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The Impacts of Geopolitical Risks on the Energy Sector: Micro-Level Operative Analysis in the European Union

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Abstract: Energy prices play a crucial role in combating geopolitical risks, especially for the major suppliers of energy resources. However, energy prices display a bilateral relationship with geopolitical risks in any economy. Any hike in the price of energy stimulates geopolitical risk factors and visa-versa. The consequences adversely impact economies and bring forth international tensions. This paper bridges a gap between the influence of geopolitical risks relating to energy and international tensions by analyzing micro-level operational measures. We deploy an empirical model to predict the energy sector and possible risk factors incorporating Eurostat data on twenty-seven states, from 2011 to 2020. This study collected a different energy variable to support the multiple regression model constructed by the "blocks" (hierarchical linear regression) method. The results suggest that geopolitical risks cause adverse effects on both the energy and other corporate sectors. The future direction of this research is to estimate how statistical model relationships may assist the corporate sector, and investors, in adopting mitigating measures to control upcoming geopolitical risks due to energy risks caused by geopolitical unrest.

Keywords: geopolitical risks; energy; international tension; micro-level operations

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Citation: Figueiredo, Ronnie, Mohammad Soliman, Alamir N. Al-Alawi, and Maria José Sousa. 2022. The Impacts of Geopolitical Risks on the Energy Sector: Micro-Level Operative Analysis in the European Union. *Economies* 10: 299. https://doi.org/10.3390/economies10120299

Academic Editor: Ştefan Cristian Gherghina

Received: 15 September 2022
Accepted: 9 November 2022
Published: 28 November 2022

1. Introduction

The geopolitical risk can be described as the risk connected with some crisis (e.g., wars, terrorist attacks, and conflicts between nations), which in turn substantially impacts international relations' peaceful, regular flow (e.g., Lee et al. 2021a). Geopolitical risk encompasses both the likelihood that these risks will occur as well as the additional risks brought on by an intensification of current events (Caldara and Iacoviello 2018). In other words, such risks could raise tensions at both national and international levels. According to Olasehinde-Williams and Balcilar (2022), concerns regarding geopolitical risks (GPRs) have grown recently as a result of recent geopolitical conflicts and tensions between countries all over the world. This reflects the fact that both academic economists and policymakers pay close attention to GPRs (B. Li et al. 2020). GPRs are considered one of the most crucial factors affecting businesses belonging to different sectors. GPRs are currently ranked among the top five global business threats (e.g., Lee et al. 2021b). Similarly, prior studies were conducted to highlight the major consequences of GPRs among different settings and facets, such as energy (e.g., Su et al. 2021), trade flows (e.g., Gupta et al. 2019), stock market returns (e.g., Apergis et al. 2018; Oloko et al. 2021), investment (e.g., Bilgin et al. 2020), renewable energy consumption (e.g., Cai and Wu 2020), renewable energy deployment (e.g., Sweidan 2021) oil prices (e.g., Ding et al. 2022; Fernandois and Medel 2020; J. Li et al. 2020; Zhang et al. 2022), insurance premiums (Olasehinde-Williams and Balcilar 2022), tourism investment and tourism destination selection (e.g., Lee et al. 2021b), etc. In addition, Demiralay and Kilincarslan (2019) indicated that GPRs are referred to as one of the key factors influencing consumption and investment-associated decisions. Due to the precautionary saving motivation, GPRs and uncertainty may cause businesses to defer investments and delay consumption (Cheng and Chiu 2018). Moreover, Zhao et al. (2021) argued that environmental and economic indicators can be affected by geopolitical risks in a way that makes nations more likely to lose their welfare benefits.

