Energy 277 (2023) 127528

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Commodity exposure in the eurozone: How EU energy security is conditioned by the Euro

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ARTICLE INFO

Handling Editor: X Zhang

JEL classification:
D81
Q49
G19

Keywords:
Risk
Exposure
Commodity
Europe

ABSTRACT

The European Union is immersed in a process of energy transition focused on reducing the weight of fossil fuels. The current context is also characterized by the increasing attention paid to energy security, conditioned by the volatility of the prices for energy raw materials, among other factors. This work analyzes the raw material price exposure of electricity producers in the Eurozone. The results indicate that the listing of raw materials in U.S. dollars is the primary cause of business exposure, with an impact greater than the price of the raw material itself. A geographic analysis also indicates that there are important differences in the level of exposure among companies in different countries, which can make it difficult to reach a consensus in the European Union.

1. Introduction

According to the [1]; the outlook for 2030 is for the world energy demand to increase by 4%–9%. This is essentially due to the growth of the emerging markets and developing countries, led by India and other Asian regions. Therefore, in this context, an important increase is estimated in energy prices, along with greater volatility, which has been caused by the drop in prices during the pandemic, which will have an influence on the economic development of certain countries. In addition, the current wartime context between Russia and the Ukraine has added even more volatility and uncertainty to the world's currently already difficult geopolitical and energy context.

Several studies have confirmed the impact of the Russian invasion of Ukraine on energy and the economy [2]. point out that after the beginning of the conflict, a greater intensity of cross-correlations was detected between prices in the crude oil market and capital markets for oil-importing countries. They also confirm the loss of efficiency in oil markets after the invasion [3]. observe, through the analysis of the share prices of more than 1600 energy companies around the date of the Russian invasion, that these companies outperformed the stock market, with North American companies particularly well-performing as compared to their European and Asian counterparts [4]. confirm increased volatility in agricultural, metallurgical and energy markets resulting from the conflict. The increase in volatility is observed in both the field of economics (the greater the world market share of Russia's exports, the greater the volatility) and in the financial dimension (derived from the risk aversion in central banks caused by the conflict). Finally, these authors link the existence of greater volatility in commodity markets (derived from the conflict) to the existence of Russia's high foreign exchange reserves.

In the case of the Russian invasion of Ukraine, the impact of the conflict on European energy policy is clear. Russia's militarization of gas supplies to Europe has led to increased general volatility, and more specifically, price volatility [5]. As a result, European countries have sought to reduce their energy vulnerability by reducing dependence on Russian supplies through greater diversification. Germany is the paradigmatic case of a member state affected by energy uncertainty and dependence on Russian gas. In this sense, [6] detect a higher level of uncertainty in German energy policy derived from the conflict between Russia and Ukraine and the associated geopolitical risks. In any case, the

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https://doi.org/10.1016/j.energy.2023.127528
Received 2 October 2022; Received in revised form 6 April 2023; Accepted 13 April 2023
Available online 28 April 2023

political objective set by the European Union is to accelerate an energy transition that will enable the decarbonization of the economy, for which it is necessary to maintain the commitment to coordination among the member states and joint decision-making, with a clear European vision [5].

The EU is a net importer of energy, with a level of energy dependence of close to 60% in 2020 [7]. This explains the growing concern by the European Commission to increase the energy security of the European Union [8], aimed at reducing the socioeconomic effect that the external supply of oil and natural gas has — and will continue to have — in the future [9]. indicated more than a decade ago the need for European authorities to implement mechanisms to apply common European policy with regard to energy, in a way that is coordinated, integrated and long-term, making it possible to overcome the conditioning that stems from the fact that each EU country resolves its own supply issues on an individual basis. Along these lines, [10] indicated that it was precisely the economic-financial interests of the large companies and political interests of governments that play a role in a geostrategic and risk environment. Electric companies decide on the profile of their energy investments by considering variables such as returns and the financial risk assumed, even beyond the impact that this might have on energy planning in the region in which they operate or on the security of supply of the region itself. Along these lines, investments by energy companies are conditioned by three main factors, which are: i) the absence of a common European energy policy in terms of negotiating contracts with suppliers – each Member State negotiates them individually –; ii) the current design of the energy infrastructures linked to the use of fossil fuels conditions the transition towards a free mix of emissions; iii) the lack of regulatory security in terms of support for non-pollutant energies in the Member States. Furthermore, the governments of countries importing fossil fuels seek to define the energy mix they wish to achieve over the medium-long term with the aim of attaining greater energy independence by reducing the weight of those energy resources that they do not have. In this context, the communications from the European Commission [11,8] and recent regulations from the [12,13] emphasize the importance of the EU's foreign energy policy as a complementary link to the possibilities of the internal energy market, and in particular with regard to electricity, natural gas and hydrogen. Consequently, the future of the EU is related to the challenge of all its states to achieve a stable, economically sustainable and abundant supply of energy [8]. Recently, serious concerns in terms of energy supply security and a common EU policy have arisen as a consequence of the Russian armed invasion of the Ukraine, joined to Russia's decision to suspend the delivery of gas to some EU member states. This has implied a paradigm shift in the EU energy policy, materialized in the Versailles Declaration agreed in March 2022, according to which member states will scale back their dependence on Russian fossil fuels. Thus, the European council agreed in May 2022 a ban on almost 90% of Russian oil imports by the end of the year. Consequently, EU member states were encouraged to diversify their energy supply sources, to increase energy efficiency and to promote the development of renewables. Different agreements were also reached regarding gas supply security, gas demand reduction and gas storage regulation. Specifically, the lack of Russian gas faced by member states was compensated with other Liquefied Natural Gas (LNG) sources [14,15,5].

From a business perspective, the previous literature on risk management and hedging stresses that the risk management policy designed and applied by each company is a key area that has been proven to have an effect on the value of the company (Vivel-Búa & Lado-Sestayo, 2013). Focusing on the commodity risk, recent events in international economics also highlight the important role of raw material price fluctuations on both an operational and strategic level. Over the final months of 2021, the European Union has seen how natural gas reserves from Russia have gradually decreased, due to a lower-than-contracted import flow, evidenced following the Russian invasion of the Ukraine. Movements like this are joined by other such as those which occurred in the winters of 2006 and 2009, when the European Union suffered cuts in the supply of natural gas coming from Russia [8,16]. It was precisely what happened during these two winters that revitalized the EU's own energy security strategy. In 2014, the crisis that arose over the Crimean Peninsula resulted in greater tensions between the main supplier of fossil fuel energy sources, Russia, and its main customer, the European Union [17], which cast doubt on the supply of natural gas to Europe. In this context, the construction of the NordStream 2 gas pipeline connecting Russian gas reserves to the center of the European Union (Germany is the primary recipient), has been a topic of discussion within the EU itself, since it means a new link of gas energy dependence on Russia (as seen following the invasion of the Ukraine) [18].Furthermore, since mid-2021, among other causes, the price escalation of electricity in the EU has been associated with the increasing price of natural gas. This is due to a combination of several factors: the strong recovery of demand, a reduced offering and the concurrence of several weather events, such as an exceptionally long and cold heating season last winter and a decrease in wind flow, which decreased the availability of this technology [19]. In any case, the European prices are reflecting the bullish dynamics of the world's natural gas market.

The aim of this work is to identify and quantify the economic exposure of European electricity producers to the commodity risk, in other words, to the risk related to the impact of unexpected fluctuations in the price of energy raw materials with respect to their value. In particular, it analyzes the relationship between the market value of the energy companies in the Eurozone and the evolution of the price of the raw materials, i.e., oil, natural gas, coal and uranium, between September 19, 2008, coinciding with the start of the economic crisis in not just in Europe, rather worldwide, and September 24, 2021. Therefore, this paper addresses two main research questions. First, to identify the level of exposure of European electricity utilities to changes in commodity prices (oil, gas, coal and uranium). Second, to calculate the value-at-risk of European utilities to changes in commodity prices.

