3. Global Economic Policy Uncertainty and Energy Prices: A Markov-Switching VAR Approach

Deniz AYTAÇ[1]

Abstract

Economies are under the influence of global macroeconomic variables as well as national macroeconomic variables. In this context, global economic policy uncertainties are used as an important variable. The relationship between economic uncertainties and energy prices in the literature is examined over oil prices, and natural resources such as coal and natural gas, which have a significant share in world energy consumption, are rarely discussed. In this study, the relationship between the global economic policy uncertainty index and the prices of fossil fuels coal, natural gas, and oil as natural resources has been examined with the Markov Switching VAR Model. The model used enables the analysis of uncertainty and energy prices variables, which are directly affected by the expansion and recession periods of the world economy, under different regimes. As a result of the model application, it has been concluded that there is an asymmetrical relationship between global economic policy uncertainties and oil, coal, and natural gas prices, especially during the expansion periods of the global economy, and that the 1 standard deviation shock in all energy prices is explained by the global economic policy uncertainty index by approximately 50%.

Keyword: *GEPU, Oil Prices, Coal Prices, Natural Gas Prices, MS-VAR*

JEL Classification: *Q47, Q3*

1. Introduction

Uncertainty has a direct impact on economic decision-making processes. Keynes (1936) and Galibraith (1977) defined uncertainty as a factor that affects the preferences, expectations, and tendencies of economic decision-makers. In this context, uncertainty is affected by economic variables not only at the national level, but also at the globalization and international level, and it has become an influence on these variables.

The effect of increasing national and international uncertainty regarding the economic decisions of governments, businesses, and households has led researchers to work on the measurement of uncertainties in economic policies (Al-Thaqeb and Algharabali, 2019). The global crisis and the threat of economic recession in recent years, unemployment, income distribution inequalities, price instability, migration, and finally the global epidemic can be closely associated with economic policy uncertainty (EPU). With globalization, investment, consumption and production moving beyond national borders, the economic policy uncertainty (EPU) index has been an important guide when making decisions for economic agents.

[1] *Hitit University, Faculty of Economics and Administrative Sciences, Department of Public Finance.* ***Corresponding author****. E-mail: denizaytac@hitit.edu.tr*

The relationship between EPU and many macroeconomic variables has been the subject of many studies. Studies are mainly based on the effects of EPU on economic growth (Balcilar et al, 2019; Barrero *et al.*,2017; Handley and Limao, 2015; Antonakakis *et al.*, 2013), inflation (Leduc and Liu, 2016; Jones and Olson, 2013; Istiak and Alam, 2019) stock market changes (Chang *et al.*, 20152016; Pastor and Veronesi,2012; Chinzara, 2011; Momin and Masih, 2015), unemployment (Caggiano *et al.*, 2014; Nallareddy and Ogneva, 2016; Li *et al.*, 2016; Julio and Yook, 2012), investment (Bloom, 2009; Pastor and Veronesi, 2012; Gulen and Ion, 2013; Riddick and Whited, 2009; Jeong, 2002; Rodrik, 1991; Wang *et al.*, 2014; Oskooee and Nayeri, 2019), consumption and savings (Bernanke, 1983).

Economic policy uncertainties will affect economic expectations, and economic expectations will affect the energy market as well as all markets. Aloui *et al.* 2016; Yin 2016; Wei *et al.* 2017, Chen *et al.* 2020, Wei *et al.* 2021 stated in their study that EPU may be related to energy markets. One of the first determinations on this subject was made in Hamilton's study in 1983. According to Hamilton (1983), EPU can affect energy prices indirectly due to its effect on macroeconomic variables, and directly due to its effect on energy consumption. Thus it can be expected that the EPU will interact with all variables in the energy markets.

Globalization can be defined as "a process in which goods and services, production factors, technological accumulation, and financial resources can circulate freely between countries and where factor, goods, services, and financial markets are gradually integrated" (Şenses, 2009), is integrated with the economy, directly affecting the economies of the countries. In this context, the relationship between global economic and political uncertainties and macro and micro-economic variables needs to be investigated, especially in this period when the economic, social, and even political effects of a global pandemic are effective on all countries' economies.

The relationship between economic policy uncertainties and macro and micro variables has been studied mainly on a national-country basis in the economics literature. As Hoque and Zaidi stated in their work in 2020, in parallel with the success of the EPU index, which is used as an explanatory variable in many publications in the literature, Baker *et al.* (2016) developed the GEPU index to examine the effects of global economic uncertainties.

In this study, the relationship between the global economic policy uncertainty index and the global prices of primary energy sources, namely oil, coal, and gas as natural resources will be discussed within the scope of expansion and contraction periods. The main reason for choosing the subject is that, as Wang and Kong stated in their study to be published in 2022, political economy uncertainties directly cause fluctuations in energy prices (oil, coal, and renewable energy).

Political economy uncertainties are effective on the prices of all types of energy (Wang and Kong, 2022; Dash and Maitra, 2021), the studies mainly focused on the relationship with oil prices, as discussed in the literature section of the study. However, as of 2020, the world's energy consumption has been 31.2% oil, 27.20% coal, and 24.20% natural gas. Although the prices of natural gas and coal, which have a relatively important share in world energy consumption, seem less volatile compared to oil, the price increase in coal and natural gas in 2008, 2011, and 2018 compared to previous years was almost higher than that of oil. The energy prices, which affect and are affected by the economic contraction and expansion periods of the world economy, parallel to the decrease in demand due to the contraction in the world economy, the price decreases experienced on the supply side in 2014-2016 lasted longer unlike the decrease in energy prices in 1998, 2001 and 2008-2009 (World Bank, 2020). The global economic recession, triggered by the COVID-19 epidemic and the limitations imposed within the scope of the fight against the epidemic, caused an unprecedented decrease in energy and especially oil demand and prices, and in the first quarter of 2020, oil prices decreased by 5%. It is estimated that the stagnation and the decrease in oil prices due to the global epidemic in 2020 will continue relatively in 2021 and 2022 and that oil prices will average $62/barrel in 2022 (IEA, 2021). The expansion and contraction periods in the economy can have a decreasing or increasing effect on energy prices and economic policy uncertainty. In his 1989 study, Mork focused on the asymmetric effects of oil prices and stated that the increase in oil prices had a greater effect on macroeconomics than the decrease.

In the globalizing world, the financial crisis of 2008 and the global pandemic of 2020 showed that global economic uncertainties were as effective as national and regional uncertainties on the country's economy. The determination of the factors affecting global economic uncertainties is also important for national economies. Energy prices, which are among the main natural resources in terms of global macroeconomics, are the main variables associated with economic policy uncertainty. As mentioned before, although world energy consumption consists of 31.2% oil, 27.20% coal, and 24.20% natural gas, research on the subject was mainly limited to examining the relationship between oil prices and economic policy uncertainties. The main contribution of this study to the literature is to examine the relationship between oil, coal and natural gas prices, which are important energy sources in global energy consumption, and economic uncertainties from a global perspective. As far as we know, this is the first study examining the relationship between the natural resources oil, coal and natural gas prices and the global economic policy uncertainty index with the Markov switching VAR model. In addition, the model can provide information about how long the economy will remain in expansion and contraction regimes. Thus, with the Markov Switching VAR method, policy recommendations can be developed for different periods.

It is important to consider the relationship between the global economic policy uncertainty index and energy prices within the scope of different regimes, in terms of expansion and contraction periods. For this reason, unlike other studies, the relationship between the prices of oil, natural gas and coal, which are the primary energy sources that have a significant share in world energy consumption, and the Global economic policy index is discussed within the scope of the Markov-Switching Vector Auto-Regressive (MS-VAR) model. Unlike other studies, this study is the first to consider coal prices, where volatility is almost higher than oil prices in 2011 and 2018. The fact that coal consumption still has a very important share in both households and industries in the world increases the importance of the study. Considering the high volatility seen in energy prices within the scope of this importance, the Markov regime –Switching model was used in the study.

The remainder of the study is organized as follows: the second part is the literature review; the third part explains methodology and data; the fourth part introduces empirical results, and finally, the fifth part covers the conclusion and policy implications. This part summarizes the findings and includes policy recommendations.

2. Literature Review

We can associate the relationship between Economic Policy uncertainty and energy prices with neo-classical production technology, where energy is the main production input.

The price of energy, which is the main production input in economy, is expected to be directly or indirectly related to economic policy uncertainty along with many macroeconomic variables.

