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THE IMPACT OF THE COVID-19 PANDEMIC AND THE WAR BETWEEN RUSSIA AND UKRAINE ON ELECTRICITY PRICES IN SELECTED EUROPEAN COUNTRIES IN 2022 IN TERMS OF ECONOMIC SECURITY

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Abstract. The research includes a multidimensional comparative analysis of electricity prices in 28 European countries for non-household consumers. The highest energy prices in the first half of 2022 were also ranked in the respective analyzed countries. Increases in electricity prices for non-household consumers were examined in terms of percentage and value from the second half of 2019 to the first half of 2022 and the increases were ranked. Their leader in terms of percentage and value was Greece with the result of 353,50% which constitutes EUR 0,288 of the price increase per 1 KWh in the considered time period. A multiple regression model was also built and showed that the time series of natural gas price quotations had an impact on the increase in electricity prices for non-household consumers.

Keywords: price; electricity prices; COVID-19; war between Russia and Ukraine; economic security

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JEL Classifications: F51, F52

1. Introduction

The research problem focuses on the answer of the question: at what level did electricity price increases for non-household consumers in the 28 European countries under consideration occur from the second half of 2019 to the first half of 2022?

For the adopted research problem, the purpose of the work has been outlined and concerns a multidimensional comparative analysis of electricity prices for non-household consumers in 28 European countries from the second half of 2019 to the first half of 2022.

For the research problem and the purpose of the work, a thesis has been outlined: the Russian-Ukrainian war, as well as gas price quotations led to an increase in electricity prices for non-household consumers in 28 European countries in the first half of 2022.

In the study, multidimensional comparative analyzes were conducted and a multiple regression binary model was built which was analyzed and evaluated.

2. Analysis of the literature on the research subject

There is a whole strand of contemporary literature devoted to solving problems related to energy security (Grega, Nečas, 2022; Sikimić, 2022; Aliu et al., 2022; Chehabeddine et al., 2022).

The research addresses issues related to energy prices for non-household consumers in 28 European countries. In the literature, price is a complex economic category, expressed in money as the value of goods, services, another kind of money (currency) and production factors (Owsiak, 2015, p. 64). On the other hand, electric energy is defined as a physical quantity that causes the movement of components (PWN Encyclopaedia, entry: energy, 2022), which the electric current transfers to the receiver performing work or changing it into another form of energy. The analysis of secondary documents, such as databases available on internet portals, shows that electricity prices between 2021-2022 in Europe and across the world are characterized by large increases. The reason for the increase in energy prices was the COVID-19 pandemic. It stopped the passenger transport sector from March 2020 (Mitkow et al., 2022; see Jurgilewicz et al. 2021, 2022). This, in turn, had a negative impact on various sectors of the economies of the European Union and other countries of the world, causing a huge increase in unemployment rates, e.g. in April 2020 in the United States to 14.7% (Kozicki, Górnikiewicz, 2020), large fluctuations in oil prices and exchange rates, among other things (Kozicki, 2022, pp. 125-146), and then led to an increase in inflation, including electricity prices.

Energy prices in the European Union skyrocketed in 2022 and one of the main reasons was the aggression of Russia against Ukraine on February 24, 2022 (Rosja zaatakowała Ukrainę, 2022). The war also led to a huge migration of Ukrainians to various European countries, mainly Poland (Sobieraj, 2022). In 2022, Russia unilaterally decided to stop supplying gas to many EU countries, including Poland (Business Insider Polska, 2022). This reduced the certainty of supplies and pushed gas prices (Polska Agencja Prasowa, 2022) to record levels (Gwałtowny wzrost cen gazu w Europie, 2022; Maciuch, 2022). High gas prices have driven electricity prices up sharply due to the current way the EU energy market works (European Council, 2022).

On websites, you can also find other reasons for the increase in energy prices (Mielczarski, 2022): speculation related to the prices of CO_2 emission permission, mass liquidation of mines, failure to include the creation of new power plants in the plans until 2021 for continuous operation, and an increase in demand for energy caused by downtime because of the COVID-19 pandemic.

Respective European Union countries have started to implement plans to support energy consumers with financial means as early as 2021 (Centrum Informacji o Rynku Energii, 2022). In Poland, a protection allowance has been introduced, the purpose of which is to compensate for rising electricity prices and rising inflation. In Romania, electricity and gas prices are administratively defined and selected households will receive subsidies. France has frozen electricity prices and pays €100 to consumers with monthly incomes below €2000. The UK has an energy subsidy fund of £500 MLN. In Spain, until the end of the year, a reduction from 5 to 0,5 percent applies for excise tax on electricity, and the VAT rate for energy consumers fell from 21 to 10 percent. In addition, the UK government applied VAT tax exemption on electricity produced. On the other hand, in Latvia in 2022, a specific group of so-called low-income households are to receive 15-20 Euros a month as help to pay bills.