This paper makes three contributions. The main contribution is that it constitutes unprecedented evidence of the economic exposure to commodity risk in the Eurozone, taking into account the role of utilities. Furthermore, this is analyzed in: i) a recent period, marked by an important economic crisis that has conditioned a new macroeconomic environment and important fluctuations in the prices of raw materials; ii) in a relevant market for the EU, such as the energy sector, in both economic and political terms, for the reasons set out above; iii) in an era characterized by important changes in the currency market, which can contribute to the modification of the international reference currency for the purchase of raw materials. The second contribution refers to the fact that, considering the geographic location of each company, this research also contributes to identifying the commodity risk profile for the European countries analyzed through the evaluation of the geographic distribution of the commodities risk in the Eurozone, which is important not only on an internal level in each country, but also from the perspective of designing the energy policy and foreign policy of the European Union. The previous literature studying the acquisition of raw materials in the energy sector has focused on oil and natural gas companies, neglecting the role of utility companies [20]. Furthermore, the differences in the mix of energy generation technologies among the countries of the European Union, in some author's opinions, highlights the importance of conducting an empirical study focused on the level of exposure by utility companies and their geographic distribution among the countries, in order to attempt to propose hedging measures adapted to the factors inherent to each country. Finally, the third contribution this study makes is related to the input this research provides for the definition of the complex concept of energy security, from the perspective of utility companies and their risk exposure. Along this line, the literature has commonly focused on the availability of energy resources and the diversification of suppliers and the types of energy used by the region as a whole. This research provides a new focus centered on identifying and assessing the exposure to raw materials and their trading prices, which are listed in U.S. dollars.

The work is organized in six sections. Following this introduction, the second section presents the review of the previous literature. Next, the third and fourth sections include the empirical study, identifying the materials and methods and presenting the analysis of the results obtained. The fifth section includes the conclusions and finally, the sixth section lists the biographical references.

2. Framework

2.1. Risk exposure

In a global context such as that characterizing today's world, companies are exposed to multiple risks. Economic exposure to risk can be defined as the volatility in the amount of the assets, liabilities or revenue related to an unexpected fluctuation in the reference variable, such as the exchange rate, interest rate or cost of raw materials, for example [21]. In the academic literature, three lines of work can be identified that are related to the study of risk exposure. First of all, it identifies a body of scientific literature that is focused on defining and applying an appropriate method to quantify the economic exposure to risks such as those associated with exchange rates, interest rates or the price of raw materials (commodity price risk). This branch of research dates back to the 1980s, when [22] proposed the use of a time series of business cash flows to identify the exchange rate risk exposure, which initially prevailed in subsequent research studies. However, a new model appeared in the 1990s, which would become the most widely used in the literature after this point. Developed by Ref. [23]; this model was initially designed to quantify the exchange rate risk exposure, although it has also been applied in various studies to analyze the risk related to interest rates and the price of energy raw materials. Specifically, [23] proposes estimating the economic exposure through a regression that considers the company's returns as the dependent variable and the returns of the risk variable (exchange rate, interest rate or price of the energy raw material) and the market returns as the explanatory variables. From then on, subsequent studies have referred to this as the Jorion two-factor model. In this specification, the coefficient for the risk variable returns represents the company's exposure to fluctuations in the risk variable [24]. The bases upon which the model lies are currently widely accepted. In fact, authors such as [25] have indicated that the stock price constitutes an aggregate measure of the company's performance, which is to say the current value of current and future flows. This eliminates any controversy regarding the selection of the dependent variable in the model, since the estimates of the economic exposure with cash flows or returns are related to one another. Likewise, the explanatory part of the model also rests on sound theoretical bases. As [26] indicate, the specification of a market portfolio in the model generates a significant effect on the estimation of economic exposure, contributing to the control of macroeconomic factors.

The second line of research, in turn, focuses on the quantification of the business exposure to risk. Especially in the first two decades of the 21st century, an important body of literature was developed focusing on the analysis of the exchange rate risk [27] (United States); [28] (France) [29] (United Kingdom); [30] (United Kingdom); [31] (Europe); [32] (Nigeria); [33] (Latin America); [34] (India); [35] (United Kingdom)). While these studies are focused on different markets and geographical areas, all reach similar conclusions. Based on the Jorion two-factor model (1990), this research shows that the instability of exchange rates is an important obstacle to corporate performance in the business world. It should be pointed out that the results are obtained in the case of European businesses, which are the focus of attention in this study [31]. conclude in this regard that multinational European businesses have significant exposure to different currencies, particularly the U.S. dollar. These authors also sustain that the depreciation of the euro as compared to other currencies has a negative impact on the returns of European stocks.

The exchange rate risk is not the only risk addressed in the literature. Over the last few decades, various authors have attempted to quantify business exposure to the price of energy raw materials. In general, these studies have indicated that the unexpected movements in this factor significantly affect the value of companies, although results vary among the different markets and sectors. For example, [36]; using a sample of German non-financial companies and applying Jorion's model (1990), indicates that the companies evidence net exposures with regard to several energy raw material prices. This same model was previously applied by several authors in relation to commodities risk, such as by Refs. [37,38]; who focused on studying the exposure of U.S. Companies in the gold mining industry to changes in gold prices. These authors conclude that the influence is significant, but they point out that it varies over time, and from company to company. In turn, [39] analyze the exposure to the risk related to oil prices by financial and non-financial companies in the United States. The results show that the magnitude of the impact of oil prices on non-financial sectors is significantly greater, although the level of sensitivity differs among sectors and over time. On their part, [40] analyze the impact of oil price volatility on oil and gas companies in emerging markets, indicating that the effect is both significant and persistent.

Framed within the third line of literature is a theoretical and empirical body that emerged in the 1990s, referring to the analysis of hedging theories. These studies attempt to identify the determining factors that lead companies to apply hedging tools, especially derivative products, when faced with an exchange, commodity or interest rate risk [41]. Among these determining factors are those such as the existence of informational asymmetries and the problem of underinvestment, the existence of financial insolvency costs, tax convexity, the level of exposure and the existence of scale economies. More recently, research has been focused on not only analyzing the determining factors behind the adoption of hedging strategies, it has also been aimed at knowing the specific impact that their use has on reducing the exposure to the risk and on the value of the company. It is expected that the risk hedging contributes to reducing the volatility of business cash flow and that this generates a positive effect on its value [42]. However, [43]; in a meta-analysis of 51 studies, indicate that the literature does not provide a unanimous conclusion on whether the use of derivatives leads to a higher valuation of the company. In addition, this article explains whether the absence of consensus is due to specific factors in the country or the types of hedging considered. The results show that the use of exchange rate derivatives, by themselves or in combination with other types of derivatives, positively affects the value of the company. Likewise, it reveals that the hedging provides an economic advantage for all companies, especially for those that come from developed countries with common law systems.

In turn, in relation the management of the price risk for energy raw materials, particularly interesting is the empirical evidence obtained by Ref. [44]; who, based on 48 countries, sustain that the use of commodity derivatives by non-financial companies is more common in those industries where energy raw materials are the most important, such as those belonging to the utilities, oil, mining, steel and chemical sectors. For example, studies like that by Refs. [45,46] highlight the frequent use of derivative products among companies in the gold mining sector, and [47] reveals their use, which is also prevalent, in the gas and oil industry. More recently, [48]; in a broad review of the literature in relation to commodity risk management by non-financial companies, indicate that the application of commodity hedging measures can reduce the exposure to this risk. However, they sustain that the results are not conclusive with regard to whether commodity risk management adds value to the company.