In the most recent years, it is evident that different industries and sectors have been remarkably and negatively influenced by some crises, such as the outbreak of the Covid-19 pandemic (e.g., Alkathiri et al. 2021; Anasori et al. 2022; Hassan and Soliman 2021; Mekawy et al. 2022). However, geopolitical-associated occurrences (i.e., the war between Russia and Ukraine) also had several considerable and negative consequences on the world economy and its connected sectors, particularly the energy sector. The debate over the economic effects of the shift in focus of international trade policy from the reciprocal economic benefits of open trade policies to geopolitical issues limiting interdependence has become more heated in light of the situation between Ukraine and Russia (Bekkers and Góes 2022).

Thus, the current situation between Russia and Ukraine provides a clear picture of the geopolitical risks facing multinational companies worldwide, and in particular, Europe. To this end, the background of this study derives from the GPRs involved in the situation concerning the Russia-Ukraine war. It strives to explore the effects of these risks on different aspects of the economy, especially the energy sector. To meet this purpose, the research presented seeks to test micro-level operative measures, in this case, for the EU energy sector.

Considering the aforementioned discussion, the research question is developed as follows: "How to predict the impact of GPRs on the energy sector and corporate business productivity in European nations?". To answer the aforementioned question, the research aims to explore how the energy sector in Europe could be affected by the GPRs raised by the current Russia-Ukraine war. To be more specific, the study aims to empirically investigate the impact of energy supply, energy intensity, energy productivity, and energy efficiency (as predictor variables) on energy consumption (as an outcome variable) considering the recent GPRs in Europe due to the Russia-Ukraine war.

Taken collectively, the current work does produce insightful implications for both academia and practitioners. The findings of this paper contribute to the existing literature on geopolitical risks and their linked, adverse outcomes. It is vital to take into consideration the causes and effects of geopolitical risks when formulating and deciding upon economic and business policies, including energy-related issues. In addition, this paper adds to its body of knowledge by investigating relationships between the studied variables (i.e., energy productivity, energy efficiency, energy supply, and energy consumption) and different aggregates. Both the methodology and the selected variables ensure the uniqueness of the research, which examines a hitherto unexplored facet in this field. The focus on micro-level operative management represents another significant contribution to this study. Furthermore, it is asserted that all economic sectors must be aware of the consequences of geopolitical risks and take prompt action to minimize costs to the business sector and other stakeholders. As a result, examining the correlations between these variables could aid policymakers in foreseeing the effects of geopolitical risks on the energy sector and empower them to take preventative action to lessen the effects.

The rest of this paper will be structured as follows. The literature review and the connections between the studied variables will be illustrated in Section 2, while the research design and methodology will be explained in Section 3. Section 4 represents data analysis and results, and Section 5 presents discussions and conclusions.

2. Literature Review

2.1. Geopolitical Risks: Concept and Consequences

According to Ding et al. (2022), the frequent occurrence of GPRs, and the associated economic and trade friction, hinders the financial market's smooth development and interferes with various nations' normal economic activity. The consequences of GPRs vary across different economic sectors. For instance, Lee et al. (2021b) indicated that GPRs have a significant impact on the socioeconomic environment and frequently cause problems in different contexts and settings (e.g., GPRs lead to a reduction in the amount of tourism that goes to the impacted areas). In addition, Gupta et al. (2019) analyzed the impact of GPRs on trade flows in 164 countries. The study results demonstrated how geopolitical risks negatively affect trade flows. Many studies have tested the relationship between GPRs and investment in different economies. One study reported that GPRs positively affect government investment (Bilgin et al. 2020). While Zhou et al. (2020) concluded that higher GPR index levels reduce the domestic credit made available by the financial sector. GPRs have also served to explain the variations in outputs amongst a sample of 38 developing countries (Cheng and Chiu 2018). Apergis et al. (2018) reported no evidence of any predictive capacity of GPRs for stock market returns. Similarly, Balcilar et al. (2018) examined the impact of geopolitical uncertainty on trends in returns and volatility of the BRICS stock markets but found that GPRs caused stock market volatility. Additionally, Bouri et al. (2019) reached similar conclusions when examining the effects of geopolitical uncertainties on the volatility of Islamic equities and bonds. Oloko et al. (2021) incorporated the predictability approach with a quasi-generalized least square model to analyze the Korean stock market according to geopolitical risks. The results found that the GPRs did affect Korean stock market returns.