Germany, as a country recognized as the largest gas consumer in Europe, started looking for alternative energy sources in 2021. One of the solutions was to extend the operation of nuclear power plants which would mean a turnaround in German energy policy and a system of incentives to save electricity was also prepared (Nowy rekord ceny gazu po zapowiedzi Gazpromu, 2022). Since 2022, there has been plans to reduce the EEG-Umlage fees from 6,5 to 3,7 Euros per kilowatt hour (kWH) or even abolish them completely.

In the study, multidimensional comparative analyzes were used and a multiple regression model was built in order to indicate the impact of the considered explanatory variables on the dependent variable which was the time series of gas prices taken dynamically in terms of the maintenance of economic security. According to W. Kitler, economic security has several dimensions. It is associated with the economically efficient function-

ing of the state, prosperity, sustainable development of society, counteracting threats, as well as support, protection, guarantees, certainties for selected sectors of the economy and the collection of public funds, the creation of reserves and stocks (Kitler, 2018, p. 101).

1. Multidimensional analysis of fluctuations of electricity prices in Europe and their causes between 2019-2022

The first stage of the research was to analyze the arithmetic means of prices of one barrel of crude oil in dollars on a monthly basis from January 2019 to November 2022. The test results are shown in Figure 1.

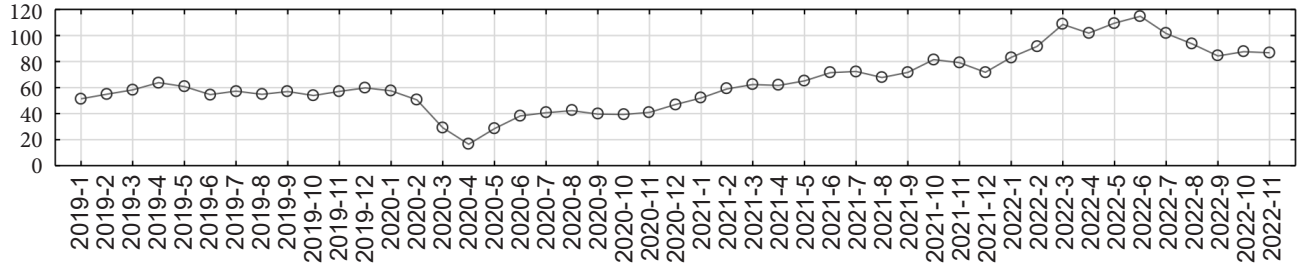

Figure 1. Arithmetic means of oil prices in dollars per barrel on a monthly basis from January 2019 to November 2022

Source: own study based on data obtained from the website: https://fred.stlouisfed.org/ (as of 02.12.2022)

Research shows that due to the impact of the COVID-19 pandemic, the price of one barrel of crude oil in 2020 fell compared to 2019 from USD 56,99 to USD 39,16 per barrel. A very large drop in oil prices is visible in Figure 1 in the period from January 2020 to April 2020 – the price of one barrel of oil fell from USD 57,52 to USD 16,55, and then the low price of around USD 40 per barrel of oil maintained at this level by December 2021.

On the other hand, the attack of Russia on Ukraine on February 24, 2022 led to an increase in oil prices. The arithmetic mean of crude oil prices from February 2022 to June 2022 increased from USD 83,22 to USD 114,84 per barrel. The increase in prices in 2022 compared to 2021 took place from USD 68,14 to USD 97,07 per barrel.

The next stage of the research will be an analysis of gas prices in dollars per 1 million BTU (28,52 m^3) on a monthly basis from January 2019 to November 2022 in terms of the impact of the COVID-19 pandemic and the war between Russia and Ukraine.

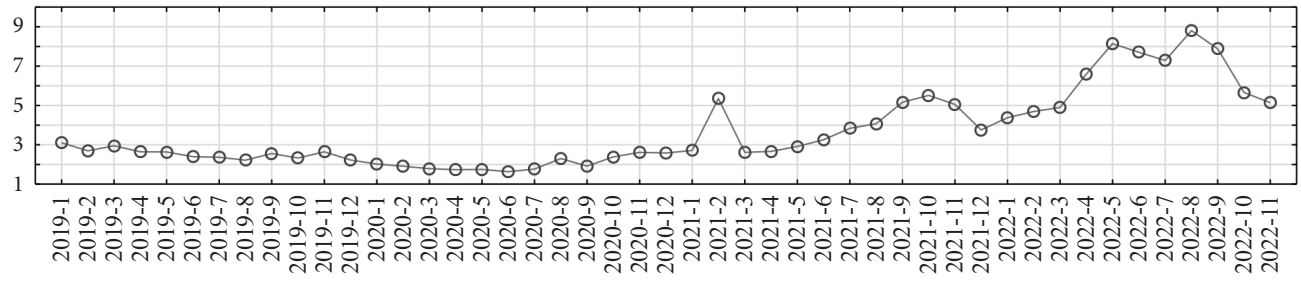

Figure 2. Gas prices in dollars per 1 million BTU (28,52 m^3) on a monthly basis from January 2019 to November 2022