Given that this research intends to quantify the exposure to the energy raw material price risk in the electricity sector, the level of exposure to this risk can be defined for these purposes as the volatility in the amount of assets, liabilities or income of an electrical company when faced with unexpected changes in the price of energy raw materials. As demonstrated in the previous literature, the level of exposure can be measured precisely through the variations in the company's trading prices as compared to variations in the price of the commodity being studied [48,38]. The quantification of the exposure to this source of risk is crucial for energy companies, permitting their efficient management and thus contributing to their hedging [49]. In turn, this can help ensure the energy security and the stabilization of the business value. As a matter of fact, according to Ref. [50]; companies affected by the basis risk (imperfect hedging) in the energy sector reduce their investment, show a lower valuation, sell more assets and maintain a lower level of debt. In spite of the importance of this topic, most studies that have evaluated the price exposure of energy raw materials have focused on sectors other than the utilities sector. It should be pointed out that within the small body of literature on the risk exposure of utility companies, most works have focused on the study of the impact of the price of coal and weather conditions [51,52,53]. Related to this, [49] analyze the management of the weather risk through weather derivatives and [54] evaluate the risks associated with renewable energy production in Germany, with a focus on weather conditions. However, from the perspective of energy raw material price risk management, the utility companies have clearly taken the backstage to oil and gas companies [20], as observed in the review of the second and third line of literature. As a result, with the exception of errors or omissions by the authors, there do not seem to be any studies focused in the exposure of utility companies to oil, gas, coal and uranium commodities. It should also be pointed out that, given that there are important differences in the coverage (hedging) decisions made due to cultural issues [55], studies conducted on other markets may not be applicable to the European market, which in turn presents important differences among countries [56]. This reveals the need to determine the level of exposure by utility companies and their geographic distribution among the countries to propose adequate hedging measures that take into account the cultural, economic and regulatory factors of each country.

2.2. Energy security

If an attempt is made to expand the focus of the risk definition with regard to the investment in financial assets linked to utilities, this investment could conceptually approximate the investment in real electricity generation assets (technology plants) [57]. It is in this area in which authors like [58,59] classify the energy risks as either systematic or specific, thus according to a financial perspective. Systematic-type risks would be related, among others, to those derived from economic growth factors (future demand for electricity, availability of capital, etc.), regulatory or political risks (financial conditions, control and environmental policies, geopolitical insecurities, tax-related modifications to the regulatory framework, payments for capacity or design of the electricity market, among others), those inherent to the functioning of the electricity market (raw material and fuel prices, electricity prices, variations in demand, intermittency of renewable energy flows, volume, etc.) and technological risks (those linked to systems supporting the development of certain technologies, such as renewable energies and the capture and storage of carbon -which can be classified as *learning by research* or *learning by doing* [60]. The main specific risks related to investments in energy assets would be those related to the size and diversification of the portfolio, those derived from technologies (derived from the control over the service life times of the portfolio — since they are captive investments for long period of time of 15 or 20 years — and the suitability of the investment policy), reputational risks (related to possible accidents in the plant and environmental and/or social damages) and those linked to the system (reliability of the technological plant type in the system). Other authors such as [10,61,62] opt for a more restricted classification of risk, composed primarily by three elements: geopolitical risks related to technological uncertainty; energy security risks (fuel price volatility) and the impact on society and the environment; and the risk related to the design of the technology portfolio, the reduction of capital costs and the agents who intervene (social acceptance).

In all cases, it is once again observed that the concept of variability is commonly employed in the literature as a synonym of energy risk. Accordingly, [63,64]; point to the variability and uncertainty (operational) caused in the system by the incorporation of electricity generated by renewable resources – based on unmanageable flows that are difficult to predict over the long-term and are intermittent. Other authors such as [65,66,61] and [67] opt to present fuel price volatility as a determining factor of energy risk [66]. complement this proposal, adding the volatility of the *feed-in tariffs* for renewable technologies. Together with the problem of cost variability, the uncertainty generated by the technological change is an element that authors like [61,67] propose as key in terms of risk.

It is precisely energy risk management that allows progress to be made in terms of energy security, one of the challenges that any state or region faces, and which is essentially related to climate change, economic growth and with it, the regional security of each State [8,68]. When it comes to defining the concept of energy security, one of the perspectives can be that of its impact over time, in terms of the short or long term. From a short-term perspective, energy security would have a relation to the capacity the system offers for a certain territory to reacting quickly to unexpected changes in the energy supply and/or demand (such as, for example, a rapid increase in energy prices, a reduction in the quality of the marketed resources or supply interruptions, among others) and to offer an energy flow that meets the demands of an economy in terms of form and price, in such a way that the very development of the economy itself is not interrupted [69]. Alternatively, from a long-term perspective, the concept would make reference to the set of investments necessary to ensure the energy supply (generation, transmission and distribution facilities), taking into account the economic development, social needs (consumers) and environmental needs of a territory [70].

In short, the existing link between energy security and the analysis and management of investment risk in utility companies is what motivates this study, with the primary objective being to identify and quantify the economic exposure of European companies producing electricity to commodity risk.

3. Materials and methods

The sample includes all utilities from the Eurozone with available data in Refinitiv (40 firms) and 4 energy raw materials, namely oil, liquefied natural gas (hereafter, gas), coal and uranium. Table 1 shows the proxy variables for each of these energy raw materials.

The empirical study is organized into two stages. The first stage estimates the level of exposure to variations in the price of the energy raw materials, i.e., oil, gas, coal and uranium, based on Jorion's model (1990). Next, considering the estimated exposure levels, the second stage estimates the value at risk of European utility companies to variations in the prices of energy raw materials, considering a weekly time horizon.

Table 1
Proxy variables for the energy raw materials.

Energy raw material	Variable proxy
Oil	Brent barrel
Gas	Dutch day-ahead gas price at the Title Transfer Facility (TTF) hub
Coal	Free on Board (FOB) price at the Vladivistok port
Uranium	Spot price of U3O8

3.1. The exposure to variations in the price of the energy raw materials of European utility companies

Focusing on the first stage of the empirical study, in a situation of equilibrium, the returns of an asset would be explained according to the following expression [71]:

$$r_j = r_f + \left(\frac{r_m - r_f}{\sigma_m}\right)\frac{\sigma_{jm}}{\sigma_m} \quad [1]$$

Where:

r_j = returns of the asset j.

r_f = risk-free returns

r_m = market portfolio returns

According to equation (1), the returns of an asset j is explained by the profitability of the risk-free investment alternatives (r_f), by the non-diversifiable risk of the asset j ($\frac{\sigma_{jm}}{\sigma_m}$) and by the compensation per unit of non-diversifiable risk $\left(\frac{r_m - r_f}{\sigma_m}\right)$, which is known as the Sharpe ratio. According to the model, it is important to point out that only non-diversifiable risk is compensated, since it is the only one that cannot be eliminated. As a result, the risk-free returns and the market portfolio returns would be sufficient to explain the returns of the asset j, and meeting the assumptions of the model, the econometric estimate would produce white noise errors, in order words, surprise effects in the market. For this reason, any dependence by the returns of asset j to changes in another asset, such as increases or decreases in exchange rates or the prices of energy raw materials, would reflect a lack of hedging for changes in these unexpected elements by investors. According to this premise and taking into account the characteristics of the financial series related to the existence of autoregressive conditional heterocedasticity, the decision was made to estimate a Generalized Autorregresive Conditional Heterocedasticity (GARCH) model, which is also in line with what was done in previous works [72]. The estimated model presents the following expression:

$$r_{jt-}r_{ft} = \alpha_j + \beta_{j1}(r_{mt} - r_{ft}) + \beta_{j2}r_{Ct} + \beta_{j3}r_{Et} + \varepsilon_{jt} \quad [2]$$

$$\sigma^2_{jt} = \omega_j + \theta_1\sigma^2_{j(t-1)} + \theta_2\varepsilon^2_{j(t-1)}$$

$$\varepsilon_{jt} \sim iid\ N\left(0, \sigma^2_{jt}\right)$$

where:

r_{jt} = return of the company stock j at moment t.

r_{ft} = risk-free return at moment t.

r_{mt} = return of the market portfolio at moment t.

r_{Ct} = return of the Euro/U.S. dollar exchange rate at moment t.

r_{Et} = return of energy raw material E at moment t.

