renewable energy companies have been rising steadily since the start of the war, including those of European giants like Ørsted, Vestas, and Siemens Gamesa.

Even though shares of renewable energy companies have recently increased in price, the European Union's changeover will take some time. Germany's updated plan increased solar power to 20 gigawatts by 2028 and onshore wind energy to 10 gigawatts by 2027, rather than 2035 as reported in (Goldman Sachs: ESG Implications of Russia-Ukraine Conflict).

The implications for investors and stakeholders in the ESG sector are profound and far-reaching. Firstly, understanding the correlation between macroeconomic variables and the sustainability of the ESG sector provides investors with valuable insights into risk management strategies. By recognizing how factors such as interest rates, exchange rates, and commodity prices impact the ESG index, investors can make more informed decisions regarding portfolio allocation and risk mitigation. This knowledge allows stakeholders to adjust their investment strategies to navigate market volatility effectively.

Additionally, this research gives investors the ability to adapt their financial objectives with their environmental, governance and social principles. Investors should prioritize sustainable investments that benefit society and the environment in addition to producing financial rewards by understanding how macroeconomic factors affect the ESG sector. Making ethical and financial decisions in harmony encourages more responsible and long-term investment decision-making.

The results of this study also have consequences for regulators and policymakers in the ESG industry. Through an awareness of the ways in which macroeconomic factors impact the sustainability of ESG investments, governments can enact focused measures to encourage and facilitate responsible investment practices. This might involve actions to advance accountability, openness, and disclosure in the ESG space, which would boost investor trust and maintain the integrity of the market.

The limitations of our study are that due to the lack of data and information, the S&P Europe 350 ESG Index may not represent the real situation. Also, in order to cover all possible aspects, we had to limit the scope and focus on just one factor that affects Europe's ESG index – political conflict between Russia and Ukraine. However, I would still recommend this research for those who are interested in how political conflict affects a country's ESG index. One of the limitation of our research on how the Russian-Ukrainian conflict affects the S&P Europe 350 ESG Index is that there is no negative news for the market when there are long periods of time with low yields. One of the important factors in establishing the link between ESG and Russia-Ukraine war is that most investors are concerned about long-term growth prospects in Russia due to their proximity to Europe.

For continuing the research line, we suggest that in future it is more appropriate to increase the time span of data because in our research the data is limited and we cannot rely on it for future outcome, one more thing they can add is the number of injuries and injuries as a proportion of total casualties.

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References

- Addison, P. S. (2017). *The Illustrated Wavelet Transform Handbook: Introductory Theory and Applications in Science, Engineering, Medicine and Finance* (2nd Edition ed.). Boca Raton: CRC Press. <http://dx.doi.org/10.1201/9781315372556>
- Adekoya, O. B., Asl, M. G., Oliyide, J. A., & Izadi, P. (2023). Multifractality and Cross-Correlation between the Crude Oil and the European and Non-European Stock Markets During the Russia-Ukraine War. *Resources Policy*, 80(C), 1-12. <http://dx.doi.org/10.1016/j.resourpol.2022.103134>
- Aguilar-Conraria, L., Magalhaes, P. C., & Soares, M. J. (2013). The Nationalization of Electoral Cycles in the United States: A Wavelet Analysis. *Public Choice*, 156(3-4), 387-408. <http://dx.doi.org/10.1007/s11127-012-0052-8>
- Ahmed, S., Hasan, M. M., & Kamal, M. R. (2023). Russia-Ukraine crisis: The effects on the European stock market. *European Financial Management*, 29(4), 1078-1118. <http://dx.doi.org/10.1111/eufm.12386>
- Apergis, N., Poufinas, T., & Antonopoulos, A. (2022). ESG Scores and Cost of Debt. *Energy Economics*, 112(C), 1-10. <http://dx.doi.org/10.1016/j.eneco.2022.106186>
- Bahmani-Oskooee, M., & Saha, S. (2016). Do Exchange Rate Changes Have Symmetric or Asymmetric Effects on Stock Prices? *Global Finance Journal*, 31(C), 57-72. <http://dx.doi.org/10.1016/j.gfj.2016.06.005>
- Basdekis, C., Christopoulos, A., Katsampoxakis, I., & Nastas, V. (2022). The Impact of the Ukrainian War on Stock and Energy Markets: A Wavelet Coherence Analysis. *Energies*, 15(21), 1-15. <http://dx.doi.org/10.3390/en15218174>
- Billio, M., Getmansky, M., Lo, A. W., & Pelizzon, L. (2012). Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors. *Journal of Financial Economics*, 104(3), 535-559. <http://dx.doi.org/10.1016/j.jfineco.2011.12.010>
- Bloomberg. (2022a). Energy Shock Is Huge for EU, Manageable in U.S., Blackrock Says. Retrieved from <https://financialpost.com/pmn/business-pmn/energy-shock-is-huge-for-eu-manageable-in-u-s-blackrock-says>