Source: own study based on data obtained from the website: https://fred.stlouisfed.org (as of 02.12.2022)

The data in Figure 2 shows that the price of gas in dollars per 1 million BTU (28,52 m^3) fell in 2020 compared to 2019 from USD 2,56 to USD 2,03. This was followed in 2021 by an increase in gas prices per 1 million BTU (28,52 m^3) to $3,59. Russia's attack on Ukraine led to further big price hikes – to $6,53 for 1 million BTU (28,52 m^3) of gas in 2022.

The abovementioned trends observed in the analyzes conducted in the study most likely had an impact on the increase in electricity prices in respective European countries, currently visible in 2022.

The next part of the research is a multidimensional analysis of electricity prices for non-household consumers in selected European countries. It began in Figure 3 with the outline of the median of electricity prices for the aforementioned consumers in 28 European countries from 2018 to 2022.

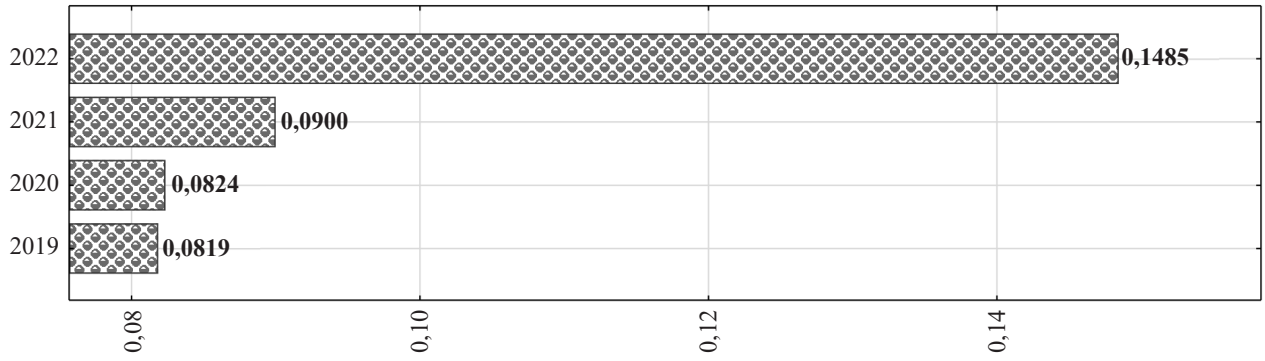

Figure 3. Median of electricity prices per KWh in EUR for non-household consumers in 28 European countries from 2018 to 2022

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The conducted research shows that in 2019 and 2020 electricity prices in the 28 analyzed European countries were similar to each other. In 2019, they amounted to EUR 0,0819 per 1 KWh, and in 2020 to EUR 0,0824 per 1 KWh. In 2021, an increase to EUR 0,09 per 1 KWh was observed. In 2022, the price for 1 KWh of energy in the 28 European countries under consideration increased to EUR 0,1485.

In the study, the ranking of the 28 analyzed countries was conducted in terms of the highest price for 1 KWh of energy in the first half of 2022. The results of the analyzes are presented in Figure 4.