GPRs generate several consequences for energy consumption and production which are also reflected in the case of the conflict between Russia and Ukraine. This conflict has triggered an adverse effect on stock markets, energy consumption, and production, in addition to increases in energy prices. Fernandois and Medel (2020) introduced the Granger causality model to examine the impact of geopolitical tensions and unexpected changes in oil prices. In turn, Cai and Wu (2020) apply the time-varying parameter of the Bayesian vector autoregressive model to analyze the relationship between GPRs and renewable energy consumption.

The findings convey how GPRs provide a positive effect on renewable energy consumption. Similarly, Su et al. (2021) states that there is a two-way relationship between geopolitical risks and energy. Ivanovski and Hailemariam (2022) applied a nonparametric model to study the effects of oil prices on geopolitical risks. Their data was sourced from 16 countries and covered the period from 1997 to 2020 with the findings demonstrating how oil prices negatively relate to geopolitical risks. Gkillas et al. (2018) approached the relationship between GPRs and regime change over a two-decade period and reported that GPRs contributed to the regimes.

Furthermore, Olasehinde-Williams and Balcilar (2022) stated that the macroeconomic and financial cycles in many countries are significantly impacted by GPRs which, at present, top the list of concerns for multinational corporations. This impression is not anticipated to change over the coming years. B. Li et al. (2020) argued that for the West Texas Intermediate (WTI) and Brent markets, GPRs positively influence oil prices, however, the effect is the opposite for the Dubai and Nigerian markets. Oil prices have a positive correlation with the GPRs. Through a variety of avenues, geopolitical considerations can have a considerable impact on how oil markets behave. Global media coverage of geopolitical risks may affect the risk premium that investors in the global energy market seek (Lee et al. 2021a). According to Zhang et al. (2022), GPR predictors do, in fact, include extra predictive data beyond economic and oil-associated fundamentals. They claimed that petroleum markets are significantly impacted by GPRs, which in turn, can produce substantial economic returns for investors with alternate risk aversion behaviors.

2.2. Geopolitical Risks, Energy, and Energy Security

In the present era of interconnectedness, advanced technology, and globalization, energy is seen as a crucial component in the growth and prosperity of societies (Flouros et al. 2022). Energy is considered a key component of economic resources and is categorized as a land resource (Sweidan 2021). Energy transition and its effects on current levels of employment, production, and accumulation patterns are increasingly taking center stage in global public policy in the current geopolitical economy (Zhao et al. 2021). Geopolitics and energy have long been intertwined. In the 20th century, oil producers banded together to form new international alliances, price fluctuations encouraged or discouraged superpower adventurism, and access to energy resources became a crucial element in determining the outcome of wars. The relationships between the two fields are being rewritten by the massive and fast-moving changes in the energy sector of the 21st century (Pascual 2015). In general, fossil fuels—especially oil and natural gas—are linked to geopolitics in the energy sector. Energy geopolitics is concerned with the dwindling and geographically concentrated oil and gas deposits in nations with fragile political systems. (Scholten 2018). According to Antonakakis et al. (2017), deeply reshaping geopolitical shifts, the friction and stress they usually cause, large security risk-generating events, and other factors can all negatively impact the energy and equity markets. The efficient use of energy resources and the stability of fuel markets, particularly natural gas markets, are increasingly important in the policies of many countries in Europe and around the world due to the rising global demand for energy and the diminishing availability of non-renewable reserves (Balitskiy et al. 2014). The relationship between international politics and energy from several perspectives, including environmental concerns and climate change, nuclear proliferation, and energy security, is seen as a key factor in economic growth (Flouros et al. 2022).