The relationship between global economic policy uncertainties and macroeconomic variables and especially energy prices is a relatively new issue in the literature. One of the first studies in the literature progressing within the scope of political economy uncertainties is the study by Hamilton in 1983 in which he determined that there was a statistically significant relationship between energy prices and economic recession in the USA between 1948-1972. Subsequently, the relationship between energy prices and especially oil prices and macroeconomic fluctuations has been the subject of many studies (Hamilton, 2003; Kilian, 2009; Sum, 2013; Alexopoulos and Cohen, 2015; Demir *et al.*, 2017, Abhyankar *et al.*, 2013). The first study examining the causal relationship between energy prices and economic policy uncertainty (EPU) was conducted by Kang and Ratti (2013). In the study, it was determined that there was a reciprocal relationship between oil price shocks and political economy uncertainty. A follow-up study by Antonakakis *et al.* (2014) concluded that there was a negative correlation between EPU and oil prices during recession periods in the USA. Arouri *et al.*, in their study of 2014, concluded that the change in oil prices in their countries was interactive with uncertainty. The following studies mainly focused on investigating the relationship between EPU and especially oil prices in national economies. As a matter of fact, in the study of You *et al.* in 2017, it was concluded that oil price shocks and political economy uncertainty in China affected the stock market asymmetrically. In another study dealing with China specifically, a similar result was obtained. In the study by Wei 2019, it was found that oil prices in China were statistically effective on the economic policy index. Chen *et al.* (2019) found in their study focused on China between 2000 - 2017 that EPU and oil prices were the Granger cause of economic growth. In their study using the FAVAR model by Xu et.al. (2021), it was concluded that oil prices responded very strongly to the uncertainties in the energy market. In another study examining the Chinese economy, Liu et.al (2023) concluded that there was a relationship between oil price volatility and EPU, but the relationship was adverse. In parallel with this result, it was found that there was a reverse linkage between oil price and EPU in He et. al(2021) studies. Ringim et.al. (2022), in their study using the DCC-MGARCH model within the scope of the Russian economy, concluded that there was a correlation between oil prices and EPU.

Jeris and Nath (2020) showed that there was an inverse relationship between Brent oil prices and economic policy uncertainty in the United Kingdom in the long run. Unlike other studies, Sun et. al. (2020) took different countries together and in the study in which G7 countries, China, Brazil, and Russia were examined, it was concluded that there was no Granger causality relationship between oil prices and economic policy uncertainty in countries other than America. Apostolakis et.al (2021) tested the relationship between EPU and oil prices with the help of the VAR-GARCH –M model in their study covering the G7 countries. As a result of the study, they concluded that the uncertainty in oil prices was not related to the EPU.

The relationship between economic policy uncertainty and energy prices has been mainly discussed within the scope of causality, Aloui *et al.* had a different approach by examining the relationship in question in the short, medium and long term in their study of 2016. This study was followed by studies by Gunes *et al.*(2018), Yang(2019) and Chen *et al.* in 2019 and Alaou *et al.*(2016) concluded that there was no short-term relationship between the variables, while Chen *et al.*(2019) concluded that policy uncertainty was positively affected by the shock in oil prices in the short and long term. The high volatility in oil prices, oil being the main production input, and having the highest share in consumption in terms of conventional energy types in the energy market, has increased the weight of the relationship between oil prices and EPU in the literature. For this reason, Dash and Maitra emphasized that although the effects of EPU on oil prices were studied in detail in their study in 2021, there are very limited studies in the literature on the relationship between EPU and natural gas prices. Coal prices, which are examined in this study and still have an important share in world fossil fuel consumption, have not been discussed as far as it can be reached in the relevant literature. In parallel, Dash and Maitra (2021) mentioned the limited number of studies on the link between natural gas prices and EPU in Scarcioffolo and Etienne (2021) studies and analyzed the relationship between energy prices and EPU with the Markov Switching GARCH model. As a result of the analysis, they concluded that EPU increased volatility in the natural gas and oil markets.

Many empirical researches have discussed the relationship between economic policy uncertainties and energy prices within the scope of country-based EPU indices Hamilton, 2003; Kilian,2009; Yang, 2019; Xu et.al. 2021, Ringim et.al 2022, Liu et.al. 2023). Following the study of Bloom which covered the relationship between global economic policy uncertainty and recession in 2017, the global economy politics uncertainty index (GEPU) developed as the GDP-weighted average of news-based national EPU index by Baker *et al.* in 2013 for 21 countries and created by Davis(2016), has been a subject for the researches. Considering that global trade makes the existence of a closed economy impossible, Chen *et al.* (2019) examined the relationship between the global economic policy uncertainty (GEPU) index and oil prices and stated that there was an asymmetrical relationship between the variables. In this context, Dai *et al.* (2021) stated in their study that the global economic policy uncertainty index was a consistent and good indicator of global economic policy uncertainty.

Yu *et al.* (2018) stated that Global Economic Policy Uncertainty (GEPU) was associated with crude oil market volatility. Feng *et al.* (2020) stated that the global EPU had a maturity-varying effect on crude oil price volatility.

The results vary according to the variables used in the literature, the period studied, and the countries. Another factor affecting the results is the econometric model differences used in the studies. In this context, as Scarcioffolo and Etienne stated in their study in 2021, the relationship between energy prices and economic policy uncertainty has been examined in the literature mainly with the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model and VAR models. One of the econometric models used when examining the relationship between EPU and energy prices was the GARCH model (Ringim, et. al,2022; Liu et.al. 2023; Degiannakis, Filis, 2017). Hamilton (2003), Kilian(2009), Antonakakis et. al(2013), Yang et.al. (2019), Kang et.al.(2017), while using the Structural VAR (S(VAR)) model in their studies, Bekiros et. al.(2015), Byrne et.al. (2019), Apostoakis et.al. (2021), TVP-VAR, Van Robays(2016) Thershold VAR, and Xu *et.al.* (2021), used the FAVAR model. The reason for preferring the MS-VAR model in this study is the emergence of unsafe and erroneous estimates, especially in studies examining energy prices with high volatility, when regime changes are not taken into account (Zhang and Zhang, 2015; Scarcioffolo and Etienne, 2021). Unlike other studies, to contribute to the literature, the relationship between the global economic policy uncertainty index and oil, coal, and natural gas prices, which still have a significant share in world energy consumption, was tested with the Markov Switching VAR model within the scope of different regimes.

3. Methodology

3.1. Markov Switching Model

The reason for choosing the MS-VAR model in this study is that the Markov regime change vector autoregressive (VAR) model, which is called the Hamilton model in the literature, allows the expansion and contraction periods of the economy to be modeled as different regimes and the transition between regimes to be expressed as probabilistic. There may be structural breaks in time series due to financial crises, epidemics, wars, natural disasters, and changes in national and international policies (Sims and Zha, 2004). If these changes, especially in macroeconomic variables, occur once and do not return to their initial behavior, this is called a "structural break". The situation in which the series begins to exhibit a new behavior is expressed as "regime change"(Brooks,2008).

MS-VAR models can be used to examine the causality between the variables since the predicted linear vector autoregressive models will be insufficient if the studied variables switch between regimes. Thus, with the MS-VAR model, the parameters of the VAR model depend on the latent variable (regime) (Fallahi, 2011).

The MS-VAR model is based on the linear vector autoregressive model of Sims (1980), the Markov variation vector autoregressive model (MS-VAR) was developed by Hamilton (1989,1990) as the univariate Markov variation model, while the main contribution belongs to Krolzig (1997). Krolzig (1998, 2000, 2001, 2006) adapted the model in question to dynamic multivariate systems. Krolzig (2006) MS-VAR model could be expressed as

$$y = \mu(s_t) + A_1(s_t)y_{t-1} + \cdots + A_p(s_t)y_{t-p} + u \;\;„u_t \,\big|\, s_t \sim NID(0, \Sigma s_t)) \qquad (1)$$

In the model, $\mu(s_t), A_1(s_t), \dots\dots\dots\dots, A_p(s_t), \Sigma s_t$ the realized regime is $s_t \in \{1, \dots, M\}$ while $\mu, A_1, \dots\dots\dots\dots, A_p\, \Sigma$ is the parameter change functions defining dependence on parameters. In this function:

$$(s_t) = \begin{cases} \mu_1 \text{ if } s_t = 1 \\ \mu_M \text{ if } s_t = M \end{cases} \quad (2)$$

The impact reaction function in MS VAR models that have autoregressive dynamics not dependent upon the regime of Krolzig (2006) is as follows:

$$ET_{\nabla\xi}(h) = J(\textstyle\sum_{k=0}^{h} A^k\, HF^{h-k})\nabla\xi \quad (3)$$

In the function, $J = [I_k \quad 0 = J = \imath_1' \otimes I_K, \imath_j$ is the j'th column of the unit matrix, which is a matrix of(KxK_p) dimensions. In this context, the Krolzig (2006) MSA(M) VAR (1) model is expressed as follows:

$$y_t = A(\xi_t)_{y_{t-1}} + u_t \quad (4)$$

$$\xi_t = F\xi_{t-1} + v_t \quad (5)$$

In the model $u_t \sim NID(0, \Sigma)$, v_t andv_t are a martingale difference series. In this series, since. $y_t = \sum_{i=1}^{M} \xi_{it}\, y_t$ the conditional expectation y_{t+h} *is* expressed as follows:

$$E\left[y_{t+h} \,\middle|\, y_t, \xi_t\right] = \sum_{i=1}^{M} E\left[\xi_{it+h}\, y_{t+h} \,\middle|\, y_t, \xi_t\right] = (1_M' \otimes I_k)E[y_{t+h} \,|\, y_t = (1_M' \otimes I_k)\Pi^h(\xi_t \otimes y_t)$$

and the impacts and reactions are as follows:

$$ET_{\nabla\mu}(h) = (1_M' \otimes I_K)\Pi^h(\xi_t \otimes \nabla_u), \quad (6)$$

$$ET_{\nabla\xi}(h) = (1_M' \otimes I_K)\Pi^h(\nabla\xi_t \otimes y_t) \quad (7)$$

One of the most important features that distinguish Markov regime change models from other regime models is that they provide information about how long the economy will remain in expansion and contraction regimes (Kim and Nelson, 1999).