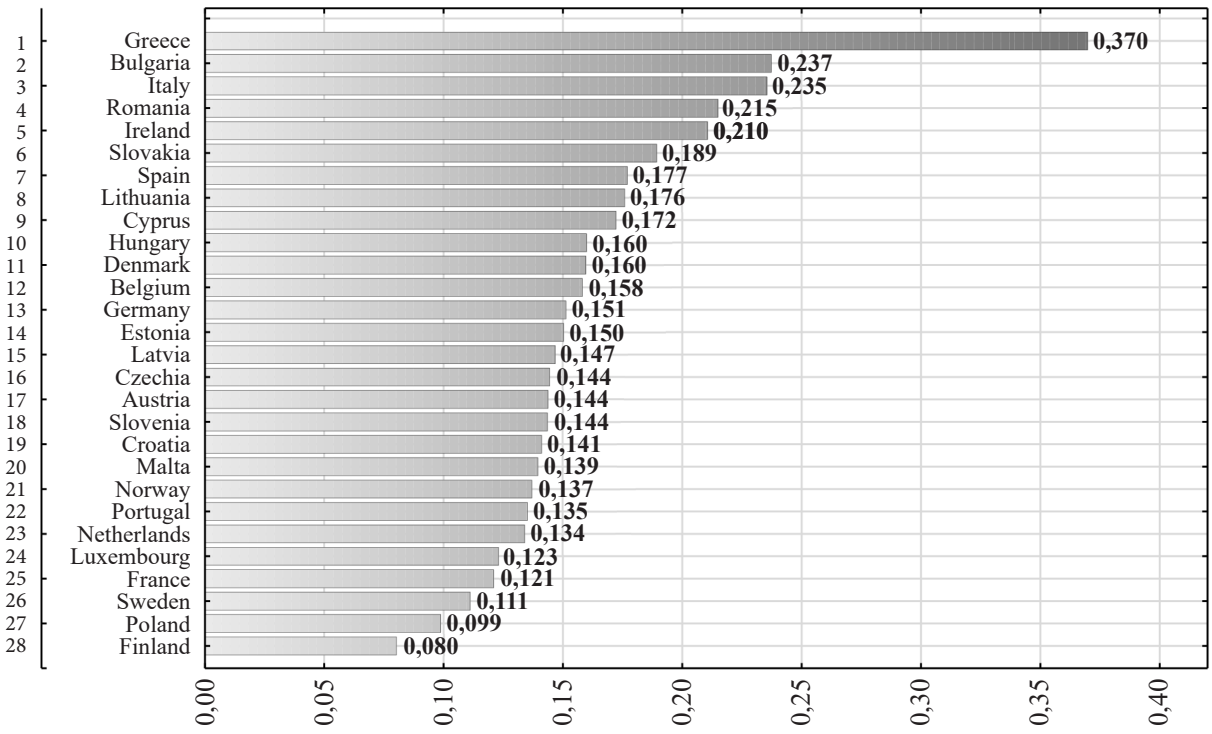

Figure 4. Prices of electricity per 1 KWh in EUR for non-household consumers in 28 European countries in S-1 2022

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The data in Figure 4 shows that the highest price for 1 KWh in the 28 European countries under consideration in the first half of 2022 was in Greece and amounted to EUR 0,37. The second place in the ranking was taken by Bulgaria with a price per 1 KWh amounting to EUR 0,237 and the third place was taken by Italy with a price of EUR 0,235. The lowest price among the 28 analyzed European countries was recorded in Finland (EUR 0,08 for 1 KWh) and Poland (EUR 0,099 for 1 KWh). The arithmetic mean of prices for 1 KWh of energy in the 28 European countries under consideration is EUR 0,163 and the median is EUR 0,148. The standard deviation from the arithmetic mean was EUR 0,055.

The next part of the research was the percentage analysis of the percentage increases in electricity prices per 1 KWh for non-household consumers in 28 European countries from S-2 2019 to S-1 2022. The results of the research outlined as the ranking of the increase in energy prices per 1 KWh in Euro in respective European countries under consideration are presented in Figure 5.