α_j = Jensen's alpha of company j.

β_{j1} = Market beta of company j.

β_{j2} = level of exposure to exchange rate changes in company j.

β_{j3} = level of exposure to energy raw material E of company j.

It should be noted that the excess of return of the asset in relation to the market ($r_{jt-}r_{ft}$) is also affected by its variance, where:

ω_j = mean of the variance, which would coincide with the expected variance over the medium and long term.

$\theta_1\sigma^2_{j(t-1)}$ = prediction of the effect that the variance would have that was observed in the previous period.

$\theta_2\varepsilon^2_{j(t-1)}$ = prediction of the volatility from the previous period.

The model proposed in Equation (2) considers the possible impact of changes in the trading prices of energy raw materials and changes in the exchange rates for the euro and the U.S. dollar, as well as the returns of the market portfolio and the risk-free return. The reason for this is that the aim of the work is to evaluate the exposure of energy raw materials, considering the fact that their trading prices are listed in U.S. dollars. In this manner, in relation to the market portfolio, the Eurostoxx has been considered, due to the fact that all the companies analyzed share the same reference currency (the euro) and this index synthesizes the main investment alternatives in the European market. With regard to the risk-free return, the Central European Bank's official rate is used as a proxy for the interest rate for operations with a short-term guarantee (weekly operations with weekly maturity), due to the current situation of the interbank market in unguaranteed operations and the existence of negative rates in public debt.

The return calculation has taken into account continuous compounding, according to the following expression:

$$r = \log\left(\frac{P_t}{P_{(t-1)}}\right) \quad [3]$$

A weekly time reference has been applied for the calculation of the returns. If daily or monthly returns were applied, a high number of observations would have been excluded. For example, Monday vs. Friday could not have been considered in the case of daily returns, and some days could not have been considered in the case of monthly returns. Furthermore, it should be indicated that the use of weekly data contributes to reflecting changes over the short term, thus avoiding possible sharp decreases or increases in a company's trading prices as the result of irrational market behavior, or one-off operations by institutional investors. Likewise, this time period corresponds to the maturity of operations that are used as a reference for the calculation of the official interest rate of the European Central Bank and can be calculated for all the variables.

3.2. The value at risk of European utility companies to variations in energy raw materials

Once the levels of exposure to energy raw material prices were calculated, the empirical study then consisted of estimating the value at risk of European utility companies with regard to variations in energy raw materials. Therefore, to begin with, the impact of a decrease in weekly trading prices for each energy raw material was estimated, corresponding to a 95% percentile, according to historical information. Secondly, for each energy raw material, the function was estimated that best describes the variations observed, using Different Parametric Generalized Additive Models for Location, Scale and Shape Distributions [73]. Based on the observed data, these semi-parametric models estimate the parameters that best fit up to four parameters of different distributions, corresponding to the mean, standard deviation, asymmetry and Kurtosis. Following this, the results for the distributions considered were compared using the Generalized Akaike Information Criterion (GAIC), and to estimate the distribution, all the continuous distributions were compared that are defined on the real line available in the R gamlss package [73].

The marginal distributions of each of the energy raw material functions, in addition to those of the market and exchange rate, are unknown and potentially different. However, important dependent relationships do exist between them that may be neither linear nor asymmetric, and therefore a joint simulation was performed for all of them, using copulas. A copula is a multivariate distribution function with marginal uniform distributions that are different from one another, which makes it possible to gather information about dependent relationships in a set of variables based on their respective density functions. According to this approach, first of all, the copula was estimated to reflect these dependent relationships, using a Generalized Additive model Vine Copula. According to the method used by Refs. [74,75]; the "gamcopula" statistical software package R was used. The approach consisted of starting with an absolute ignorance of the optimal structure of the copula and the interrelationships among the different variables [76,77]. In this manner, the copula is obtained with the best fit to represent the interrelationships between the variables based on an estimate of different families of bivariate copulas. Specifically, the following bivariate copulas were estimated for all the possible combinations: Gaussian, Student t, Frank, Double Clayton type I (standard and rotated 90°), Double Clayton type II (standard and rotated 270°), Double Clayton type III (survival and rotated 90°), Double Clayton type IV (survival and rotated 270°), Double Gumbel type I (standard and rotated 90°), Double Gumbel type II (standard and rotated 270°), Double Gumbel type III (survival and rotated 90°), Double Gumbel type IV (survival and rotated 270°). Once all the above copulas were estimated, the Akaike criterion was used to select the best-fitting bivariate copula, while the maximum spanning tree of the Kendall's tau was used to construct each node. These were the criteria used to generate the Generalized Additive model Vine Copula, i.e., the set of bivariate copulas and the relationships between them. Once 10,000 scenarios were generated using the Montecarlo method with the best-fitting copula, the results were transferred to the distribution functions, according to the results of the Parametric Generalized Additive Models for Location, Scale and Shape Distributions.

4. Results and discussion

4.1. Commodity exposure

Table 2 shows the descriptive statistics for the sample data. Appendix I identifies the companies associated with the tickers used. The results of the Jarque Bera test indicate that it is not possible to assume normalcy in the distribution of weekly performances, which in most cases show asymmetry and a high Kurtosis, with a standard deviation far above the mean. These results show that there might be abrupt movements in the market, and that the behavior in situations of growth could differ from that presented for market troughs.

Table 2
Descriptive analysis.

Ticker	Mean	Standard Deviation	sk	Kurt	Jarque Bera p-value
VERB.VI	0.161	4.564	−0.299	2.463	<0.01
EVNV.VI	0.053	3.066	−0.197	4.565	<0.01
BHAV.VI	0.679	6.209	0.575	3.497	<0.01
FORTUM.HE	0.207	3.931	−1.617	11.298	<0.01
VLTSA.PA	0.019	5.913	1.468	10.465	<0.01
ABIO.PA	0.103	4.305	−0.345	4.001	<0.01
EDSP.PA	0.111	2.454	−0.154	7.536	<0.01
MLEES.EUA	3.207	28.784	2.667	13.740	<0.01
EBKG.DE	0.184	3.715	0.653	6.356	<0.01
SWHGg.F	−0.071	4.037	0.361	4.438	<0.01
LECG.F	0.199	2.698	0.471	3.609	<0.01
ECVG.DE	0.396	3.832	0.439	4.436	<0.01
EKTG.DE	0.772	5.025	3.360	32.706	<0.01
H2OG.F	2.937	36.073	10.677	174.040	<0.01
ETGG.DE	0.252	4.919	0.406	7.260	<0.01
HRPKk.DE	0.343	3.154	0.554	3.787	<0.01
ABOG.D	0.143	1.583	0.006	8.828	<0.01
PRYG.D	0.791	6.449	0.502	2.147	<0.01
CV3.MU	0.245	12.857	8.072	124.088	<0.01
MYTr.AT	0.215	6.320	0.119	1.915	<0.01
DEHr.AT	0.260	8.302	0.212	2.991	<0.01
TENr.AT	0.329	6.312	0.942	6.651	<0.01
ROEN.CY	−2.341	17.177	−5.030	25.664	<0.01
GRPG.I	0.171	1.922	−0.020	1.567	<0.01
ENEI.MI	0.186	3.874	−1.125	7.255	<0.01
A2.MI	0.164	4.454	−0.726	5.180	<0.01
ERG.MI	0.266	4.041	−0.058	3.995	<0.01
FKR.MI	0.246	5.317	−0.290	5.186	<0.01
ARN.MI	0.213	5.152	1.606	8.687	<0.01
FDE.MI	0.153	5.300	1.906	10.648	<0.01
IRLP.WA	0.306	4.725	1.009	12.477	<0.01
SELU_p.LU	2.129	14.243	0.259	−0.734	0.200
DGB.AS	−0.182	8.275	3.028	25.569	<0.01
NSEN.AS	1.352	16.084	2.640	12.829	<0.01
EDP.LS	0.187	3.681	−0.246	2.841	<0.01
IBE.MC	0.236	3.785	−0.868	7.805	<0.01
ELE.MC	0.206	3.730	−0.972	10.822	<0.01
EDPR.LS	0.224	4.077	−0.393	3.256	<0.01
SLRS.MC	0.611	10.411	6.494	100.439	<0.01
HLZZ.MC	0.448	5.523	−0.294	5.118	<0.01