- Bloomberg. (2022b). Central Europe's Huge Gas Depot Risks Being Empty Next Winter. Retrieved from <https://financialpost.com/pmn/business-pmn/central-europes-huge-gas-depot-risks-being-empty-next-winter>
- Bundesbank. (2022a). War Against Ukraine: Energy Embargo Could Significantly Weaken German Economy. Retrieved from <https://www.bundesbank.de/en/tasks/topics/war-against-ukraine-energy-embargo-could-significantly-weaken-german-economy-889696>
- Bundesbank. (2022b). Monthly Report: Economic Activity May Have More or Less Stagnated in the First Quarter. Retrieved from <https://www.bundesbank.de/en/tasks/topics/monthly-report-economic-activity-may-have-more-or-less-stagnated-in-the-first-quarter-889702>
- Cerqueti, R., Ciciretti, R., Dalò, A., & Nicolosi, M. (2021). ESG Investing: A Chance to Reduce Systemic Risk. *Journal of Financial Stability*, 54(10), 1-13. <http://dx.doi.org/10.1016/j.jfs.2021.100887>
- Chortane, S. G., & Pandey, D. K. (2022). Does the Russia-Ukraine War Lead to Currency Asymmetries? A US Dollar Tale. *Journal of Economic Asymmetries*, 26(1), 1-26. <http://dx.doi.org/10.1016/j.jeca.2022.e00265>
- Cohen, M. X. (2019). A Better Way to Define and Describe Morlet Wavelets for Time-Frequency Analysis. *NeuroImage*, 199(October), 81-86. <http://dx.doi.org/10.1016/j.neuroimage.2019.05.048>
- Deng, M., Leippold, M., Wagner, A. F., & Wang, Q. (2022). War and Policy: Investor Expectations on the Net-Zero Transition. *Swiss Finance Institute Research Paper*(22-29), 1-78. <http://dx.doi.org/10.2139/ssrn.4080181>
- DeStatis. (2022). Producer Prices in March 2022 [Press release]. Retrieved from https://www.destatis.de/EN/Press/2022/04/PE22_172_61241.html
- Dewenter, K. L., Higgins, R. C., & Simin, T. T. (2005). Can Event Study Methods Solve the Currency Exposure Puzzle? *Pacific-Basin Finance Journal*, 13(2), 119-144. <http://dx.doi.org/10.1016/j.pacfin.2004.07.002>
- Diebold, F. X., & Yilmaz, K. (2012). Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers. *International Journal of Forecasting*, 28(1), 57-66. <http://dx.doi.org/10.1016/j.ijforecast.2011.02.006>
- Ding, L., & Vo, M. (2012). Exchange Rates and Oil Prices: A Multivariate Stochastic Volatility Analysis. *The Quarterly Review of Economics and Finance*, 52(1), 15-37. <http://dx.doi.org/10.1016/j.qref.2012.01.003>
- DW news. (2022). Euro plummets to a 20-year low amid war in Ukraine – DW – 09/22/2022. Retrieved from <https://www.dw.com/en/euro-plummets-to-a-20-year-low-amid-war-in-ukraine/a-63199120>
- ECB. (2022a). Inflation in the Near-Term and the Medium-Term. Retrieved from https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220217_1~592ac6ec12.en.html
- ECB. (2022b). Assessing Corporate Vulnerabilities in the Euro Area. Retrieved from https://www.ecb.europa.eu/pub/economic-bulletin/articles/2022/html/ecb.ebart202202_02~7a61e442be.en.html
- Elbahnasawy, N. G., & Ellis, M. A. (2022). Inflation and the Structure of Economic and Political Systems. *Structural Change and Economic Dynamics*, 60(March), 59-74. <http://dx.doi.org/10.1016/j.strueco.2021.11.006>
- Eurostat. (2024). Natural Gas Price Statistics. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Natural_gas_price_statistics&oldid=582365#:~:text=In%20the%20first%20semester%20of
- Fahmy, H. (2022). The Rise in Investors' Awareness of Climate Risks After the Paris Agreement and the Clean Energy-Oil-Technology Prices Nexus. *Energy Economics*, 106(3), 1-17. <http://dx.doi.org/10.1016/j.eneco.2021.105738>
- Gencay, R., Selcuk, F., & Whitcher, B. (2002). An Introduction to Wavelets and Other Filtering Methods in Finance and Economics. *Waves in Random Media*, 12(3), 399. <http://dx.doi.org/10.1088/0959-7174/12/3/701>
- Gong, X., & Xu, J. (2022). Geopolitical Risk and Dynamic Connectedness between Commodity Markets. *Energy Economics*, 110(6), 1-15. <http://dx.doi.org/10.1016/j.eneco.2022.106028>