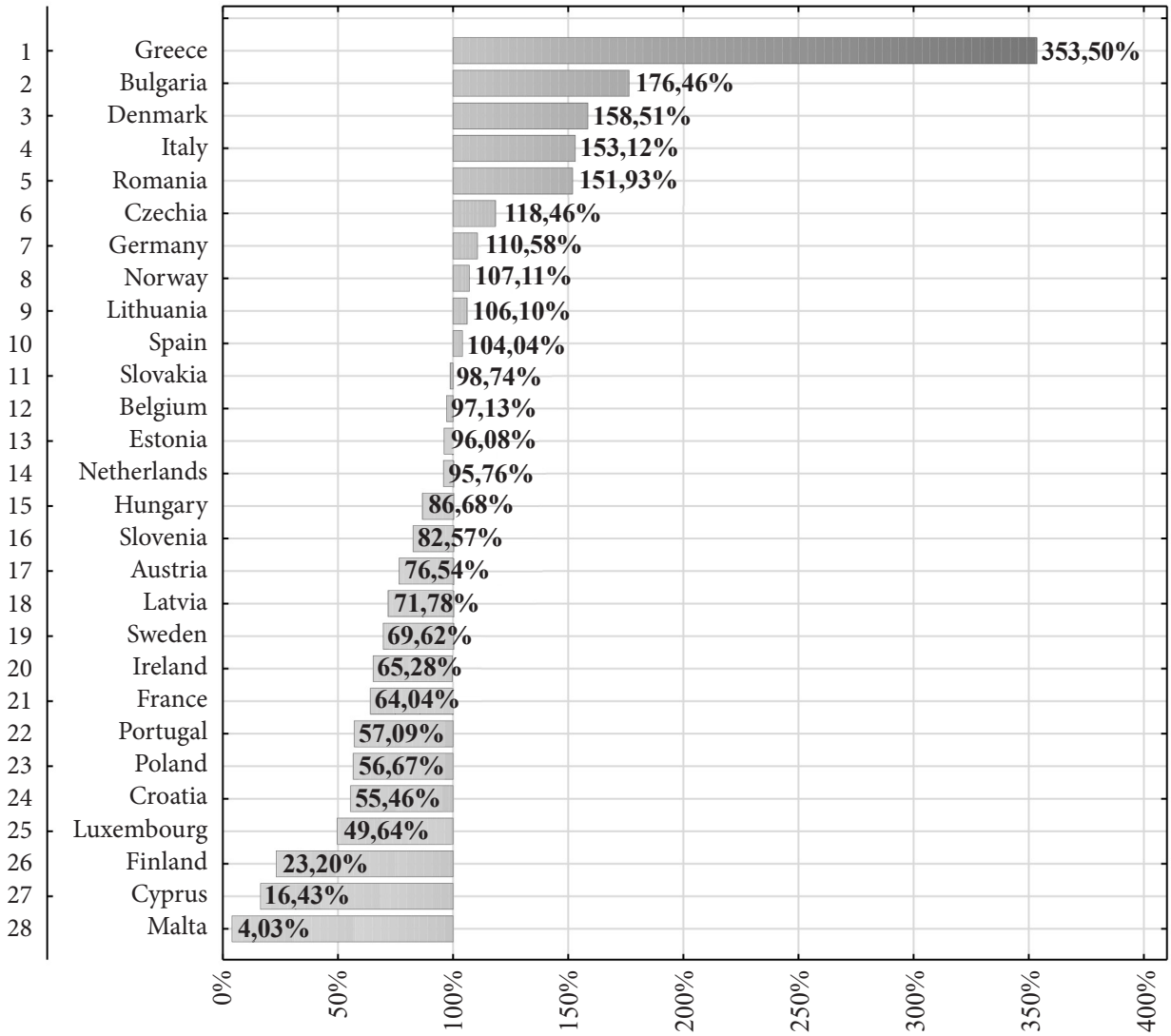

Figure 5. Percentage increase in electricity prices per 1 KWh in Euro for non-household consumers in 28 European countries from S-2 2019 to S-1 2022

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The largest increase in energy prices per KWh from the second half of 2019 to the first half of 2022 was recorded in Greece: 353,50%. Bulgaria was in the second place with the result of 176,46% and Denmark was third where an increase in energy prices per 1 KWh by 158,51% was recorded. The lowest increase was recorded in Malta: 4,03%. Poland was ranked 23rd with the increase of 56,67%.

The following part of the research was the analysis of the value increases in energy prices per 1 KWh in the 28 European countries under consideration from S-2 2019 to S-1 2022. The results of the analyzes are presented in Figure 6.