Focusing on the first stage of the empirical study, after estimating the models according to equation (2), an analysis of significance at 5% of each of the betas obtained shows that 31 of the 40 companies (77.5%) have a statistically significant exposure to the variations in the energy raw material trading prices and currency exchange rates. In particular, 5 companies exclusively show exposure to one energy raw material, without showing exposure to the currency risk; 16 companies are exposed exclusively to the currency risk; and 10 companies have exposure to the currency risk, together with one or two energy raw materials. These results indicate that the currency has a direct influence on the returns of 26 of the 40 companies analyzed. This statistic is especially relevant when we take into account the fact that these companies target the European market (the Eurozone) and have located their main production structure in the countries where they offer their services, and therefore, their payments and collections could be specified exclusively in euros. This exposure to the currency risk could owe to the fact that the different energy raw materials are quoted in U.S. Dollars and not in euros. Since energy raw materials are traded in U.S. Dollars and the European companies included in our sample have to use this currency to purchase them, it is possible that some might mitigate or reduce their exposure with hedging mechanisms. Likewise, it is important to stress that the use of hedging techniques can result in overexposure, caused by the speculative use of the hedging instruments [78].

The analysis must also consider that some companies may benefit from increases in the costs of their competitors. For example, companies with greater energy production that rely on renewable energy raw materials could benefit from an increase in gas and carbon prices, since this increases market prices and thus their margin. As a result, it is important to check whether the estimated exposure is positive or negative and not just limit the empirical study to identifying whether or not it is significant. Fig. 1 shows the sign for the level of estimated exposure, and it is observed that the companies show a primarily negative exposure to Brent barrel and coal prices, while the exposure is primarily positive with regard to uranium. This result could be explained by the existence of long-term contracts that guarantee a fixed purchase price for energy raw materials in a context of price increases, or also due to the use of alternative energies as compared to competitors who use these two energy raw materials more intensively. In any case, of note is the exchange rate effect, which has very similar values in terms of the number of companies with positive and negative exposure, which could indicate the existence of excess hedging or the use of an alternative energy source to the four energy raw materials studied in this work (uranium, Brent oil, gas, coal).

4.2. Value at risk

Next, taking into account the significant levels of exposure previously identified, the exposure was quantified in terms of market capitalization, in other words, what impact an increase by one percentage point in the return of each energy raw material or currency would have on the value in euros of each of the companies (Table 3). Considering the mean and the median, the price variations for uranium are those that generate the greatest impact. The consideration of currency together with the changes in the prices of the energy raw materials noticeably increases the effect on the value of the companies.

According to the previous results, the impact on the value of the companies has been calculated as the result of the variations in the trading prices of each of the energy raw materials, taking into account the historical changes observed during the analyzed period (Fig. 2). The results obtained indicate that the variations in the gas trading prices are those that have triggered the greatest variations in the value of the

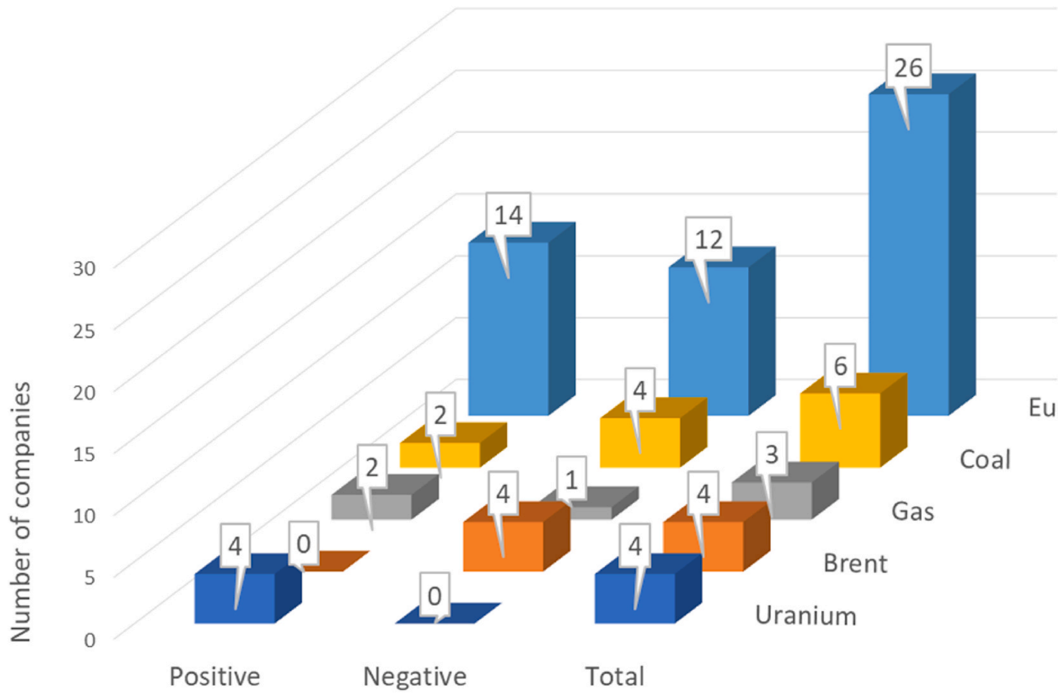

Fig. 1. Type of exposure (positive/negative) to energy raw material prices and currency (number of companies).

Table 3
Descriptive statistics of the impact of an increase by one percentage point in the return of the energy raw material and of the currency (euros as compared to the U.S. dollar) on the value of the companies.

Data in thousands of €	Mean	Minimum	Median	Maximum	Q25	Q75	IQR
Uranium	20,549.63	21.30	4748.90	72,679.41	2498.52	22,800.00	20,301.48
Brent	−5692.16	−21,667.51	−549.18	−2.76	−5959.94	−281.39	5678.55
Gas	14,616.70	−2042.75	22.57	45,870.27	−1010.09	22,946.42	23,956.51
Coal	6216.63	−10,260.85	−28.64	48,300.80	−528.62	2.13	530.75
EUR&Uranium	9921.86	−6820.33	8.07	74,311.11	−895.37	5028.58	5923.95
EUR&Brent	1978.71	−69,971.17	26.95	53,751.66	−3222.99	10,372.07	13,595.05
EUR&Gas	700.76	0.98	293.73	2864.99	89.11	1267.13	1178.02
EUR&Coal	307,287.98	11.59	68,611.51	1,218,534.02	59,230.82	190,051.97	130,821.15

Note: Q25 refers to the 25th percentile, Q75 is the 75th percentile and IQR is the interquartile range.

utility companies in the Eurozone.

Fig. 3 below shows the distribution observed for the variations in market capitalization, the estimated distribution after eliminating the effect of the energy raw material price changes, and the estimated distribution after eliminating both this effect and that generated by the exchange rate changes between the euro and the U.S. dollar. As can be seen, eliminating the exchange rate risk drastically reduces the estimated variation in the market capitalization, which shows the importance of its management. If the impact of the price of a energy raw material is observed exclusively and not taking into account the currency (second figure in the graph), it is observed that the estimated risk is reduced, although with a much lower intensity than for the currency (one week value at risk at 95% is −4.039 and −0,688 billions of euros respectively for raw materials and currency).