2.3. Theoretical Framework

This section sets out the theoretical aspects depicting the nature and relationships of all the incorporated variables.

a. *The influence of energy productivity on total energy consumption*

While studying energy productivity, J. Li et al. (2020) noted that, alongside other factors, such as human capital, income, and energy prices, energy production also affects energy consumption. Ding et al. (2021) studied the impact of energy productivity on consumption-based carbon-dioxide emissions in G7 countries and described how, alongside factors like GDP, trade, et cetera, energy productivity indicates energy consumption.

b. *The influence of energy intensity on total energy consumption*

In several industrial sectors, such as cement production, energy substitution approaches have reduced the intensity of energy consumption. Nevertheless, increasing industrial output in emerging economies, in keeping with their rising populations and economic growth, drives higher levels of energy consumption (Reddy and Ray 2010). Zhang et al. (2017) explored how changes in energy consumption transpire due to economic output and energy intensity. Wei et al. (2019) also elaborated on how energy intensity represents an important determinant of energy consumption.

c. *The influence of energy efficiency on total energy consumption*

In keeping with the green economy and sustainable development concepts, reductions in energy consumption and energy efficiency have become global priorities (Sineviciene et al. 2017). Murshed et al. (2022) explained how energy efficiency positively impacts energy sustainability. Phylipsen et al. (2002) observed how the most energy-efficient companies can achieve energy savings of approximately 5% of their current consumption.

d. *The influence of energy supply on total energy consumption*

Supply factors play an important role in energy crises and consumption. The supply side can shape both the demand and the supply of energy markets. This, in turn, affects energy costs and prices, which causes energy risk to an economy. Most researchers reported that energy supplies generated positive effects on energy consumption and productivity in the business sector, keeping with how supply constitutes the backbone of industries. Any shortage has a severe impact on growth and productivity (Khan et al. 2020). Furthermore, Keppler (2007) explored how the energy supply can trigger disturbances in international relations. To attain the aforementioned objectives of this study, we defined the following research hypotheses:

H0: *model fit = model fit without predictor*

H1: *model fit* $\neq$ *model fit without predictor*

3. Research Design and Methodology

3.1. Sample

This paper aims to empirically analyze relationships that help predict consequences and enable the taking of corrective measures to reduce negative impacts. The study sample includes cross-sectional data from 27 member states of the European Union (Bulmer and Lequesnes 2020). In consideration of relevance and the cost of the data in the research collected, secondary data from the statistical office of the European Union and member states (Eurostat: https://ec.europa.eu/eurostat (accessed date on 1 April 2020)) was used from 2011 to 2020 (available in April 2022). The final sample is shown in Table 1.

Table 1. Description of the 27 member states of the European Union.

Austria	Estonia	Italy	Portugal
Bulgaria	Finland	Latvia	Romania
Belgium	France	Lithuania	Slovakia
Croatia	Germany	Luxembourg	Slovenia
Cyprus	Greece	Malta	Spain
Czechia	Hungary	Netherlands	Sweden
Denmark	Ireland	Poland	-

3.2. Measure and Procedure

This study collected the dependent variable and the independent variables that support the multiple regression model from the same source (Eurostat). In accordance with Hair et al. (2014), multiple regression analysis provides a dependence technique with the objective of applying independent variables to predict the dependent variable. In our study, the regression model was constructed by the "blocks" (hierarchical linear regression) method which considers the "economic components" as "Independent Variables". Fussey (2004, 2007) defines micro-level operations as management processes that, in fact, wield an indirect influence on central government. In this study, the "supply, transformation, and consumption" constitutes the "Dependent Variable" reflecting one type of micro-level operation. Table 2 sets out the variables in detail.

Table 2. Description of the variables.