3.2. Data

This study aims to examine the relationship between global political economy uncertainty (GEPU) and energy prices in parallel with different regime (stagnation and expansion) periods. In this context, monthly time series of the global economic political uncertainty index, global oil prices, global coal prices, and global natural gas prices between 1997-2021 were used in the study.

The reason for choosing GEPU in this study is that it is a competent variable in terms of global economic policy uncertainties. It is calculated by taking the weighted average of the GDP data of the monthly EPU index values of 21 countries since 1997. As the 21 countries included in the GEPU Index account for approximately 71% of global production on an adjusted basis and roughly 80% at market exchange rates, it can be said to be representative of the global economy. There are two versions of GEPU. One of these versions is the GEPU index based on current price GDP measurements and the other is based on GDP adjusted for PPP.

In the representation of the global political uncertainty (GEPU) index, the index calculated through the method developed by Davis(2016)[2], in the representation of the global oil prices, the Global price of Brent Crude[3](U.S. Dollars per Barrel), in the representation of Global oil prices, the Global

---

[2] *Global Economic Policy Index. https://www.policyuncertainty.com/global_monthly.html*

[3] *Global price of Brent Crude. https://fred.stlouisfed.org/tags/series?t=oil*

price of Coal[4](U.S. Dollars per Metric Ton) and in the representation of global natural gas prices, the Global price of Natural gas[5](U.S. Dollars per Million Metric British Thermal Unit) were used. Since it was stated in the studies of Dash and Maitra in 2021 that nominal or real energy prices do not change the results, energy prices are included in the estimation in nominal terms in this study.

Since the time series covers the period 1997:2-2021:5, it also covers the global COVID-19 pandemic period, so that the impact of the pandemic on the GEPU and energy prices can be examined.

Figure 1. The fluctuations in the level of the global economic policy uncertainty index, oil prices, coal prices, and natural gas prices series at levels

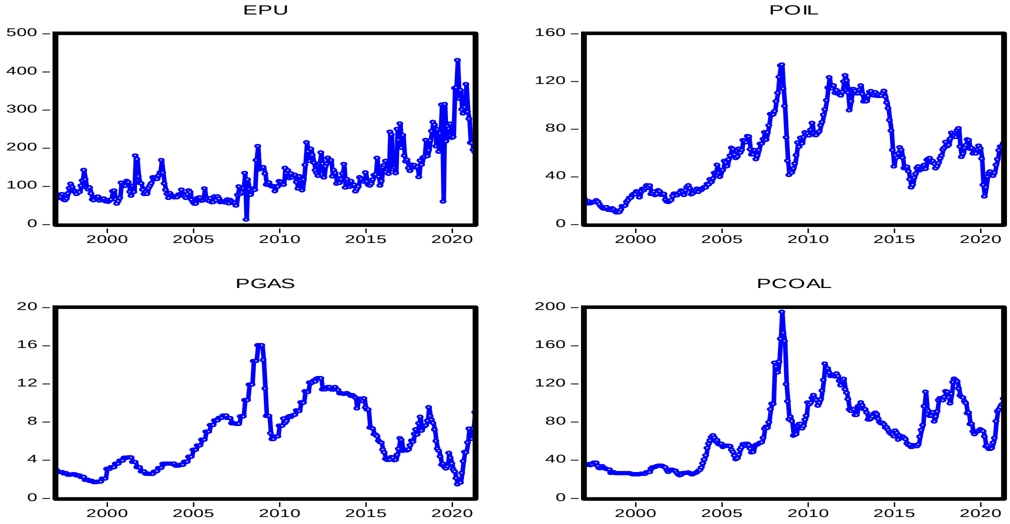
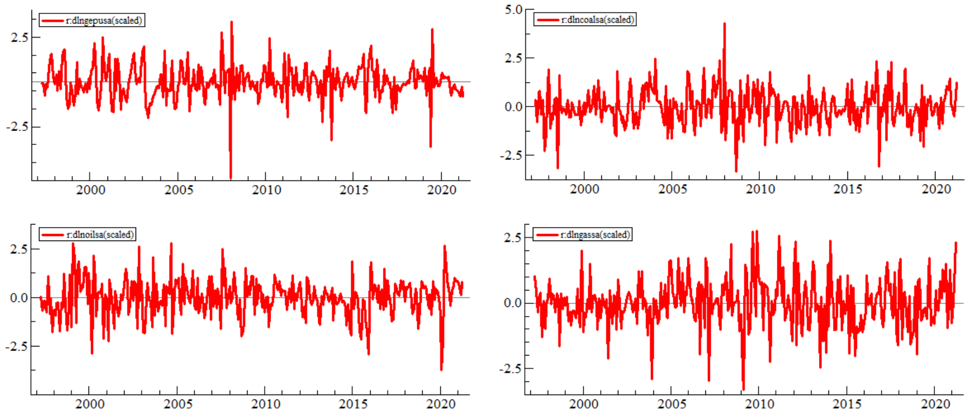


Figure 1 shows the fluctuations in the level of the global economic policy uncertainty index, oil prices, coal prices, and natural gas prices series over time. Figure 1 shows the fluctuations in energy prices roughly in 2008, 2010, 2016, and 2020, while higher volatility can be detected in the global economic policy uncertainty index.

[4] *Global price of Coal. https://fred.stlouisfed.org/tags/series?t=coal%3Bprice*

[5] *Global price of Natural gas. https://fred.stlouisfed.org/series/PNGASEUUSDM*

Figure 2. Time series rate of change graph



Comparing the rate of change graph of time series with Figure 2, it is roughly seen that all series fluctuate with a higher frequency over time.

Table 1. Descriptive Statistical Information of Variables

	Pgas	Pcoal	Poil	Gepu
Mean	6.414116	68.56971	57.79968	126.9751
Median	6.010000	64.48323	55.16286	108.0900
Maximum	16.02000	195.1863	133.8991	430.0100
Minimum	1.447498	24.00000	9.800000	11.87000
Std. Dev.	3.473746	34.49317	31.68506	67.06421
Skewness	0.555821	0.599285	0.464037	1.568130
Kurtosis	2.425106	2.905935	2.200646	5.704571
Jarque-Bera	19.12133	17.64612	18.31604	209.3831
Probability	0.000070	0.000147	0.000105	0.000000

Table 1 contains descriptive statistical information about the variables. All series used in the model have been converted to logarithmic form. Then, the series were seasonally adjusted with the Census X12 method to eliminate the seasonal effects that may arise from the use of monthly series (After this stage, in our study, the series were expressed as Ingepusa, Inpcoalsa, Inpolisa, Inpgassa).

4. Empirical Results

4.1. Unit Root Tests

At this stage, it was examined whether the variables used in the study contained a unit root, in other words, whether they were stationary or not.

Table 2. Unit Root Test Results of Epu, Pcoal, Poil, Pgas Variables

Variable	ADF statistics (level)	MacKinnon 5% critical value	PP statistics (level)	MacKinnon 5% critical value
lngepusa	-2.871298	-2.559760	-3.452596	-3.336689
lnpcoalsa	-2.871298	-1.581564	-2.871229	-1.373827
lnpoilsa	-2.871263	-1.809859	-2.871229	-1.729236
lnpgassa	-2.871332	-2.554598	-2.871229	-1.745428
Variable	ADF statistics (first-degree difference)	MacKinnon 5% critical value	PP statistics (first-degree difference)	MacKinnon 5% critical value
Δlngepusa	2.871332**	-14.49602	2.871263**	-29.02114
Δpcoalsa	2.871298**	-8.503944	2.871263**	-11.83467
Δpoilsa	2.871263**	-13.42207	2.871263**	-13.42207
Δpgassa	2.871332**	-4.711685	2.871263**	-16.22694

*Note: Critical Values are from Mackinnon 1996. * Significant at 1%, ** Significant at 5%, ***Significant at 10%*

In accordance with the results obtained by applying Augmented Dickey Fuller and Phillips-Perron tests in Table 2, the null hypothesis that all four series contain a unit root in the constant could not be rejected and it was concluded that the variable was not stationary, and it was concluded that the first-order differences of the variables were stationary at the 5% significance level.

4.2. Structural Breaks and Cointegration

The time series used in forecasting are not stationary at the level. Based on Perron's 1989 study, time series can have a stationary structure around the deterministic trend as of sub-periods within the scope of the analysis. The series in question may be affected by the structural changes in the constant and/or slope parameters in these sub-periods. The reasons for this change, also called structural break, may be economic (such as crises) and political (such as wars) changes or sectoral differentiations that occurred during the period covered by the time series, Perron (1998, 2003) examined whether the variables (Ingepusa, Inpoilsa, Inpcoalsa, Inpgassa) contain a structural break within the scope of the multiple unit root test. The reason why Bai-Perron (1998, 2003) prefers multiple structural break analysis is that it allows the determination of each break, from specific to general, in determining the number of breaks in cases where the break time is unknown. In this context, the Bai-Perron (1998, 2003) test was used in this part of the study, since the MS-VAR model will count as distinctive information in determining the regime rotations.