Finally, in order to evaluate the joint impact of variations in the trading price of energy raw materials and the exchange rate on market capitalization, 10,000 scenarios generated based on the best-fitting copula were analyzed, taking into account the marginal function that best fit each of the distributions being simulated (Fig. 4). Once again, these results indicate that an important part of the variations observed in the overall market capitalization are the result of the effect of the currency and the price of the energy raw material, with the currency being the main cause (one week value at risk at 95% is −5.532 and −1.038 billions of euros respectively for raw materials and currency).

Considering a geographical distribution of the results obtained, i.e., grouping firms by country, the extent to which an increase by one percentage point in the trading price of each of the energy raw materials influences the market capitalization of the companies was calculated. This makes it possible to evaluate the geographic distribution of the commodities risk in the Eurozone and the extent to which the companies in some countries could benefit from increases in the trading price of certain energy raw materials. The evidence obtained, shown in Table 4, indicates that the value of Italian companies shows a positive relationship with the increase in the cost of uranium, which could be explained by the country's nuclear moratorium. German companies show a strong positive relationship with the price of gas, which may be due to both the fact that they are highly dependent on imported gas (with low gas reserves) and that it is strongly oriented towards implementing renewable energies, coupled with abandoning nuclear energy. Finally, a positive relationship is also observed for Spanish companies in relation to coal, which could be related to the closing of coal-fired thermal power plants (16 out of a total of 21 between the years 2011 and 2020 in this country). These relationships could likewise be explained by the fact that these energy raw materials altogether condition the final price of electricity, which would generate an increase in the margin for the rest of the generation sources. It could therefore be stated that the Italian companies could benefit from an increase in the price of uranium, Spanish companies would benefit from an increase in the price of coal and

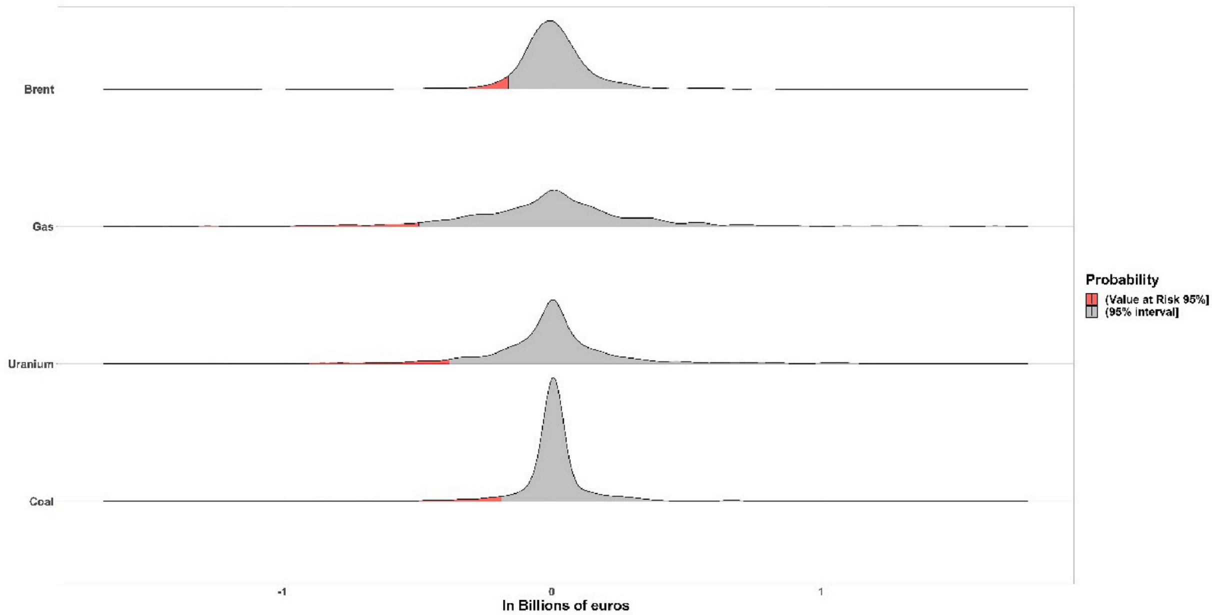

Fig. 2. Distribution of the changes in the energy raw material trading prices on market capitalization (historic data and estimated coefficients for each energy raw material).

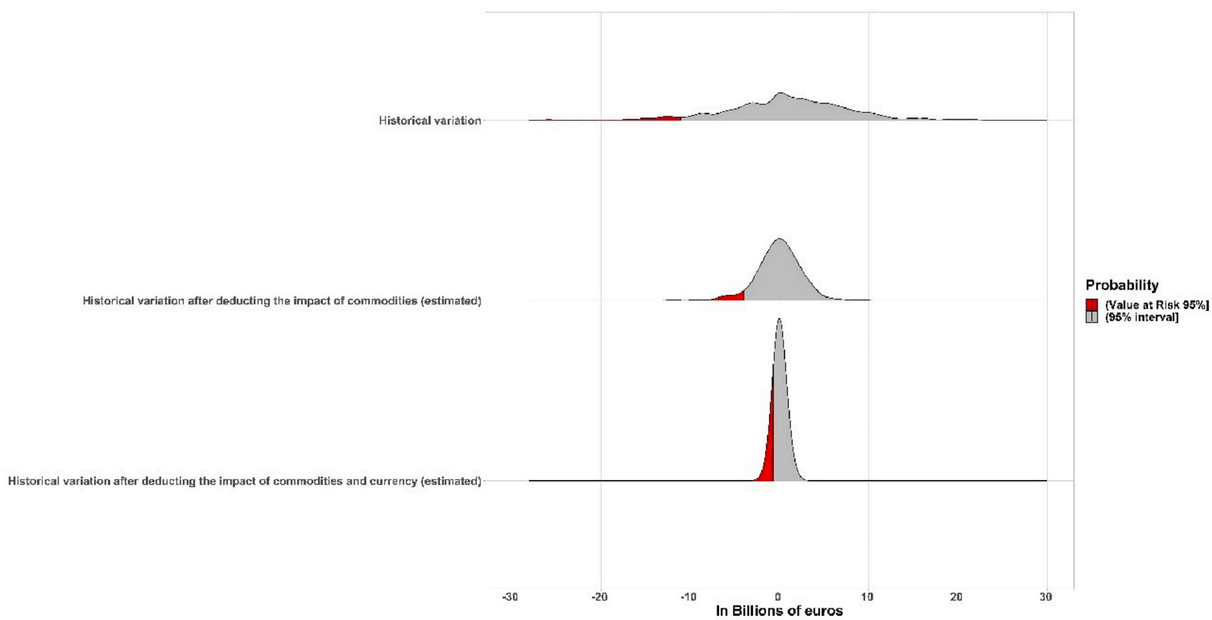

Fig. 3. Distribution of the trading price: historic data (var_val_emp), data after eliminating the effect of the energy raw material (total_with_eur), data after eliminating the effect of the energy raw material and exchange rate (total_without_eur).

German companies would benefit from an increase in the price of gas, and this could have an influence on decisions at a European level in the search for trading partners.

4.3. PUSH for the euro as the preferred currency for energy and implications for energy policy

In spite of the fact that the European Union constitutes a single economic block for foreign trade, agreements for the purchase of commodities are bilateral and between companies. Thus the level of exposure observed for each country can lead to different scenarios (in terms of energy security), according to the distribution of the purchases made by their national companies.

The hedging of the commodities risk by means of long-term contracts that guarantee the purchase price have made it possible to almost entirely mitigate this risk for utility companies in the Eurozone. This is reflected by the almost total absence of significant negative exposures throughout the Eurozone. However, referencing these contracts to a currency other than that in which the income is obtained (in this case, euros), and which in general terms affects investments and financing, exposes companies to new risks. In particular, this means exposure to the monetary policy of the U.S. dollar, which causes greater exposure to trade wars between economic blocks and dependency on decisions and strategies that lie outside the European arena.