- Graps, A. (1995). An Introduction to Wavelets. *IEEE Computational Science & Engineering*, 2(2), 50-61. <http://dx.doi.org/10.1109/99.388960>
- Grossmann, A., & Morlet, J. (1984). Decomposition of Hardy Functions into Square Integrable Wavelets of Constant Shape. *SIAM Journal on Mathematical Analysis*, 15(4), 723-736. <http://dx.doi.org/10.1137/0515056>
- GWN. (2022). Gas Prices in Europe Are Expected to Triple. Retrieved from <https://goodwordnews.com/gas-prices-in-europe-are-expected-to-triple/>
- Hayward, R. (2018). Foreign Exchange Speculation: An Event Study. *International Journal of Financial Studies*, 6(1), 1-13. <http://dx.doi.org/10.3390/ijfs6010022>
- Horton, J., & Palumbo, D. (2023). Russia Sanctions: What Impact Have They Had on its Oil and Gas Exports? Retrieved from <https://www.bbc.com/news/58888451>
- Hudgins, L., Friehe, C. A., & Mayer, M. E. (1993). Wavelet Transforms and Atmospheric Turbulence. *Physical Review Letters*, 71(20), 3279-3282. <http://dx.doi.org/10.1103/PhysRevLett.71.3279>
- Ji, Q., Shahzad, S. J. H., Bouri, E., & Suleman, M. T. (2020). Dynamic Structural Impacts of Oil Shocks on Exchange Rates: Lessons to Learn. *Journal of Economic Structures*, 9(1), 1-19. <http://dx.doi.org/10.1186/s40008-020-00194-5>
- Josephs, J. (2022a). Ukraine War to Cause Biggest Price Shock in 50 years - World Bank. Retrieved from <https://www.bbc.com/news/business-61235528>
- Karkowska, R., & Urjasz, S. (2023). How Does the Russian-Ukrainian War Change Connectedness and Hedging Opportunities? Comparison between Dirty and Clean Energy Markets versus Global Stock Indices. *Journal of International Financial Markets, Institutions and Money*, 85(June), 1-21. <http://dx.doi.org/10.1016/j.intfin.2023.101768>
- Kassouri, Y., & Altıntaş, H. (2020). Commodity Terms of Trade Shocks and Real Effective Exchange Rate Dynamics in Africa's Commodity-Exporting Countries. *Resources Policy*, 68(October), 1-17. <http://dx.doi.org/10.1016/j.resourpol.2020.101801>