The multiple linear regression model used in the Bai-Perron multiple structural break test and containing m breaks (with m+1 regime) is as shown in Equation 1 (Bai and Perron 1998).

$$y_t = x_t'\beta + z_t'\delta_j + u_t, t = T_{j-1}+, \dots\dots, T_j, \quad j = 1, \dots\dots, m+1 \qquad (8)$$

In equation 8, Yt is the dependent variable observed at time t, the independent variable vectors with xt (px1) and zt (qx1) dimensions, the coefficient vectors β and δj (j = 1, . . . , m + 1), and the error term ut, T1 , …, Tm represent unknown breakpoints. It is aimed to estimate unknown regression coefficients (β, δ1, … , δj) together with breakpoints. When the β parameter vector is not dependent on breaks and it is estimated using the whole sample, this model gains the feature of being a piecemeal structural change model. When P = 0, a pure structural change model is obtained since all coefficients depend on the changes (Bai and Perron: 1998).

In the analysis performed by Bai-Perron(1998,2003), the variance-covariance matrix was strengthened with the HAC estimator, the quadratic spectral kernel function was used with the

AR(1) approach, the Andrews automatic bandwidth method was preferred, and the error distributions were considered heterogeneous according to the regimes (See, Mert, Çağlar, 2019). In this context, in the estimation made within the scope of Bai Perron (1998, 2003) multiple structural break tests as monthly time series between the years 1997-2021, in the light of the results obtained in Appendix Table 1, the number of 3 breaks in the lnepusa series was estimated and, in the examined period, it was determined that the series broke structurally in the 8th month of 2003, the 3rd month of 2008 and the 6th month of 2016. The breaks in the global economic policy index in 2008 and 2016 are in line with the years of a sudden decline in global GDP. In the lnpcoalsa series, which is the first of the price series for fossil fuels, 3 breaks were estimated again and it was determined that the series broke structurally in the 1st month of 2004, the 9th month of 2007, and the 7th month of 2013 in the examined period. In lnpoilsa, 4 break periods were detected. The first of these turns took place in the 8th month of 2000, the second in the 10th month of 2004, the third in the 11th month of 2010, and the fourth in the 12th month of 2014. In the lnpgasa series, 3 structural breaks were detected in the 8th month of 2005, the 5th month of 2011, and the 4th month of 2015. Breakdown periods in the prices of these global energy types are parallel with decreases in oil prices in 1998, 2001, and 2008-09 due to demand after 1997, and supply-induced decreases in oil prices in 1985-86 and 2014-16 (World Bank, 2020). Out of the 11 structural breaks observed in global oil, coal, and natural gas prices, all breaks in the 8th month of 2003, the 3rd month of 2008, the 5th month of 2011, and the 12th month of 2014 occurred in parallel with the upward movement of the global energy price index.

Multiple breaks detected in the all-time series, which are the subject of the study, confirmed the results of unit root tests in the previous section. At this stage, the existence of a cointegration relationship between series with structural break and non-stationary series was tested.

Table 3. Cointegration Tests Results

H_0	H_1	Eigenvalue	Trace statistic	Max-eigen statistic
r=0	r≥1	0.064209	39.80404 (47.85613)	19.11252 (27.58434)
r≤1	r≥2	0.046329	20.69151 (29.79707)	13.66159 (21.13162)
r≤2	r≥3	0.015424	7.029928 (15.49471)	4.476670 (14.26460)
r≤ 3	r≥4	0.008826	2.553257 (3.841466)	2.553257 (3.841466)

Critical values at 5% are shown in parentheses

The Johansen approach was used to determine the number of cointegrating vectors in the model to be applied. The reason why this approach is preferred is that the model in question accepts all the variables in the model as internal and does not require variable selection for normalization, since there may be more than one equilibrium relationship between the variables in case of two or more variables (Sevüktekin and Nargeleçekenler, 2010). In this model, the existence of a possible cointegration relationship between the variables was examined with the application of Eigenvalue, Trace statistics, and Maximum Eigenvalue Statistics. In the light of the results obtained based on Table 3, the null hypothesis that there was no cointegration between the variables could not be rejected. Since the variables were not cointegrated, the first-order difference of the variables was tested with the MS-VAR model in the next stage of the study.

4.3. Model Estimation

In the MS-VAR application, it was aimed to estimate the most accurate model by using information criteria, and, in this context, the model with the smallest value of the AIC criterion and the largest

Loglikelihood value was determined as 2 regimens. The lag length is determined by using information criteria such as AIC, BIC, and HQ. In this context, the MS(2) – VAR(3) model has been determined. There are 4 vectors in the MS(2)-VAR(3) model with two regimens and 3 lags selected within the scope of AIC information criterion and Loglikelihood value.

Table 4. Estimation results for the model MS(2)VAR(3)

	Δlngepusa	**Δlnpcoalsa**	**Δlnpoilsa**	**Δlnpgassa**
		Regime 1		
c	0.03913188*	0.00257898	0.0113575*	0.0225542**
Δlngepusa(-1)	-0.314508*	-0.000170535	-0.0300501**	0.0425609
Δlngepusa(-2)	-0.146928*	0.00705235	-0.0133479*	0.196328*
Δlngepusa(-3)	-0.164733*	-0.00159361**	0.00996869	-0.0242802**
Δlnpcoalsa(-1)	0.344683	0.312820*	0.0175486	-0.213655
Δlnpcoalsa(-2)	0.0174991	0.0784362	0.218355*	0.663279*
Δlnpcoalsa(-3)	0.137960	0.0780500	0.0798517	0.219169
Δlnpoilsa(-1)	-0.156216	0.0877339*	0.157570*	0.408304*
Δlnpoilsa(-2)	-0.0619842	0.00614585	-0.101469**	0.262286***
Δlnpoilsa(-3)	0.186130	0.00978841	-0.0153838	0.525843*
Δlnpgassa(-1)	0.0483039***	-0.0201893*	-0.00920488	00682000***
Δlnpgassa(-2)	-.00505193	0.0168502*	-0.00219263	0.0283573
Δlnpgassa(-3)	-0.0201267	-0.00362762	-0.0112404	0.328860*
		Regime 2		
c	0.163467	0.000534617*	-0.0156657*	-0.0100491**
Δlngepusa(-1)	-0.204088	-0.044314	-0.047244	0.072804
Δlngepusa(-2)	-0.142828	-0.016542	-0.026486	0.009728
Δlngepusa(-3)	-0.100773	-0.005539	0.003299	0.011149
Δlnpcoalsa(-1)	0.050087*	0.280148	0.049977	-0.420539
Δlnpcoalsa(-2)	0.051754	0.127544	0.298283	1.011336
Δlnpcoalsa(-3)	0.211709	00.34903	0.045877	0.580368
Δlnpoilsa(-1)	-0.089443	0.094508	0.169627	0.559639
Δlnpoilsa(-2)	-0.149187	0.043186	*0.122927	0.49976
Δlnpoilsa(-3)	0.185527	-0.019962	-0.022372	0.7339035
Δlnpgassa(-1)	0.018950	-0.017392	*0.011898	-0.025715
Δlnpgassa(-2)	-0.010125	0.014866	0.005597	-0.153286
Δlnpgassa(-3)	0.011528	0.002669	-0.018459	0.4060275
Diagnostics Tests				
Linearity LR-test	3947.1**			
Davies	0.0000**			
Normality	98.878**			
Portmanteau(36)	595.93			

*Note: * Significant at 1%, ** Significant at 5%, ***Significant at 10%*

According to the diagnostics tests of the model in Table 4, it is seen that the model is robust. At this stage, regime classification based on smoothed probabilities was used to define the robust 2-regime model as the contraction and/or expansion period.

According to the regime classification based on the flattened probabilities, when the dates in the distribution of the regimes are considered together with the global economic growth data, it is deemed appropriate to consider regime 1 as the expansion period, the 2008 financial crisis and the second regime covering the 2020 COVID-19 pandemic dates as the contraction period. The regime dates obtained in Appendix Table 2 are considered together with the break periods of the time series, it is seen that the determination of the expansion and contraction periods coincide with the break periods. As a matter of fact, out of the 3 structural breaks in the global economic policy uncertainty index, the break in the 8th month of 2003 overlaps with the 1st Regime period, which was the expansion period in which the global economy growth rate increased, the breaks in the 3rd month of 2008 and the 6th month of 2016 overlaps with the 2nd Regime period in which the global economy contracted. However, all the breaks in energy prices, except for the break in oil prices in the 12th month of 2014, occurred during the expansion period, which is the 1st regime period. All the breaks in energy prices took place during the expansion period, which is the period when energy demand increases.

After determining regime 1 and regime 2 as expansion and contraction periods, respectively, the application of the MS(2)VAR(3) model with two regimes, 3 delays, and 4 vectors can be interpreted in accordance with Table 5. The period in which the relationship between variables is statistically significant in the model is the expansion period, which is predominantly the 1st regime. When the coefficients of the variables are examined, it is seen that dlnpgassa has a negative effect on dlngepusa in the first vector. The dlngepusa variable is negative on the dlnpcoalsa on the 2nd vector, and negative in the 3rd lag period. It is seen that there is a negative effect on the vector dlnpoilsa in the first and second delay periods, and a positive effect in the second delay period on the fourth vector dlnpgassa in the third delay period.