Independent Variables	**Description**
Energy productivity	*Measures the economic benefit we receive from each unit of energy consumed.*
Energy intensity	*Measures the energy inefficiency of an economy.*
Energy efficiency	*Measures the usage of less energy to perform the same task or produce the same economic results.*
Energy supply by-product	*Measures the energy supply for the total of all products.*
Dependent Variable	
Supply, transformation, and consumption	*Measure the total final energy consumption (consumption of transformed energy)*

Multiple regression analysis contributes to developing a model that deploys economic components both to predict the influence on micro-level operations in European Union (EU) member states and to test the study's hypotheses. We made recourse to SPSS Statistics (version 27) software for the statistical analysis.

3.3. Model Specification

Considering the regression analysis models, we developed and tested equations on the study based on the Ordinary Least Squares (OLS) estimation method. To test the predictions, the "hierarchical multiple regression" was conducted in the blocks. It helps us to analyze nested data more appropriately than via a regular multiple linear regression. We consider hierarchical regression to be more appropriate for the study because it is grounded by empirical literature for the order of entry into the model. We sought to develop the model with a set of interactions that consider the first interaction with the variable as having the highest correlation with the outcome. Then we added other variables with attenuating associations to see what would happen to the outcome. We observed evidence that suggested predictive ability in the variable being observed. Further interactions of the variable input were undertaken until we found the strongest group of variables to account for the variation of the outcome. By finalizing the variable interactions, we build an argument with greater tangibility concerning the choice of model and multivariate associations. The equation models used to verify the influence of "economic components" over "micro-level operations" are presented in Figures 1–4. Using the hierarchical strategy, we studied the incremental variations accounted for through the addition of predictors over a set of models.

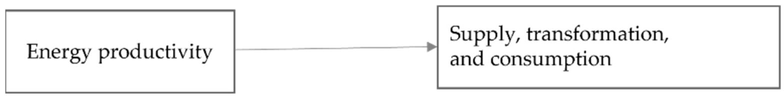

Figure 1. Regression Model 1.

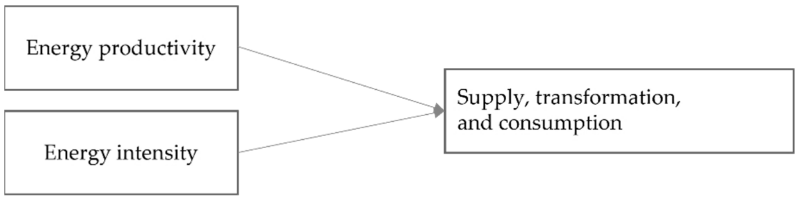

Figure 2. Regression Model 2.

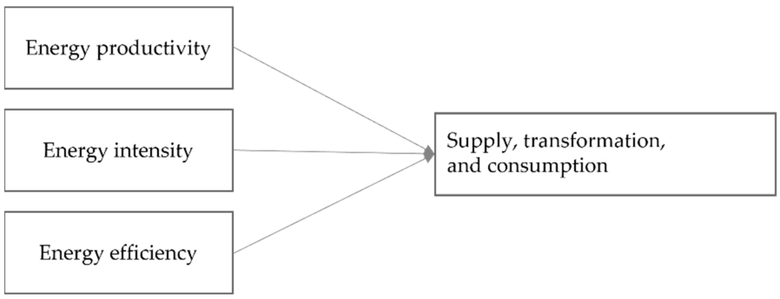

Figure 3. Regression Model 3.