- Kick, A., & Rottmann, H. (2022). Sustainable Stocks and the Russian War on Ukraine-an Event Study in Europe. *CESifo Working Paper*(9798), 1-20. <http://dx.doi.org/10.2139/ssrn.4137955>
- Krugman, P. (2022). How the Putin Shock Might Affect the World Economy. Retrieved from <https://www.nytimes.com/2022/03/08/opinion/putin-russia-ukraine-economy-sanctions.html>
- Kuşkaya, S., Ünlü, F., & Gençoğlu, P. (2021). Döviz Kuru ve Üretici Fiyat Endeksi Arasındaki İlişkinin Sürekli Dalgacık Uyumu Modeli ile Analizi: Türkiye Üzerine Ampirik Bulgular. *İzmir İktisat Dergisi*, 36(2), 365-378. <http://dx.doi.org/10.24988/ije.202136208>
- Lawler, A. (2022, May 30, 2019). How the Ukraine Conflict is Reshaping Global Oil Markets. Retrieved from <https://www.reuters.com/markets/commodities/how-ukraine-conflict-is-reshaping-global-oil-markets-2022-05-30/>
- Leterme, J. (2020). *Can ESG Factors Be Considered as a Systematic Risk Factor for Equity Mutual Funds in the Eurozone?* (Master), Université catholique de Louvain. Retrieved from <http://hdl.handle.net/2078.1/thesis:24176>
- Liboreiro, J. (2022, 28/10/2022). European Central Bank Announces New Super Hike of Interest Rates. Retrieved from <https://www.euronews.com/my-europe/2022/10/27/ecb-announces-new-super-hike-of-interest-rates-to-tame-inflation-as-recession-draws-nearer>
- Lim, W. M., Chin, M. W. C., Ee, Y. S., Fung, C. Y., Giang, C. S., Heng, K. S., . . . Weissmann, M. A. (2022). What is at Stake in a War? A Prospective Evaluation of the Ukraine and Russia Conflict for Business and Society. *Global Business and Organizational Excellence*, 41(6), 23-36. <http://dx.doi.org/10.1002/joe.22162>
- Lo, G. D., Marcellin, I., Bassène, T., & Sène, B. (2022). The Russo-Ukrainian War and Financial Markets: The role of Dependence on Russian Commodities. *Finance Research Letters*, 50(4), 1-10. <http://dx.doi.org/10.1016/j.frl.2022.103194>
- Lyócsa, S., & Plíhal, T. (2022). Russia's Ruble During the Onset of the Russian Invasion of Ukraine in Early 2022: The Role of Implied Volatility and Attention. *Finance Research Letters*, 48(453), 1-10. <http://dx.doi.org/10.1016/j.frl.2022.102995>