Figure 3. Smoothed probability estimates of regimes

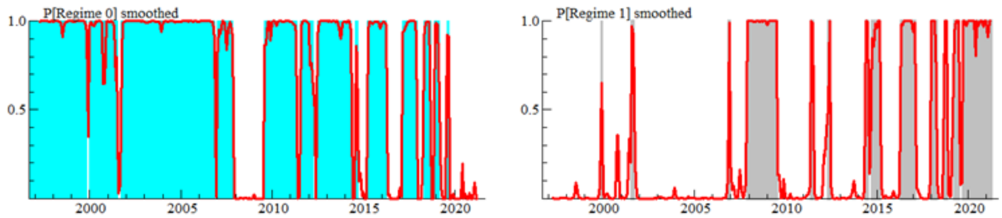


Figure 3 shows the smoothed probability estimates of the expansion and contraction regimes of the MS(2)VAR(3) model, respectively. The light blue regions in the figure correspond to the periods in which the smoothened probability of the contraction regime is at its maximum. As seen in the figure, the expansion and contraction periods fluctuate within the scope of the dates in the regime classification table based on the smoothed probabilities.

The period of staying in the regime and the regime probabilities of the model, whose expansion and contraction periods are determined, are shown in Table 7.

Transition probability matrix

$$P = \begin{pmatrix} Regim1_{t+1} 0.93010 & 0.17683 \\ Regim2_{t+1} 0.069897 & 0.82317 \end{pmatrix}$$

Table 5. Regime properties

	Probability	Observations	Duration (months)
Regime 1	0.940	214	16.46
Regime 2	0.923	75	5.77

The transition probability matrix obtained from the smoothed probabilities in Table.5 and regime duration and the probabilities of realization of these regimes are included. When the transition probabilities are examined, the probability of staying in the same regime in the next period while Regime 1 is in the expansion period is 93%, while the probability of staying in the same regime in the regime 2 contraction period is 82.317%. In Regime 1, the probability of switching to Regime 2 in the next period is 17.683%, and the probability of switching to regime 1 is 0.6 %. According to the findings, the duration of stay in the expansion period in the model is 16.46 months, while the duration of stay in the contraction regime is 5.77 months. Although the long duration of stay in the expansion period is a positive feature for the global economy, it should be noted that the probability of transition from the expansion period to the contraction period is higher than the probability of transition from the contraction period to the expansion period. The expansion period, in which the global economy remained 16.46 months during the expansion period, will be followed by a contraction period of 5.77 months with a 17.68% probability, and global economic policy uncertainty and energy prices may be adversely affected in this period.

To detail the relationship between time series in the statistically robust MS(2)VAR(3) model, in the next step of the study, variance decomposition and impulse response analyses were performed to determine the reasons for the change in the Series.

4.4. Variance Decomposition and Impulse Response Analysis

Another method used to determine the reasons for the change in the series is variance decomposition. The variance decomposition obtained from the moving averages section of the VAR model expresses the sources of shocks occurring in the variables themselves and in other variables as a percentage. The results of the variance decomposition analysis obtained in the MS(2)VAR(3) model in terms of regimes within the scope of variance decomposition analysis (Enders, 2004), which shows the source of a change in the variables used, are given in Table 6.

According to the results obtained based on the analysis made, the proportional relationship between the variables at the end of 10 periods between the time series in the regime 1 (expansion) period was significant. As a matter of fact, natural gas prices (dlnpgassa) explained a change in the global economic policy uncertainty index (dlngepusa) with a share of 54.49% in the 2nd period, while this rate was 48.36% at the end of the 10th period. Furthermore, dlngepusa explains a change in the coal price (dlnpcoalsa) series with 49.42% and dlnpgassa with 48.36% at the end of the period. The change in dlnpgassa explains dlnepusa with 51.18% at the end of the 5th term and 49.41% at the end of the 10th term. A change in oil prices (dlnpoilsa) is explained by dlngepusa with 51.58% in the 5th period and 49.41% at the end of the 10th period and also dlnpoilsa explains a change with a 48.36% share at the end of the dlnpgasa 10th period. The variance decomposition analysis explains the global economic policy uncertainty, a change in oil, coal and natural gas prices by approximately 50% at the end of 10 periods in regime 1, which is the expansion period.

Table 6[6]. Variance decomposition analysis

Regime 1 Variance Decomposition using Cholesky (d.f. adjusted) Factors

Variance Decomposition of DLNGEPU_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNOIL_SA
1	0.177383	100.0000	0.000000	0.000000	0.000000
2	1.635083	43.17901	1.710647	54.99749	0.112851
3	7.892506	51.14138	2.183311	46.57828	0.097027
4	43.83158	49.04917	2.102799	48.75276	0.095266
5	235.4890	49.50740	2.124937	48.27253	0.095127
6	1274.734	49.40048	2.120151	48.38426	0.095114
7	6888.358	49.42484	2.121272	48.35878	0.095113
8	37237.80	49.41924	2.121017	48.36463	0.095113
9	201285.7	49.42052	2.121076	48.36329	0.095113
10	1088055.	49.42023	2.121062	48.36360	0.095113

Variance Decomposition of DLNPCOAL_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNOIL_SA
1	0.054707	3.428463	96.57154	0.000000	0.000000
2	0.347689	27.16068	4.113250	68.72060	0.005472
3	1.282319	52.17057	2.584903	45.16793	0.076601
4	7.334779	48.32540	2.089268	49.49180	0.093537
5	38.97682	49.63949	2.132378	48.13315	0.094981
6	211.4555	49.36744	2.118745	48.41872	0.095101
7	1142.047	49.43220	2.121617	48.35107	0.095112
8	6174.541	49.41753	2.120940	48.36642	0.095113
9	33375.01	49.42091	2.121093	48.36288	0.095113
10	180410.6	49.42014	2.121058	48.36369	0.095113

Variance Decomposition of DLNPGAS_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNOIL_SA
1	0.462292	0.152320	1.632032	98.21565	0.000000
2	0.764496	5.981692	0.675688	93.21866	0.123960
3	0.950094	37.71228	1.802780	60.37558	0.109368
4	5.572889	41.01936	1.731593	57.15243	0.096613
5	26.14141	51.18522	2.200172	46.51928	0.095327
6	145.4359	48.99778	2.101608	48.80548	0.095125
7	780.7683	49.51642	2.125444	48.26302	0.095116
8	4227.049	49.39820	2.120054	48.38664	0.095113
9	22841.12	49.42534	2.121296	48.35825	0.095113
10	123477.9	49.41912	2.121012	48.36476	0.095113

Variance Decomposition of DLNPOIL_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNOIL_SA
1	0.086917	2.232823	9.091720	0.003626	88.67183
2	0.377945	3.815562	1.974201	89.51993	4.690306
3	0.436879	25.41374	3.055291	68.01654	3.514432
4	2.311203	38.16757	1.734799	59.88841	0.209220
5	10.33925	51.58316	2.232199	46.08454	0.100096
6	57.94404	48.86877	2.096690	48.93933	0.095208
7	310.4353	49.54351	2.126759	48.23462	0.095114
8	1681.433	49.39180	2.119768	48.39332	0.095112
9	9084.786	49.42680	2.121363	48.35673	0.095113
10	49113.05	49.41878	2.120996	48.36511	0.095113

Regime 2 Variance Decomposition using Cholesky (d.f. adjusted) Factors

Variance Decomposition of DLNGEPU_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNOIL_SA
1	0.177383	100.0000	0.000000	0.000000	0.000000
2	0.191210	92.01029	0.090337	7.899025	0.000347
3	0.197520	86.26326	0.200283	13.53595	0.000505
4	0.200943	84.10414	0.250927	15.64415	0.000781
5	0.202314	83.58369	0.265889	16.14949	0.000935
6	0.202717	83.51415	0.268760	16.21610	0.000988
7	0.202803	83.51637	0.269004	16.21362	0.001000
8	0.202817	83.51856	0.268977	16.21146	0.001002
9	0.202819	83.51788	0.268982	16.21213	0.001002
10	0.202820	83.51707	0.268997	16.21293	0.001002

Variance Decomposition of DLNPCOAL_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNGAS_SA	DLNPOIL_SA
1	0.054707	3.428463	96.57154	0.000000	0.000000
2	0.094813	53.77187	32.31989	13.90682	0.001423
3	0.099095	57.57462	29.60472	12.81793	0.002731
4	0.099719	57.77982	29.23806	12.97934	0.002768
5	0.099934	57.53925	29.11906	13.33893	0.002759
6	0.100061	57.42843	29.04981	13.51899	0.002770
7	0.100119	57.40627	29.01818	13.57277	0.002780
8	0.100137	57.40697	29.00768	13.58256	0.002784
9	0.100142	57.40895	29.00513	13.58313	0.002785
10	0.100143	57.40958	29.00468	13.58296	0.002785

Variance Decomposition of DLNPGAS_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNGAS_SA	DLNPOIL_SA
1	0.462292	0.152320	1.632032	98.21565	0.000000
2	0.578238	6.387926	1.680454	91.92876	0.002856
3	0.621742	11.10870	1.646211	87.24105	0.004039
4	0.634767	13.18311	1.622564	85.18988	0.004440
5	0.637717	13.82073	1.613544	84.56118	0.004539
6	0.638204	13.95083	1.611309	84.43331	0.004553
7	0.638277	13.96346	1.611004	84.42098	0.004553
8	0.638303	13.96239	1.611011	84.42205	0.004553
9	0.638319	13.96244	1.611019	84.42198	0.004553
10	0.638326	13.96300	1.611016	84.42143	0.004553