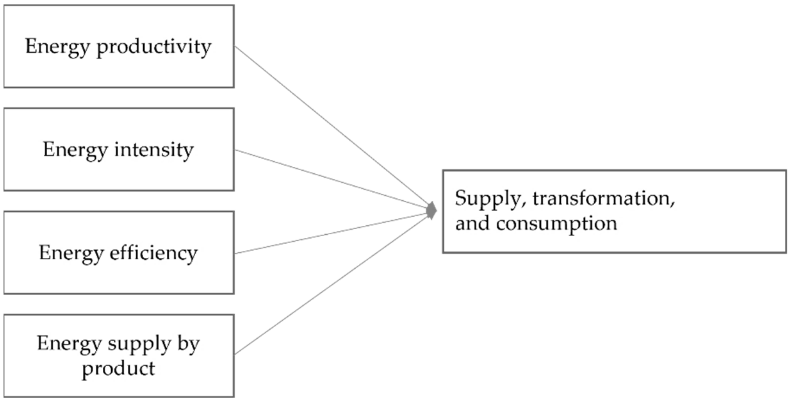

Figure 4. Regression Model 4.

4. Results

This study aims to "analyze the relationships between micro-level operations and European Union (EU) member states" to predict the influence of energy risk on international tensions. To meet this objective, we applied multiple linear regression to verify whether the independent variables would influence the dependent variable and thus, have the ability to contribute to predicting the influence of energy risk on international tensions.

4.1. Measurement Model

To perform this regression analysis, we followed the statistical assumptions required in keeping with the recommendations of Hair et al. (2014). We have included all the variables entered into the test model in Table 3.

Table 3. Variables Entered/Removed.

Model	Variables Entered	Variables Removed	Method
1	energy_supply_by_product [b]	.	Enter
2	energy_productivity [b]	.	Enter
3	energy_intensity [b]	.	Enter
4	energy_efficiency [b]	.	Enter

[b]. All requested variables were entered.

Thus, we obtained the residual independence and confirmed this by the Durbin–Watson Test (1.901) with a result accepted between 1.5 and 2.5, more specifically near 2.

4.2. Structural Model

The next step was to test the structure of the model. To evaluate the multicollinearity between the variables and factors, the variance inflation factor (VIF) was used. In terms of multicollinearity, the values for the models (a), (b), and (c) were above 0.10 (tolerance), and model (d) estimating two variables (energy_efficiency and energy_supply_by_product) was <1. In support of the multicollinearity analysis, the value of "VIF" was < 10 in models (a), (b), and (c). However, in model (d) the value of the same variables was >10 (Hair et al. 2014). This indicates the absence of multicollinearity in models (a), (b), and (c). In terms of outliers, the results came in between −3 and +3, thus confirming the absence of outliers (predicted value and residual) in the scatter plot (Ghosh and Vogt 2012). Regarding the normality and linearity assumptions, they are confirmed by their normal probability and regression plots. The plot graphic (Figure 5) displays a linear relationship and scatterplot (Figure 6) with homoscedasticity also evaluated in this study.

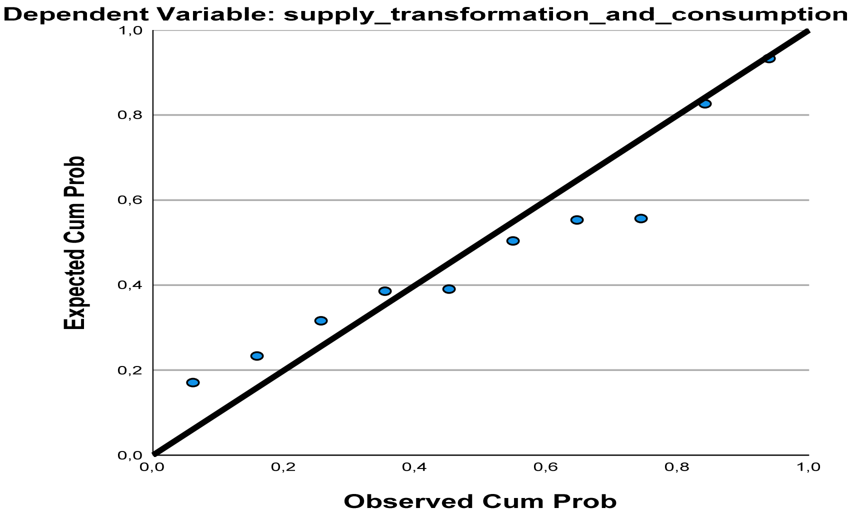

Figure 5. Plot graphic of regression standardized residual.