- Managi, S., & Okimoto, T. (2013). Does the Price of Oil Interact with Clean Energy Prices in the Stock Market? *Japan and the World Economy*, 27(1), 1-9. <http://dx.doi.org/10.1016/j.japwor.2013.03.003>
- Nusair, S. A., & Olson, D. (2022). Dynamic Relationship between Exchange Rates and Stock Prices for the G7 Countries: A Nonlinear ARDL Approach. *Journal of International Financial Markets, Institutions and Money*, 78(March), 1-20. <http://dx.doi.org/10.1016/j.intfin.2022.101541>
- Partington, R. (2022). Inflation in eurozone hits record 8.6% as Ukraine war continues. *The Guardian*. Retrieved from <https://www.theguardian.com/business/2022/jul/01/inflation-in-eurozone-hits-record-86-as-ukraine-war-continues>
- Pástor, L., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable Investing in Equilibrium. *Journal of Financial Economics*, 142(2), 550-571. <http://dx.doi.org/10.1016/j.jfineco.2020.12.011>
- Qiang, W., Lin, A., Zhao, C., Liu, Z., Liu, M., & Wang, X. (2019). The Impact of International Crude Oil Price Fluctuation on the Exchange Rate of Petroleum-Importing Countries: A Summary of Recent Studies. *Natural Hazards*, 95(1), 227-239. <http://dx.doi.org/10.1007/s11069-018-3501-y>
- Roubini, N. (2022). Russia's War and the Global Economy. Retrieved from <https://www.project-syndicate.org/onpoint/russias-war-and-the-global-economy-by-nouriel-roubini-2022-02>
- S&P Global. (2022). European Supply Shock: Sectors and Countries at Most Risk Retrieved from <https://www.spglobal.com/market-intelligence/en/news-insights/research/european-supply-shock-sectors-and-countries-at-most-risk>
- Salisu, A. A., Adekunle, W., Alimi, W. A., & Emmanuel, Z. (2019). Predicting Exchange Rate with Commodity Prices: New Evidence from Westerlund and Narayan (2015) Estimator with Structural Breaks and Asymmetries. *Resources Policy*, 62(August), 33-56. <http://dx.doi.org/10.1016/j.resourpol.2019.03.006>
- Statista. (2022). Harmonized Index of Consumer Prices (HICP) Inflation Rate of the European Union in March 2022, by Country. Retrieved from <https://www.statista.com/statistics/225698/monthly-inflation-rate-in-eu-countries/>
- Steffen, B., & Patt, A. (2022). A Historical Turning Point? Early Evidence on How the Russia-Ukraine War Changes Public Support for Clean Energy Policies. *Energy Research & Social Science*, 91(September), 1-10. <http://dx.doi.org/10.1016/j.erss.2022.102758>
- Tobias, A., & Brunnermeier, M. K. (2016). CoVaR. *The American Economic Review*, 106(7), 1705-1741. <http://dx.doi.org/10.1257/aer.20120555>
- Uddin, G. S., Tiwari, A. K., Arouri, M., & Teulon, F. (2013). On the Relationship between Oil Price and Exchange Rates: A Wavelet Analysis. *Economic Modelling*, 35(September), 502-507. <http://dx.doi.org/10.1016/j.econmod.2013.07.035>
- Vacha, L., & Barunik, J. (2012). Co-Movement of Energy Commodities Revisited: Evidence from Wavelet Coherence Analysis. *Energy Economics*, 34(1), 241-247. <http://dx.doi.org/10.1016/j.eneco.2011.10.007>
- Yahya, M., Kanjilal, K., Dutta, A., Uddin, G. S., & Ghosh, S. (2021). Can Clean Energy Stock Price Rule Oil Price? New Evidences from A Regime-Switching Model at First and Second Moments. *Energy Economics*, 95(3), 1-15. <http://dx.doi.org/10.1016/j.eneco.2021.105116>
- Zaldueño, J. (2006). Determinants of Venezuela's Equilibrium Real Exchange Rate. *IMF Working Paper* (06/74), 1-19. <http://dx.doi.org/10.5089/9781451863345.001>
- Zhang, H., Cai, G., & Yang, D. (2020). The Impact of Oil Price Shocks on Clean Energy Stocks: Fresh Evidence from Multi-Scale Perspective. *Energy*, 196(3), 1-29. <http://dx.doi.org/10.1016/j.energy.2020.117099>
- Zhao, G., Jiang, D., Diao, J., & Qian, L. (2004). *Application of Wavelet Time-Frequency Analysis on Fault Diagnosis for Steam Turbine*. Paper presented at the 5th International Conference of Acoustical and Vibratory Surveillance Methods and Diagnostic Techniques, France, CETIM.