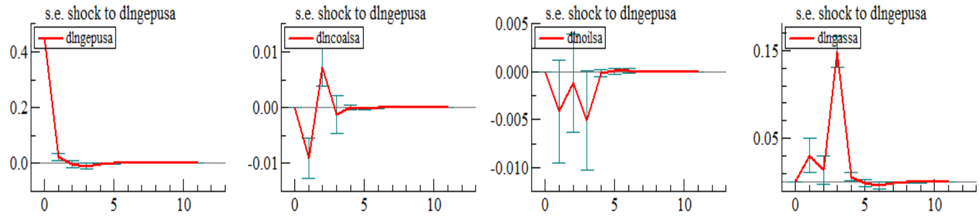
Variance Decomposition of DLNPOIL_SA:

Period	S.E.	DLNGEPU_SA	DLNPCOAL_SA	DLNPGAS_SA	DLNPOIL_SA
1	0.086917	2.232823	9.091720	0.003626	88.67183
2	0.157420	0.685465	3.860417	68.42231	27.03181
3	0.185141	5.722378	3.277766	71.45453	19.54532
4	0.195741	9.609105	3.080538	69.82347	17.48689
5	0.198892	11.29762	3.016470	68.74820	16.93771
6	0.199595	11.80439	2.999617	68.37721	16.81878
7	0.199709	11.90450	2.996333	68.29956	16.79960
8	0.199726	11.91366	2.995872	68.29378	16.79669
9	0.199733	11.91288	2.995786	68.29579	16.79555
10	0.199737	11.91306	2.995738	68.29631	16.79488

The effect of the global economic policy uncertainty index on energy prices in Regime 1 is also seen in the impulse response analysis. In the MS(2)VAR(3) analysis which does not include a structural problem, the effect of the variables examined in this phase on each other within the scope of regime 1 and regime 2 is discussed with impulse-response analysis. Impact-response analysis has an important function in analyzing the effect of a random unit standard deviation shock on other variables in the system and in guiding economic policies in this context.

[6] *The Granger Causality test is applied to support the relationship between the variables followed by the MS(2) VAR(3) model. results are shown in appendix Table 3,4,5. The results obtained are supporting MS(2) VAR(3) and the model is robust.*

Figure 4. Regim1 Inter-Serial Impact Response Analysis Results



The impact response analysis of our model was examined in line with Figure 4 above, it was seen that dlnpcoalsa's response to a one standard deviation shock given to dlngepusa decreased in the first period from the first period, and after this period, the effect decreased and increased at the end of the second period. It was observed that the effect became statistically insignificant in the 4th period and its effect ended. However, while oil prices had a decreasing effect on a standard deviation shock in the first period, the increase in the second period was followed by a decrease in the third period. The effect ended approximately in the 5th period. Oil prices gave an upward response to a shock in the global economic policy uncertainty index from the first period, the direction of the increase was reversed in the 3rd period and the effect ended in the 4th period. All responses are based on the orthogonalization of the Cholesky factor.

5. Conclusion

The starting point of this study, in which the relationship between global economic policy uncertainty and the prices of fossil fuels coal, oil, and natural gas was estimated with the Markov Switching VAR model between 1997-2021, was to examine how the relationship between uncertainty and energy prices could change during the expansion and contraction cycles of the global economy. Since energy, which is the basic input of production and a scarce resource, is not evenly distributed in the world geography, ensuring energy supply security is one of the most important issues in terms of national economies. Energy supply security includes the continuity of energy resources in terms of quantity as well as providing them with a certain price level. Although energy prices are determined according to energy supply and demand, it is necessary to examine all macroeconomic variables that directly or indirectly affect supply and demand. Examining the relationship between the economic policy uncertainty index, which interacts with many of the mentioned macroeconomic variables and takes into account different variables while calculating as an index with energy prices provides convenience to researchers at this point.

The 2000s, which can be considered crisis years in terms of economy in general, were a volatile period in terms of global uncertainties. The economy, which went into recession, especially with the global pandemic that started in 2020, has had significant periods of decline in terms of energy prices and especially oil prices. These periods created structural breaks in both energy prices and the series of economic and political uncertainties.

In this study, the relationship between energy prices and the global uncertainty index was examined under different regimes. The results obtained support the studies of Xu *et.al.* (2021), which concluded that energy prices respond strongly to uncertainties in the energy market. It has been seen in line with the coefficients of the MS(2) VAR(3) model that there is an asymmetrical relationship between global economic policy uncertainties and oil, coal, and natural gas prices, especially during expansion periods. These results do not support the studies of Alaou *et al.* (2016) in which it was determined that EPU and energy prices are not related. It also contradicts Apostolakis *et.al*.'s 2021 study, which concluded that there was no relationship between Epu and oil prices. The findings obtained in this study are consistent with the result that EPU and energy prices are related, as determined in Chen *et al.* 2019, Wei 2019 studies and there is an asymmetrical relationship that supports the studies of You *et al.* (2017), Liu *et.al.* (2023), He *et.a*l.. (2023) Dash and Maitra. Another important result obtained in the study is the high rate of natural gas prices to explain a change in global economic policy uncertainties during expansion periods.

The structurally broken series are analyzed in terms of regimes, it is seen that the dates of the expansion and contraction regimes are related to the dates of the breaking, and all energy prices reacted to the 1 standard deviation shock given to the GEPU in the expansion period, regime 1, as of the first period. It was determined that GEPU had 50% power to explain a change in energy prices during expansion periods. Yu *et.al.*(2018), and Feng *et.al.* (2020) studies, as in this study, take into account the global uncertainties instead of the local economic policy uncertainty variable. The result obtained in these studies, that GEPU is effective on the change in oil prices, was supported by this study. These findings are inconsistent with Antonakakis *et al.* (2014) study, which concluded that there is an asymmetrical relationship between EPU and oil prices in recession periods. In this study, it was concluded that natural gas prices are the only energy price that is effective in explaining a change in the global economic policy uncertainty index. This result reveals the necessity of turning attention to natural gas prices rather than oil prices to reduce global uncertainties.

Another result obtained with the Markov Switching VAR model estimation and which is important for policymakers is that the probability of staying in the expansion period within the scope of the model is .82.317%. After the expansion period lasting 16.46 months, there will be a contraction period with a probability of 17.68%. This rate cannot be considered as a low rate in terms of the economic policy uncertainties and the possibility of negative effects of the contraction period, which will last for an average of 5.77 months.

Regarding the continuity of the enlargement process, it will be possible if the economic policymakers ensure the stability of the effective macroeconomic policies on the GEPU. Preventing or delaying the contraction period will be possible by preventing the negative developments in GEPU and energy prices.

Globalization, which aims to ensure the circulation of labor, capital, goods, and services around the world without any hindrance, has made all world economies interconnected and dependent. In this context, any negativity experienced in the global economy affects all commodity prices, especially energy prices. This effect manifests itself in varying sizes in national economies. The 2008 world economic crisis, the COVID-19 pandemic, and the 2022 Ukraine-Russia war have affected all economies globally. The 2022 Russia-Ukraine war has made it problematic not only for the countries neighboring these countries but also for many economies, including the European Union, in terms of energy supply security. " European gas and electricity wholesale prices increased by 115% (109%) and 237% (138%), respectively"(Gazzanni and Ferriani, 2022) and also energy consumer price indexes (energy CPI) increased by 18 % in OECD countries for five months with war. As a precaution against these developments, the European Union decided to terminate the fossil fuel import from Russia as soon as possible with the 2022 Versailles Declaration. In support of this decision, the International Energy Agency emphasized the necessity of supporting the production of renewable energy sources in all countries. Globalization reveals the necessity of countries to act together in terms of the energy market in many areas. Almost no country can set and influence energy prices on its own. For this reason, it reveals the necessity of carrying out energy price policies with common government policies that provide stability in global cooperation. Increasing the share of renewable energy sources in the economy is one of these policies. Every step to be taken within the scope of clean energy use and green economy will play an important role in ensuring energy supply security and energy price stability. The joint incentive decisions and intervention policies that policymakers will take in this area will have important consequences on a global scale.

The interpretation of energy prices only in terms of oil constitutes an important limitation in terms of literature. In this context, considering renewable energy sources in future studies will be a guide for policymakers and investors. In future studies, it may be suggested to develop a global energy policy proposal, taking into account the economic efficiency in energy markets.

References

Abhyankar, A., Xu, B. and Wang, J., 2013. Oil price shocks and the stock market: evidence from Japan. *Energy Journal*, 34, pp.199–222. https://doi.org/10.5547/01956574.34.2.7.