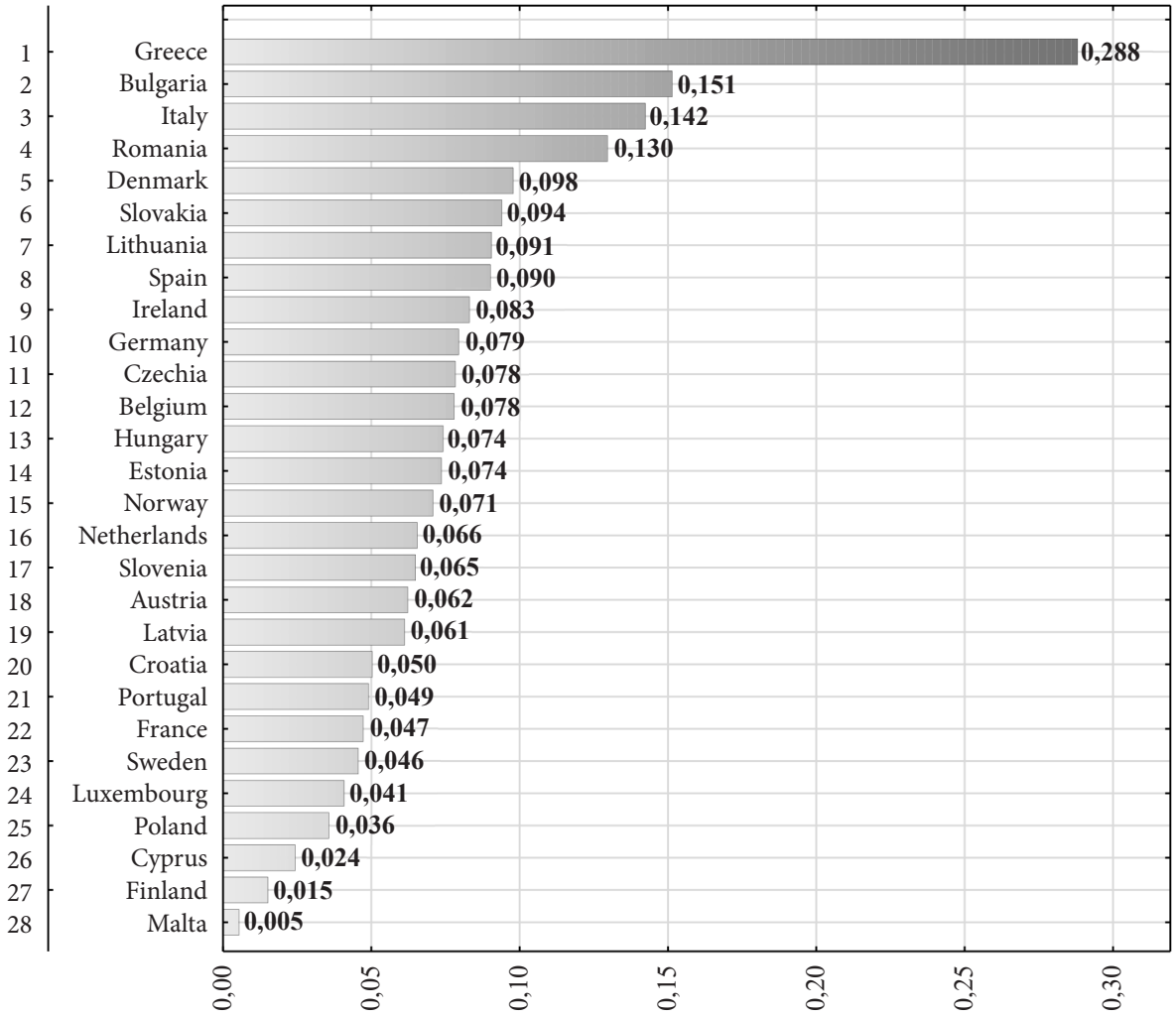

Figure 6. Value increase in electricity prices per 1 KWh in Euro for non-household consumers in 28 European countries from S-2 2019 to S-1 2022

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The analysis of the value increase in energy prices per 1 KWh for non-household consumers in the 28 European countries under consideration shows that Greece is the leader of the ranking with the increase from S-2 2019 to S-1 2022 at the level of EUR 0,288. Bulgaria is in the second place with the increase of EUR 0,151 and Italy is third with the result of EUR 0,142 in the increase in the price of 1 KWh of energy. The smallest increase in the price of 1 KWh was recorded in Malta: EUR 0,005. Poland took the 25th place in the ranking – the increase in prices for 1 KWh amounted to EUR 0,036.

The last stage of the analysis is an attempt to examine, using a mathematical model, the relationship between the price of 1 KWh of energy in Europe and the prices of crude oil and gas in dynamic terms.

2. Multiple regression model

For research purposes, the authors adopted a significance level of 0,1. Five predictors as variables were used in the research: oil price, gas price, t, lnt and t^2. Significant predictors are summarized in Table 1.

Table 1. Multiple regression model

N = 7	R = 0,99854958 R^2 = 0,99710127 Correct. R^2 = 0,99130381 Standard error of the estimation: 0,00277					
	b*	Standard error	b	Standard error	t(2)	p
Free term			0,265465	0,031911	8,31881	0,014144
Gas	-1,10311	0,387225	-0,021610	0,007586	-2,84876	0,104298
t	-9,87888	1,224935	-0,135823	0,016841	-8,06482	0,015029
Log(t)	2,67748	0,442448	0,116123	0,019189	6,05150	0,026237
t^2	9,14974	1,221331	0,015369	0,002051	7,49161	0,017355

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The model fits well. Multiple R^2 was 0,997 and adjusted R^2 was 0,99. The formula for the regression equation is as follow: Y=00,265465-0,021610*v1-0,135823*v2+0,116123v3+0,015369v4. The standard error of estimation was 0,00277. Significant predictors were explanatory variables: gas price, t, lnt and t^2.

Then, in Figures 7 to 10, an analysis of the remainder of the built model was conducted.