In this sense, the European Union recently just approved a set of proposals intended to boost the international role of the euro [79–81].

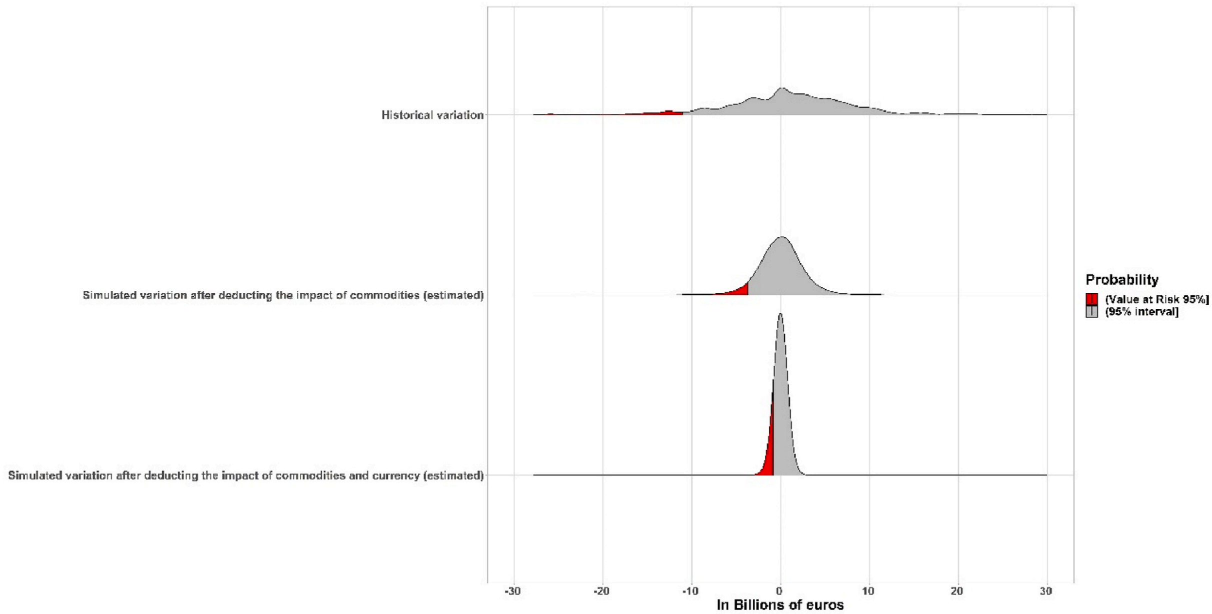

Fig. 4. Joint impact of the changes in the trading prices of energy raw materials and the exchange rate on market capitalization (data generated with scenarios and coefficients estimated for all energy raw materials).

Table 4
Estimated impact of the changes in the trading price of energy raw materials on the market capitalization by grouping firms at the country level.

Country	Uranium	Brent	Coal	Gas
Austria	*	*	*	*
Finland	*	−21,667,509.97 €	*	*
France	*	*	*	−10,257,617.13 €
Germany	3,324,265.20 €	−2763.67 €	*	48,243,519.44 €
Greece	21,297.87 €	−724,081.30 €	−2,042,749.10 €	−686,136.77 €
Ireland	*	*	*	*
Italy	78,852,937.87 €	−374,269.81 €	*	*
Lithuania	*	*	*	*
Luxembourg	*	*	*	*
Netherlands	*	*	22,574.69 €	*
Portugal	*	*	*	*
Spain	*	*	45,870,273.63 €	*

From an energy perspective, the most relevant measure is that recommending denominating en euros all intergovernmental contracts between members of the European Union. It constitutes a fundamental proposal, because according to data from the European Commission [8], every year more than €400 billion are earmarked for importing fossil fuel resources, in amounts greater than €1 billion per day. Of these imports, more than three quarters were billed in dollars, with non-U.S. origins (Russia, Africa and the Middle East). In addition to this proposal, the European Commission has established others, such as the augmentation of the European role in liquefied natural gas treatment plants, and the promotion of European reference measures for crude oil in euros. In any case, the Energy Security Strategy of the European Union [8] once again insists on the need to constitute a common energy policy based on which to establish joint negotiating strategies to sign purchase agreements for energy raw materials. In this manner, it would manage to recover negotiating power when dealing with countries supplying these resources, since the EU would be negotiating a single contract to meet the needs of more than 400 million people. Negotiations would be with “a single voice,” representing the entire population of all the member states. All of these steps, together with the energy transition promoted by the EU Green Deal can help reduce the high level of energy dependence in the EU and increase energy security.

Prior to the Russian invasion of Ukraine, the largest trade partner in terms of energy was Russia. Starting with the EU27-Russia Summit in 2000, ongoing agreements have emerged to consolidate the trade relations in terms of energy. Cooperative efforts included joint investments to improve gas and pipeline system and the building of new infrastructures, such as the recent Nord-Stream II [18,82]. On average, fossil fuel imports from Russia represent around 30% of the total imports by the EU. The level of dependence reaches such a point that some countries geographically close to Russia, such as Slovakia, Latvia, Czech Republic, Estonia and Finland have Russia as their main and practically sole provider of natural gas. For all these reasons, the European Commission established a series of clear directives to encourage the Member States to diversify both their suppliers and the energy technologies (mix design) as part of their energy security strategy [8,12,17]. The new geostrategic situation is still not clear, but everything seems to indicate a gradual and relatively quick “disconnection” of the European states from what until now has been their preferred energy partner.

Even though in this study it is not possible to reach a conclusive conclusion with regard to the risk associated with a specific energy raw material and a country of origin of the supplier (due to the idiosyncrasies of the energy mix in the Member States), the positive effect indicated of reducing the exposure to the currency exchange risk could be applied to trade relations with Russian companies, as the main energy providers of the EU.

Among the implications of the energy policy derived from the use of the euro as the preferential currency for energy transactions would be:

According to what is set out in the analyses and in the results, the first element to consider would be the revision of policies related to purchasing energy raw materials jointly on a European level, in order to achieve better risk exposure. However, the national sovereignty of each Member State and its national interests come into conflict with what could be the application of a common energy policy, in lines with what is indicated by the European Commission on the motion of the European Parliament and Council related to the establishment of an information exchange mechanism regarding the intergovernmental agreements and non-binding instruments between the Member States and other countries in the energy sector [83].

A second element to consider is the evident generalized negative exposure to the U.S. Dollar evidenced following the analysis that was performed. For this, the policies aimed at using the euro as a reference currency for the purchase of commodities is a measure that would contribute positively to reducing the value at risk of these companies. This reduction in the value at risk would contribute to both reducing the financing costs, due to improved returns adjusted to the risk by investors, and to reducing the costs derived from the currency risk hedging activities. The analysis has revealed the need and utility of applying the provisions issued by the European Commission in 2018 [79–81] with regard to the role of the euro in the field of energy and its strategic importance in relation to a greater level of energy security in Europe and complementary to the energy transition in terms of investment planning.

However, the new geostrategic scenario seems to be leading to the EU's dismissal of its formerly preferential partner (Russia) in favor of other partners-companies in the United States and other American countries like Venezuela, which will condition the type of exchange currency to be used in contracts and with it, the impulse towards a potentially greater use of the euro as a preferential currency in the area of energy. The benefits that the use of the euro as a reference currency could have represented for European companies that are indicated in this study will thus be conditioned by the room for maneuvering that the companies might have in the Member States of the EU to negotiate their contracts for energy raw materials in the new geopolitical context that is on the horizon.