Alexopoulos, M. and Cohen, J., 2015. The power of print: Uncertainty shocks, markets, and the economy. *International Review of Economics & Finance*, 40, pp.8–28. https://doi.org/10.1016/j.iref.2015.02.002

Aloui, R. and Gupta, R., Miller, S. M., 2016. Uncertainty and crude oil returns. *Energy Economics*, 55, pp.92–100. https://doi.org/10.1016/j.eneco.2016.01.012

Al-Thaqed, S. A. and Algharabali, B. G., 2019. Economic policy uncertainty: A literature review. *The Journal of Economic Asymmetries*, 20(e00133). https://doi.org/10.1016/j.jeca.2019.e00133

Antonakakis, N., Chatziantoniou, I. and Filis, G., 2013. Dynamic co-movements of stockmarket returns, implied volatility and policy uncertainty. *Economics Letters*, 120(1), pp.87–92. https://doi.org/10.1016/j.econlet.2013.04.004

Antonakakis, N. and Chatziantoniou, I., Filis, G., 2014. Dynamic spillovers of oil price shocks and economic policy uncertainty. *Energy Economics*, 44, pp.433–447. https://doi.org/10.1016/j.eneco.2014.05.007

Apostolakis,G.N, Floros,C., Gkillas, K, and Wohar, M., 2021. Financial stress, economic policy uncertainty, and oil price uncertainty. Energy Economics, 104, pp.1-18. https://doi.org/10.1016/j.eneco.2021.105686

Arouri, M. E. H., Jouini, J. and Nguyen, D. K., 2011. Volatility spillovers between oil prices and stock sector returns: Implications for portfolio management. *Journal of International Money and Finance*, 30(7), pp.1387–1405. https://doi.org/10.1016/j.jimonfin.2011.07.008

Bai, J.and Perron, P. 1998. Estimating and testing linear models with multiple structural changes. *Econometrica*, (66), pp.47–78. https://doi.org/10.2307/2998540

Bai, J. and Perron, P., 2003. Critical values for multiple structural change tests. *Econometrics Journal*, (6), pp.72–78. https://doi.org/10.1111/1368-423X.00102

Baker S., Bloom N., and S. J. Davis., 2013. Measuring economic policy uncertainty, Chicago Booth Research Paper No. 13-02. https://www.policyuncertainty.com/media/EPU_BBD_2013.pdf

Baker, S. R., Bloom, N.and Davis, S. J., 2016. Measuring economic policy uncertainty. *The Quarterly Journal of Economics*. 131(4), pp.1593–1636. https://doi.org/10.1093/qje/qjw024

Balcilar, M., Gupta, R., Kim, W. J.and Kyei, C., 2019. The role of economic policy uncertainties in predicting stock returns and their volatility for Hong Kong, Malaysia, and South Korea. *International Review of Economics and Finance*, 59, pp.150–163. https://doi.org/10.1016/j.iref.2018.08.016

Barrero, J. M., Bloom, N., and Wright, I., 2017. Short and long run uncertainty (No. w23676). Washington DC: National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w23676/w23676.pdf

Bekiros, S., Gupta, R., and Paccagnini, A., 2015. Oil price forecastability and economic uncertainty. *Economic Letters*, 132, pp.125–128. https://doi.org/10.1016/j. eneco.2014.05.007.

Bernanke, B. S. 1983. Irreversibility, uncertainty, and cyclical investment. *The Quarterly Journal of Economics,* 98(1), 85. https://doi.org/10.2307/1885568

Bloom, N., 2009. The impact of uncertainty shocks. *Econometrica,* 77(3), pp.623–685. https://doi.org/10.3982/ecta6248

Bloom, N., 2017. Policy Forum: On the Macroeconomic Effects and Policy Implications of Uncertainty. *The Australian Economic Review*, 50(1), pp.79–84. https://doi.org/10.1111/1467-8462.12203

Brooks, C., 2008. *Introductory econometrics for finance*. UK: Cambridge University Press

Byrne, J.P., Lorusso, M., and Xu, B., 2019. Oil prices, fundamentals and expectations. Energy Economics, 79, pp.59–75. https://doi.org/10.1016/j.eneco.2018.05.011.

Caggiano, G.and Castelnuovo, E., Groshenny, N., 2014. Uncertainty shocks and unemployment dynamics in US recessions. *Journal of Monetary Economics*, 67, pp.78–92. https://doi.org/10.1016/j.jmoneco.2014.07.006

Chang, T., Chen, W. Y., Gupta, R.and Nguyen, D.K., 2015. Are stock prices related to the political uncertainty index in OECD countries? Evidence from the bootstrap panel causality test. *Economic Systems,* 39(2), pp.288-300. https://doi.org/10.1016/j.ecosys.2014.10.005

Chen, J., Zhu, X. And Zhong, M., 2019. Nonlinear effects of financial factors on fluctuations in nonferrous metals prices: A Markov-switching VAR analysis. *Resources Policy*, 61, pp.489–500. https://doi.org/10.1016/j.resourpol.2018.04.015

Chen, X., Li, Y., Xiao, J.and Wen, F., 2020. Oil shocks, competition, and corporate investment: evidence from China. *Energy Economics*, 89, 104819. https://doi.org/10.1016/j.eneco.2020.104819

Chinzara, Z., 2011. Macroeconomic uncertainty and conditional stock market volatility in South Africa. *South African Journal of Economics*, 79(1), pp.27-49. https://doi.org/10.1111/j.1813-6982.2011.01262.x

Dai, P. F., Xiong, X.and Zhou, W. X., 2021. A global economic policy uncertainty index from principal component analysis. *Finance Research Letters*, 40, 101686. https://doi.org/10.1016/j.frl.2020.101686

Dash, S., and Maitra, D., 2021 Do oil and gas prices influence economic policy uncertainty differently: Multi-country evidence using time-frequency approach. *The Quarterly Review of Economics Finance*, 81, pp.397–420. https://doi.org/10.1016/j.qref.2021.06.012

Davis, S. J., 2016. An Index of Global Economic Policy Uncertainty. National Bureau of Economic Research. 22740. Available at: <https://www.nber.org/system/files/working_papers/w22740/w22740.pdf>.

Degiannakis, S., Filis, G., and Arora, V., 2018. Oil prices and stock markets: a review of the theory and empirical evidence. Energy Journal, 39. https://doi.org/10.5547/ 01956574.39.5.sdeg.

Demir, E. and Ersan, O., 2017. Economic policy uncertainty and cash holdings: Evidence from BRIC countries. *Emerging Market Review*, 33, pp.189–200. https://doi.org/10.1016/j.ememar.2017.08.001

Enders, W., 2004. *Applied Econometric Time Series*. New York: John Wiley and Sons INC.

Fallahi, F., 2011. Causal relationship between energy consumption (EC) and GDP: A Markov-switching (MS) causality. *Energy,* 36(7), pp.4165–4170. https://doi.org/10.1016/j.energy.2011.04.027

Feng, Y., Xu, D., Failler, P.and Li, T., 2020. Research on the Time-Varying Impact of Economic Policy Uncertainty on Crude Oil Price Fluctuation. *Sustainability*, 12(16), 6523. https://doi.org/10.3390/su12166523

Galbraith, J. K. 1977. *The age of uncertainty*. Houghton Mifflin Harcourt. https://www.scribd.com/doc/186173371/Kenneth-Galbraith-The-Age-of-Uncertainty

Gazzanni, A., Ferriani, F., 2022. The impact of the war in Ukraine on energy prices: Consequences for firms' financial performance. CEPR. https://cepr.org/voxeu/columns/impact-war-ukraine-energy-prices-consequences-firms-financial-performance

Gulen, H.and Ion, M., 2015. Policy uncertainty and corporate investment. *Review of Financial Studies,* 29(3), pp.523–564. https://doi.org/10.1093/rfs/hhv050

Hamilton, J.D. 1983. Oil and the macroeconomy since World War II. *The Journal of Political Economy*, 91(2), pp.228–248. https://doi.org/10.1086/261140

Hamilton, J. D. 1989. A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 57(2), pp.357. https://doi.org/10.2307/1912559

Hamilton, J. D. 1990. Analysis of time series subject to changes in regime. *Journal of Econometrics.* 45(1–2), pp.39–70. https://doi.org/10.1016/0304-4076(90)90093-9

Hamilton, J.D., 2003. What is an oil shock? Journal of Economics, 113, pp.363–398. https://doi.org/ 10.1016/S0304-4076(02)00207-5.

Handley, K. and Limao, N., 2015. Trade and investment under policy uncertainty: Theory and firm evidence. *American Economic Journal: Economic Policy*, 7(4), pp.189–222. ttps://www.grace.umd.edu/~limao/tpu_final.pdf

He, H., and Sun, M., Gao, C. Li, X., 2021, Detecting lag linkage effect between economic policy uncertainty and crude oil pr,ce: A multi-scale perspective. Physica A. 580, pp.1-14. https://doi.org/10.1016/j.physa.2021.126146

Hoque, M.E. and Zaidi, M., 2019. The impacts of global economic policy uncertainty on stock market returns in regime switching environment: evidence from sectoral perspectives. *Int J Finance Econ*., 24(2), pp.991–1016. https://doi.org/10.1002/ijfe.1702

IEA (International Energy Agency)., 2021. Oil 2021. Paris: International Energy Agency.

Istiak, K.and Alam, M. R., 2019. Oil prices, policy uncertainty, and asymmetries in inflation expectations. *Journal of Economics Studies*, 46(2), pp.324–334. https://doi.org/10.1108/JES-02-2018-0074

Jeong, B., 2002. Policy uncertainty and long-run investment and output across countries. *International Economic Review.* 43(2), pp.363–392. https://www.jstor.org/stable/826992

Jeris, S .S.and Nath, R. D., 2020. Covid-19, oil price and UK economic policy uncertainty: evidence from the ARDL approach. *Quantitative Finance and Economics,* 4(3), pp.503-514. https://doi.org/10.3934/QFE.2020023

Jones, P. M.and Olson, E. 2013. The time-varying correlation between uncertainty, output, and inflation: Evidence from a DCC-GARCH model. *Economics Letters*, 118(1), pp.33–37. https://doi.org/10.1016/j.econlet.2012.09.012

Julio, B. and Yook, Y., 2012. Political uncertainty and corporate investment cycles. *The Journal of Finance,* 67(1), pp.45–83. https://doi.org/10.1111/j.1540-6261.2011.01707.x

Kang, W.and Ratti, R.A., 2013. Structural oil price shocks and policy uncertainty. *Economic Modelling,* 35, pp.314–319. https://doi.org/10.1016/j.econmod.2013.07.025

Kang, W.; Ratti, R.A, and Vespignani, J.L., 2017. Oil price shocks and policy uncertainty: New evidence on the effects of US and non-US oil production. *Energy Economics,* 66, pp.536–546. https://doi.org/10.1016/j.eneco.2017.01.027

Keynes, J.M., 1936. The general theory of employment, interest, and Money. Macmillan, London. https://www.hetwebsite.net/het/texts/keynes/gt/gtcont.htm

Kilian, L., 2009. Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99(3), pp.1053–1069. https://doi.org/10.1257/aer.99.3.1053

Kim C.J., and Nelson, C.R., 1999. *State space models with regime switching: classical and gibbs-sampling approaches with applications*. The USA.: The MIT Press

Krolzig, H.M., 1997. *Markov-switching vector autoregressions(modeling, statistical interference, and application to business cycle analysis). Lecture notes in economics and mathematical systems.* Berlin: Springer.