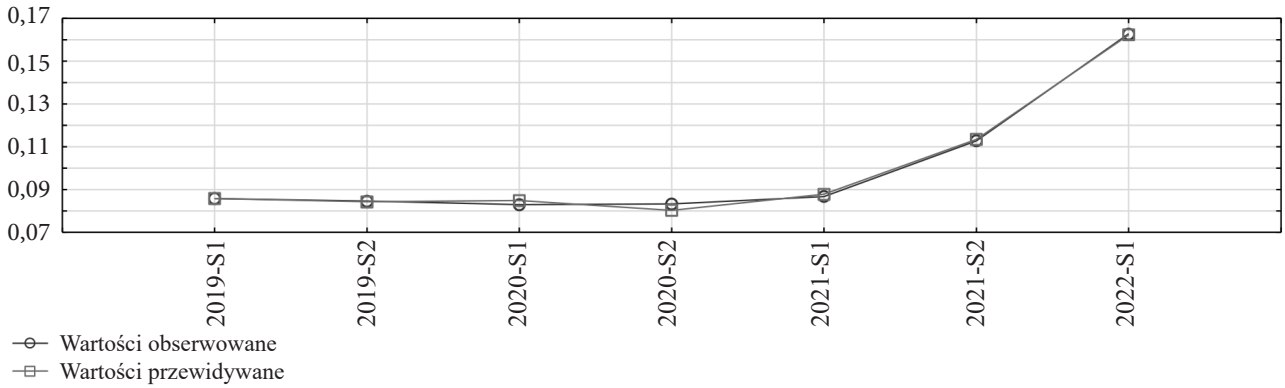

Figure 7. Line chart of predicted and observed values

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

Figure 7 shows a very good match between predicted and observed values.

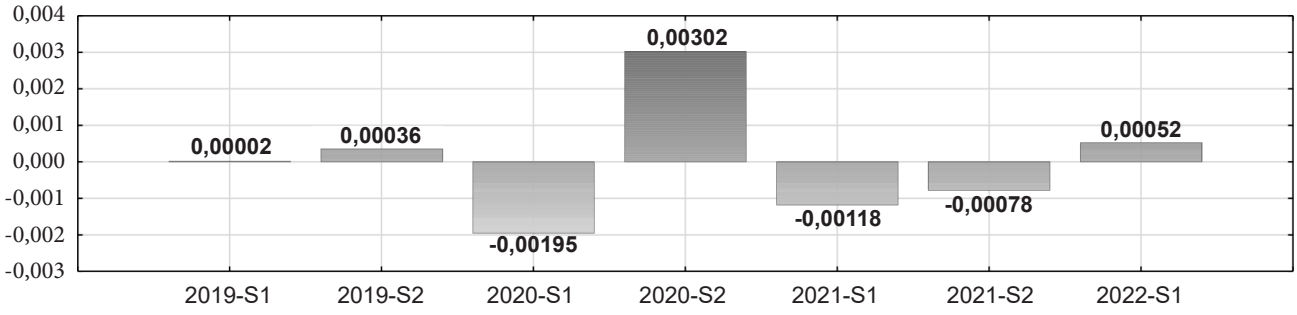

Figure 8. Bar chart of the remainder of multiple regression model

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The remainder of the model is both positive and negative.

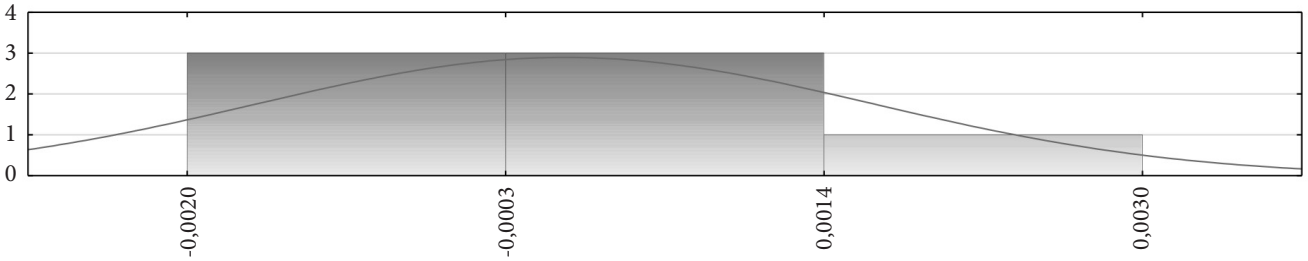

Figure 9. Histogram with the distribution function of the remainder of multiple regression model

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

The distribution of the remainder is normal. In order to determine whether the residuals are normally distributed, the Q-Q plot and the Shapiro-Wilk test were performed (Fig. 10).