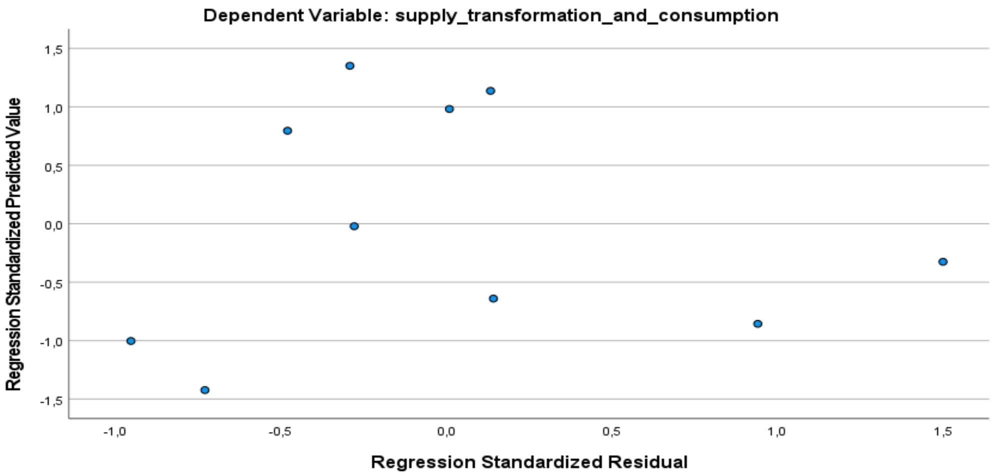

Figure 6. Scatterplot.

The previous analysis resulted in significant models; "Model C", [F (3, 23) = 39,504; $p < 0.001$; R^2 0.837]; and "Model D", [F (4, 22) = 35,147; $p < 0.001$; R^2 0.865]. The results for the other models were; "Model A", [F (1, 25) = 0.563; $p < 0.001$; R^2 0.022]; and "Model B", [F (2, 24) = 1.537; $p < 0.001$; R^2 0.114]. Additionally, we estimated "Model D" to have the value of the two variables (energy_efficiency and energy_supply_by_product) < 1. Thus, the model returning the best result was "Model C". Overall, the results obtained demonstrate significant evidence to support the importance of approaching micro-level operations in a manner that takes into account changes driven by geopolitical events capable of impacting different economic sectors worldwide, and in European countries, especially the energy sector. These changes cause uncertainty in companies, demand operational process decisions to reduce risk, and increase their susceptibility to reduced productivity. Predicting the eventual fluctuations in terms of operational decisions at the micro level represents a crucial efficiency. The contribution made by the study's findings derives from a better understanding of the relationship between decision and scenario, and how to implement decisions while keeping with predictive models. Furthermore, the prediction models were considered in the study hypotheses. Collectively, the models partially support the research hypotheses. The economic components did predict the micro-level operations and the "model fit is different to the model fit without the predictor". Thus, the multiple regression models with the best results for predicting the micro-level operations within European Union (EU) member states arise from the following equation:

Model C: $Y = 142{,}163.49 - 2326.47\ Energy\ Productivity - 705.01\ Energy\ Intensity + 12{,}055.32\ Energy\ Efficiency$

The "Model C" multiple regression attains significance and explains 83.7% of variability [F (3, 23) = 39,504; $p < 0.001$; R^2 0.837].

5. Discussion and Conclusions

The current study sought to answer the following research question: How can the impacts of energy risks on international tensions in European Union member countries be quantified at the micro level? In doing so, we developed an integrated research model that examined the links between micro-level operations in European Union (EU) member states. The proposed research model includes four independent variables (i.e., energy productivity, energy intensity, energy efficiency, and energy supply by-product) in addition to a dependent variable; specifically, supply, transformation, and consumption. Furthermore, the current study applied actual data from the European Union's statistical office (Eurostat), with the sample spanning 27 European Union member countries.