5. Conclusions and policy implications

The European Union is currently a net importer of energy resources and it has a high level of energy dependence. This causes it to be subject to a high level of energy risk, characterized by the search for a guarantee of security for its physical supply and of access at reasonable and stable prices to the necessary energy resources. The level of energy dependence is also affected by the absence of a common energy policy in terms of negotiating energy raw material supply contracts. In fact, in spite of the fact that the European Union constitutes a single economic block for foreign trade, the agreements for purchasing energy raw materials are bilateral and between companies. This has an opportunity cost for the Eurozone, associated with the greater power that it would have in negotiating contracts for purchasing energy raw materials in the case of acting with "a single voice". However, the possible success of the implementation of a common negotiating strategy would be affected by the geostrategic relationship that each of the Member States maintains with Russia. The obstacle would arise when the sovereignty of each Member State (in the form of decisions aimed at ensuring the energy supply), enters into conflict with the common European interests. It should be noted that the current warlike context between Russia and Ukraine has already emphasized the need of acting as a block in the EU. In fact, it has been made possible for member states and energy companies to jointly buy gas on global markets as an emergency measure [14].

Given the close link between the level of energy risk and the prices of energy resources, it is evident that their analysis needs to be considered in the literature so that companies can implement appropriate hedging strategies and mechanisms. This is precisely the topic analyzed in this study.

5.1. The energy raw material price exposure of electricity producers in the eurozone

Through the application of Jorion's model (1990), it is shown that the currency has a direct influence on the returns of 26 of the 40 utility companies analyzed in the Eurozone. This could be due to the fact that the different energy raw materials are traded in U.S. dollars and not in euros, which is especially relevant when taking into account that the activity of these companies resides in and targets the European market (the Eurozone). For this reason, the needs for currency exchange are evident when it comes to referencing the supply contracts for these commodities in the European electrical companies. In fact, the European Union, in a set of proposals to promote the role of the euro [79–81], has emphasized the importance of this measure.

With regard to the analysis of the risk of price exposure of the energy raw materials, the study identifies the type of estimated exposure beyond the confirmation of its significance. The results show that around half of the companies analyzed primarily show a negative exposure to the Brent barrel and coal prices, and the other half have a mainly positive exposure in relation to uranium and gas. Based on these results, two main conclusions are drawn:

- First of all, it is observed that in a situation of energy transition such as the current one, European companies will be well positioned since their positive exposure is related to fuels that are destined to be key in the transition process, especially uranium, given the now renewed enthusiasm for nuclear energy in Europe. In fact, the beginning of the war between Russia and the Ukraine pointed out the need for EU member states of phasing out dependence on fossil fuels and increasing the investment in clean energy. Governments such as the German have already stated that they will invest more in nuclear and renewable energy, strengthening energy security and ensuring lower carbon emissions and lower dependence on Russian imports [84,85]. Alternatively, fuels with a negative exposure are destined to be abandoned, especially under the current warlike context in Ukraine, which boosted the Versailles Declaration in March 2022, according to which member states agreed to scale back their great dependence on Russian fossil fuels [14].
- Secondly, it is indicated that the similarity in the number of companies with a positive and negative exposure to exchange rate effects could be indicative either of excess hedging or that the companies are using an alternative source other than the four energy raw materials studied in this work (uranium, Brent, gas and coal). One line of future research will be to attempt to check this. In this sense, the important role to be played by natural gas leads to positive expectations for European energy companies. This can be linked to Ref. [3] observations on the outperformance of energy companies, as compared to stock market performance after the beginning of the Russian invasion. However, the tightening of markets and the increase in volatility and gas prices resulting from the militarization of the gas supply are likely to have an impact on the energy policies of EU member states, as [6] noted in their study on Germany.

5.2. The value at risk of European utility companies to variations in the prices of energy raw materials

In addition to identifying the estimated exposure rate and its significance, this study quantifies the exposure in terms of market capitalization of each of the companies. Based on the conducted research, the following conclusions were drawn:

- The results bring to light that the consideration of currency along with changes in the prices of energy raw materials noticeably increases the effect on the value of the companies. They also confirm a greater sensitivity of the value of the utility companies in the euro zone to variations in the Brent barrel and gas trading prices.

- In an analysis of the value at risk of companies, it is shown that a significant part of the value of European utility companies has been historically seen with a risk of loss as the result of the currency risk and the price of these commodities, primarily as a result of the variations in the exchange rate. The extrapolation of the interrelationships observed for new scenarios indicates that these results could remain in the future.

These results reaffirm the importance of risk management linked to the exchange rate for European utilities. In fact, their elimination in the joint analysis of both types of risk drastically reduces the estimated variation in the company's market capitalization. In turn, the management of the price risk of the energy raw materials is also important to consider, given that the results show that this exposure is significant. In this study, emphasis was placed on the importance of using long-term supply contracts referenced to the euro in order to eliminate the energy raw material risk, since the contracts usually used that are referenced to the U.S. Dollar involve exposure to the monetary policy of this currency, which triggers greater dependence on the decisions and strategies that are external to the European arena. However, the intention of the European Union to strengthen energy trade relations with the U.S. after the Russian invasion of Ukraine seems to lead to a scenario in which the U.S. Dollar will gain even more prominence against the Euro. In any case, it will be crucial for the European Union to negotiate "with one voice" and assert its negotiating power as a client, in order to try to achieve contract pricing in the European currency, in line with what [5] have also pointed out.

Given the vast differences that exist in terms of energy among the countries of the European Union, the study also evaluates the geographic distribution of the commodities risk in the Eurozone and the potential benefit that the utility companies would obtain from the increase in the trading price of certain energy raw materials. This could have an influence on the decisions at a European level with regard to the search for trading partners and in the design of energy policies.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix

Appendix I
Tickers: company identification and the country of headquarters

TICKER	COMPANY NAME	COUNTRY OF HEADQUARTERS
VERB.VI	Verbund AG	Austria
EVNV.VI	EVN AG	Austria
BHAV.VI	Burgenland Holding AG	Austria
FORTUM.HE	Fortum Oyj	Finland
VLTSA.PA	Voltalia SA	France
ABIO.PA	Albioma SA	France
EDSP.PA	Electricite de Strasbourg SA	France
MLEES.EUA	Galatia Energie SA	France
EBKG.DE	EnBW Energie Baden Wuerttemberg AG	Germany
SWHGg.F	Enercity AG	Germany
LECG.F	Lechwerke AG	Germany
ECVG.DE	Encavis AG	Germany
EKTG.DE	Energiekontor AG	Germany
H2OG.F	Enapter AG	Germany
ETGG.DE	EnviTec Biogas AG	Germany
HRPKk.DE	7C Solarparken AG	Germany
ABOG.D	clearvise AG	Germany
PRYG.D	Pacifico Renewables Yield AG	Germany
CV3.MU	Carpevigo Holding AG	Germany
MYTr.AT	Mytilineos SA	Greece
DEHr.AT	Public Power Corporation SA	Greece
TENr.AT	Terna Energy SA	Greece
ROEN.CY	R Energy 1 SA	Greece
GRPG.I	Greencoat Renewables PLC	Ireland; Republic of
ENEI.MI	Enel SpA	Italy
A2.MI	A2A SpA	Italy
ERG.MI	ERG SpA	Italy
FKR.MI	Falck Renewables SpA	Italy
ARN.MI	Alerion Clean Power SpA	Italy
FDE.MI	Frendy Energy SpA	Italy
IRLP.WA	Inter RAO Lietuva AB	Lithuania
SELU_p.LU	Societe Electrique de l'Our SA	Luxembourg
DGB.AS	DGB Group NV	Netherlands
NSEN.AS	New Sources Energy NV	Netherlands
EDP.LS	EDP Energias de Portugal SA	Portugal
IBE.MC	Iberdrola SA	Spain
ELE.MC	Endesa SA	Spain
EDPR.LS	EDP Renovaveis SA	Spain
SLRS.MC	Solaria Energia y Medio Ambiente SA	Spain
HLZZ.MC	Holaluz Clidom SA	Spain

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