Krolzig, H.M., 1998. *Econometric modeling of Markov-switching vector autoregressions using MSVAR for OX*.Institute of Economics and Statistics and Nuffield College, Oxford. Available at: <http://fmwww.bc.edu/ec-p/software/ox/Msvardoc.pdf>

Krolzig, H.M., 2000. *Predicting Markov-switching vector autoregressive processes.* UK: Nuffield College. Available at: <https://www.nuff.ox.ac.uk/economics/papers/2000/w31/msvarfor.pdf>

Krolzig, H.M., 2001. General-to-specific reductions of vector autoregressive processes. Econometric Studies-A Festschrift in Honour of Joachim Frohn, 129-157. Available at: <http://www.nuff.ox.ac.uk/Economics/papers/2000/w34/frohn.pdf>

Krolzig, H.M., 2016. *Impulse-response analysis in Markov switching vector autoregressive models*. Economics Department. University of Kent. Keynes College.

Leduc, S.and Liu, Z., 2016. Uncertainty shocks are aggregate demand shocks. *Journal of Monetary Economics*, 82, pp.20–35. https://doi.org/10.1016/j.jmoneco.2016.07.002

Li, X.-L., Balcilar, M.and Gupta, R., Chang, T., 2016. The causal relationship between economic policy uncertainty and stock returns in China and India: Evidence from a bootstrap rolling window approach. *Emerging Markets Finance and Trade,* 52(3), pp.674–689. https://doi.org/10.1080/1540496X.2014.998564

Liu, F., Shao, S., Li, X., Pan, N., and Qi, Y., 2023, Economic policy uncertainty, jump dynamics and oil price volatility. Energy Economics, 120, pp.1-12. https://doi.org/10.1016/j.eneco.2023.106635

MacKinnon, J., 1996. Numerical distribution functions for unit root and cointegration tests. Journal of Applied Econometrics, 11, pp.601-618. https://doi.org/10.1002/(SICI)1099-1255(199611)11

Mert, M. and Çağlar, E., 2019. *Eviews ve Gauss uygulamalı zaman serileri analizi*. Ankara: Detay Yayıncılık.

Momin, E., and Masih, M., 2015. Do US policy uncertainty, leveraging costs and global risk aversion impact emerging market equities? An application of bounds testing approach to the BRICS. MPRA Paper No. 65834. Available at: <https://mpra.ub.uni-muenchen.de/65834/>

Mork, K. A. 1989. Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. *Journal of Political Economy*, 97(3), pp.740–744. http://dx.doi.org/10.1086/261625

Nallareddy, S.and Ogneva, M., 2016. Predicting restatements in macroeconomic indicators using accounting information. *The Accounting Review*, 92(2), pp.151–182. https://doi.org/10.2308/accr-51528

Oskooee, M.and Nayeri, M., 2019. On the effects of policy uncertainty on stock prices: an asymmetric analysis. *Quantitative Finance and Economics*, 3, pp.412–424. https://doi.org/10.3934/QFE.2019.2.412

Pastor, L., Veronesi, P., 2012. Uncertainty about government policy and stock prices. *The Journal of Finance*, 67(4), pp.1219–1264. https://doi.org/10.1111/j.1540-6261.2012.01746.x

Riddick, L. A., Whited, T. M., 2009. The corporate propensity to save. *The Journal of Finance,* 64(4), pp.1729–1766. https://doi.org/10.1111/j.1540-6261.2009.01478.x

Ringim, S.H., Alhssan, A., Güngör, H., and Bekun, F.S., 2022. Economic Policy Uncertainty and Energy Prices: Empirical Evidence from Multivariate DCC-GARCH Models. *Energies*, 15, pp.1-18. https://doi.org/10.3390/en15103712

Scarcioffolo, A., and Etienne, X.L. Regime- switching energy price volatility: The role of economic policy uncertainty.International Review of Economics and Finance, 76, pp.336-356. https://doi.org/10.1016/j.iref.2021.05.012

Sevüktekin, M. and Nargeleçekenler, M.2007. *Ekonometrik Zaman Serleri Analizi*. Ankara: Nobel Yayınları.

Sims, C.A., 1980. Macroeconomics and Reality. *Econometrica,* 48(1), pp.1–48. http://links.jstor.org/sici?sici=00129682%28198001%2948%3A1%3C1%3AMAR%3E2.0.CO%3B2-A

Sims, A., and Zha, T., 2004. Were there regime switchies in U.S. monetary policy?. Federal Reserve Bank Of Atlanta Working Paper Series.

Sum, V., 2013. Economic policy uncertainty in the United States and Europe: A cointegration test. International *Journal of Economics and Finance*, 5, pp.98–101. https://doi.org/10.5539/ijef.v5n2p98

Sun, X., Chena, X., Wanga, J.and Lia, J., 2020. Multi-scale interactions between economic policy uncertainty and oil prices in time-frequency domains. *North American Journal of Economics and Finance*, 51, 100854. Available at: <https://doi.org/10.1016/j.najef.2018.10.002>

Şenses, F., 2009. *Neoliberal küreselleşme ve kalkınma*. İletişim Yayınları, İstanbul.

Van Robays, I., 2016. Macroeconomic uncertainty and oil price volatility. *Oxford Bulletin of Economics and Statistic,* 78, pp.671–693. https://doi.org/10.1111/obes.12124.

Wang Y., Chen, C.R.and Huang, Y.S., 2014. Economic policy uncertainty and corporate investment: evidence from China. *Pacific-Basin Finance Journal*, 26, pp.227–243. https://doi.org/10.1016/j.pacfin.2013.12.008

Wang, Y. and Kong, D., 2022. Economic Policy Uncertainty and the Energy Stock Market: Evidence From China. *Energy Economics*, 3, early view. https://doi.org/10.46557/001c.28171

Wei, Y., Liu, J., Lai, X. and Hu, Y., 2017. Which determinant is the most informative in forecasting crude oil market volatility: fundamental, speculation, or uncertainty?. *Energy Economics*, 68, pp.141–150. https://doi.org/10.1016/j.eneco.2017.09.016

Wei, W., Hu, H. And Chang, C. P., 2021. Economic policy uncertainty and energy production in China. *Environmental Science and Pollution Research*, 28(38), pp.53544-53567. https://doi.org/10.1007/s11356-021-14413-4

World Bank., 2020. Global Economic Prospects. Washington, DC.

Yang, L., 2019. Connectedness of economic policy uncertainty and oil price shocks in a time domain perspective. *Energy Economics*, 80, pp.219–233. https://doi.org/10.1016/j.eneco.2019.01.006

Xu, B., Fu, R., and Lau, C.K. M., 2021. Energy market uncertainty and the impact on crude oil prices. Journal Of Environmental Management, 298, pp.1-12. https://doi.org/10.1016/j.jenvman.2021.113403

Yin, L., 2016. Does oil price respond to macroeconomic uncertainty?, New evidence. *Empirical Economics*, 51(3), pp.921–938. DOI 10.1007/s00181-015-1027-7

You, W., Guo, Y., Zhu, H.and Tang, Y., 2017. Oil price shocks, economic policy uncertainty and industry stock returns in China: asymmetric effects with quantile regression. *Energy Economics*, 68, pp.1–18. https://doi.org/10.1016/j.eneco.2017.09.007

Yu, H., Fang, L. and Sun, B., 2018. The role of global economic policy uncertainty in long-run volatilities and correlations of U.S. industry-level stock returns and crude oil. *Plos One*, 13(2), pp.1-17. https://doi.org/10.1371/journal.pone.0192305

Zhang, C., and Qu, X., 2015. The effect of global oil price shocks on China's agricultural commodities. Energy Economics, 51, pp.354–366. https://doi.org/10.1016/j.eneco.2015.07.012

World energy consumption. [online] Available at: <https://www.bp.com/content/dam/bp/business sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf#page13> [Accessed August 2022]

Global Economic Policy Index. https://www.policyuncertainty.com/global_monthly.html [Accessed in18 October 2021]

Global price of Brent Crude. [online] Available at: <https://fred.stlouisfed.org/tags/series?t=oil> [Accessed 18 October 2021]

Global price of Coal. [online] Available at: <https://fred.stlouisfed.org/tags/series?t=coal%3Bprice> [Accessed in18 October2021]

Global price of Natural gas. [online] Available at: <https://fred.stlouisfed.org/series/PNGASEUUSDM> [Accessed in 18 October 2021]