We performed multiple linear regression to determine whether the predictor variables (energy productivity, energy intensity, energy efficiency, and energy supply by-product) affected the outcome variable (supply, transformation, and consumption) and whether these independent variables might serve to predict the impacts of energy risk on international tensions. We developed and tested the respective models. According to the multiple regression model results, the best model examines the impact of three independent variables, namely energy productivity, energy intensity, and energy efficiency on total energy consumption. The findings demonstrate the importance of addressing micro-level operations to cope with changes brought about by geopolitical shifts or risks that affect a variety of economic sectors and European countries, particularly the energy sector. The conclusions of the current study produced various implications and contributions for both academics and in practice. Initially, the current study adds to the existing body of knowledge across a variety of subjects and fields, for instance, geopolitical research, crisis management, energy sector research, and financial and economic-associated studies, amongst others.

In addition, the findings of the current study contribute to the literature by developing and examining a research model which incorporates four predictor variables (energy productivity, energy intensity, energy efficiency, and energy supply by-product) and an outcome variable (supply, transformation, and consumption) to examine the influences of energy risks on international tensions in European Union member states in terms of micro-level operations. Furthermore, this study represents one of the first attempts to provide in-depth understanding and insights into this topic from the context of the energy sector.

Despite the fact that several previous studies have examined the effects of some crises (for example, terrorism, Demiralay and Kilincarslan 2019) on the performance of organizations in various contexts and fields (Apergis et al. 2018; Aysan et al. 2019; Balcilar et al. 2018; Demir and Danisman 2021; Gkillas et al. 2018; Gozgor et al. 2022; Zhou et al. 2020), only a few studies have assessed the impact of geopolitical risks on energy companies, particularly in EU states. Another theoretical contribution made by the present study involves deepening our understanding of the relationship between decision and scenario along with how to approach this in keeping with predictive models.

Furthermore, the findings of this research provide useful, practical guidance, and managerial implications for the concerned policymakers, stakeholders, and business managers involved in the energy sector. Ultimately, businesses must make operational decisions to prevent risk and boost productivity as a result of these adjustments and changes. Especially now, when international tensions are at an all-time high, governments and other relevant authorities, particularly in the energy sector, should design and develop strategic plans, regulations, and processes to assist businesses in surviving periods of high worldwide geopolitical risks. As a result, they are able to boost the performance of energy-related businesses by constructing and improving micro-level operations.

In addition, it may be argued that the proposed and demonstrated model may contribute to today's risky and uncertain reality. It is crucial to foresee possible movements in terms of operational decisions at the micro level. Furthermore, based on the findings of this paper, all relevant parties, including host governments, corporations, and non-governmental organizations (NGOs), must collaborate and participate in the development and deployment of crisis management strategies and procedures in order to mitigate the negative effects of geopolitical risks. The main limitation of the study is that the data is present in a specific period. However, the analysis provided was based on Eurostat data on twenty-seven states from 2011 to 2020. New contributions could have been made according to possible data available in 2021 and 2022.

Author Contributions: R.F. contributed to the research design, methodology, data analysis, and results. M.S. contributed the abstract, introduction, discussion, and conclusion. M.J.S. contributed to the theoretical background and conclusion. A.N.A.-A. contributed to the literature review. All authors contributed to editing, reviewing, and improving the paper. All authors have read and agreed to the published version of the manuscript.

Funding: This paper is financed by National Funds awarded by the FCT—Portuguese Foundation for Science and Technology to the project «UIDB/04928/2020».

Informed Consent Statement: Not applicable.

Data Availability Statement: The dataset generated during this study is available from the Eurostat. https://ec.europa.eu/eurostat/data/database.

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

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