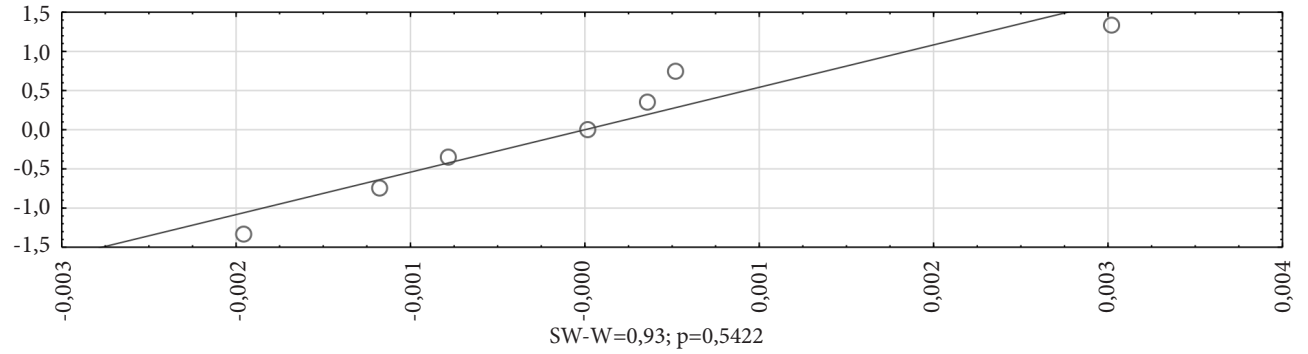

Figure 10. Quantile-quantile plot with the Shapiro-Wilk test

Source: own study based on data obtained from the website: https://ec.europa.eu/ (as of 02.12.2022)

Figure 10 shows that the residuals of the built multiple regression model may have a normal distribution. The quantiles deviate slightly from the straight line drawn. This leads to the hypothesis that the residuals are normally distributed. The performed Shapiro-Wilk test gives us information that there are no grounds for its rejection. Thus, it can be concluded that the built model describes the data well.

3. Summary and conclusions

The research shows that the COVID-19 pandemic led to a drop in oil prices from February to December 2020 to a level around $40 per barrel. On the other hand, the attack of Russia on Ukraine in February 2022 pushed prices to $114,84 per barrel in June 2022.

Similar trends were observed for the gas time series. The COVID-19 pandemic has led to a decline in the price of gas calculated in the unit of 1 million BTU (28,52 m^3) in dollars from USD 2,56 in 2019 to USD 2,03 in 2020. On the other hand, the attack of Russia on Ukraine pushed gas prices up to $6,53 per 1 million BTU in 2022.

In the first half of 2022, a strong increase in energy prices was observed in the 28 European countries under consideration. The price of 1 KWh of energy from 2021, amounting to EUR 0,09, increased in 2022 to EUR 0,1485.

The highest price among the 28 analyzed European countries for 1 KWh in the first half of 2022 was recorded in Greece: EUR 0,37. The second place in the ranking was Bulgaria: EUR 0,237 and the third was Italy: EUR 0,235. The lowest prices were in Finland (EUR 0,08 for 1 KWh) and Poland (EUR 0,099 for 1 KWh).

In turn, the largest increase in energy prices per 1 KWh from the second half of 2019 to the first half of 2022 was recorded in Greece and amounted to 353,50%. Bulgaria came second with 176,46% and Denmark came third with the increase of 158,51%. The lowest growth was recorded in Malta and amounted to 4,03%. Poland was ranked 23rd with the increase of 56,67%.

The goal of the study has been achieved. The article presents a multidimensional analysis of electricity prices for non-household consumers in 28 European countries. The leader of the ranking in terms of the value increase in energy prices is Greece with the increase from S-2 2019 to S-1 2022 of EUR 0,288. Bulgaria was in the second place with the increase of EUR 0,151 and Italy was third with the increase of EUR 0.142 in the price of 1 KWh of energy. The smallest increase in the price of 1 KWh was recorded in Malta: EUR 0.005. Poland took 25th place in the ranking. Prices here increased by EUR 0.036.

In the study, a multiple regression binary model was built in which the relationship between the increase in energy prices in the 28 European countries under consideration and gas price quotations in dynamic terms was observed. The evaluation of the remainder of the model, as well as the indices, such as multiple R, R^2 and adjusted R2 indicate its correctness.

The multiple regression model shows that the large increase in gas prices from January 2022 had an impact on the increase in energy prices in 28 respective analyzed European countries in the first half of 2022. Thus, the research thesis adopted at the beginning was confirmed. According to the authors, the increase in electricity prices was also influenced by high oil prices which have been ongoing since 2021, and the rising inflation.

One of the ways to counteract the increase in energy prices in the European Union is the scheme to introduce a price cap on Russian gas and energy produced from renewable sources.

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