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THE EFFECTS OF POSITIVE AND NEGATIVE SHOCKS IN ENERGY SECURITY ON ECONOMIC GROWTH: EVIDENCE FROM ASYMMETRIC CAUSALITY ANALYSIS FOR TURKEY

Abstract. *In this study, it is aimed to examine the causality relationship between energy security and growth in Turkey between the years 1980-2018, using Asymmetric Causality Test proposed by Hatemi-J (2012). The most important factor that makes this study important is that it is the only study to examine the asymmetric relationship between energy security and economic growth among the few studies that empirically examine the effects of energy security on economic growth. According to the classical causality analysis performed in this study, there is not causality relationship between energy security and economic growth. The Asymmetric Causality Test results of Hatemi-J (2012) reveals that there is one-way causality relationship from an increase in the energy security risk level (i.e., a positive shocks) to a negative shock in GDP, while there is not the causality relationship from a decrease in the energy security risk level (i.e., a negative shocks) to growth. This result, which implies that the effects of positive and negative shocks on growth are different at the level of energy security risk, demonstrate that the priority policies for energy security are the measures to prevent the emergence of factors that increase the energy security risk level.*

Keywords*: Energy Security, Economic Growth, Energy Policy, Asymmetric Causality, Turkey Economy.*

JEL Classification: C22, O13, Q40, Q43

1. Introduction

Energy security is defined by IEA (2020) as the uninterrupted availability of energy sources at an affordable price. This definition is quite important in terms of forming the essence of the concept of energy security. In addition, this definition includes 3A of energy security, including usability, affordability and accessibility, and reflects the classical energy security perception. According to this definition, the most important element of energy security is uninterrupted access to energy. This requires having energy resources (availability) or being able to import these resources without interruption from countries having energy resources (accessibility). In terms of uninterrupted access to energy (accessibility), field security of energy resources is one of the most important issues encountered by countries having rich energy resources; on the other hand, more comprehensive

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factors such as the security of crossing routes and problems experiencing or likely to be experienced in relations between countries are one of the most important issues encountered by countries, which dependent on energy imports. For this reason, country and crossing-routes diversification in importing for countries that are highly dependent on energy imports are very important factors in ensuring energy security, because of reduce risks in terms of uninterrupted access to energy. In addition, increasing the use of alternative energy sources such as renewable energy sources are another factor in ensuring energy security, because of reduce the dependency on imports in fossil fuels. On the other hand, for energy exporting countries, since energy exports have a very high share of in total exports, adverse situations that will affect energy exports, such as the security of crossing routes and problems experiencing or likely to be experienced in relations between countries, directly affect the economies of their countries, similar to the situation of importing countries. For this reason, country and crossing-routes diversification in exporting for countries that are highly dependent on income from energy exports, are very important factors in ensuring economic stability, because of reduce risk of decline in export revenues by ensuring the continuity and security of energy exports.

While “affordable” access to energy, for countries that is self-sufficient in energy, is associated with the cost of obtaining energy resources such as extracting, processing and transporting the source; for countries that are highly dependent on energy imports, it is face to revealed with a rather complex network of relationships and, significantly are influenced energy security by making price movements an important risk factor. There are many risk factors that cause price fluctuations in the energy market (for example, the increase in oil prices after OPEC’s energy supply cuts, terrorist attacks or wars endangering the physical security of energy sources in major oil exporting country or region, political problems experienced or likely to experience in countries with mutual commercial relations) and, mostly the solution of this is not in the hands of energy importer country. That's why, price fluctuations are becoming an important energy security risk factor in countries that are highly dependent on imported energy. On the other hand, fluctuations in energy prices constitute a different risk factor for exporter countries, as fluctuations in energy prices (especially decreases) directly affect the income of energy-exporting countries. In addition, if the cost to be incurred for the extraction of the existing resource is higher than the current price of the resource, there is no importance of “availability” of energy sources, since production will not be profitable. To put it briefly in this context; while importance of "affordability" for countries that are highly dependent on energy imports stems from fluctuations (increases) in energy prices, it for exporter countries fluctuations (decreases) in energy prices and difference between production costs and energy prices.

According to today’s perception of energy security, for ensure energy security not only it is required that to have energy resources (availability) or to accessible these resources without interruption at the most affordable (accessibility and affordability), but also it is required that these resources should be used in a way that does not harm to environment. For this reason, modern energy security is briefly referred to as 4A of energy security by adding "Acceptability" dimension to 3A of energy security, which take place in IEA's definition of energy security. Acceptability added to the dimensions of energy security as 4th A of energy security means the acceptability of environmental impacts of energy systems and energy consumption. This dimension of energy security represents sustainability in a sense and, it included factors such as preventing the use of the energy sources, which harm the environment, increasing the use of renewable energy sources, which eco-friendly, and ensuring energy efficiency. This dimension of energy security is a very important factor affecting energy security for countries, which both rich and poor in energy resources. In addition to this, since this dimension of energy security promotes the use of renewable energy sources, it is much more important factor in terms of the decreasing the degree of import-dependency for countries, which strong import-dependency in energy.

Although the dimensions of energy security are expressed with 4A of energy security, it can be expanding as to include the provision of available, affordable, reliable, efficient, eco-friendly, properly governed and socially acceptable energy services (Pasqualetti & Sovacool, 2012: 167). In this context, for ensure energy security are required complex measures such as establishing self-sustaining national energy systems, building independent energy-transporting infrastructure, boosting energy production capacity, improving energy efficiency, increasing the share of renewable energy sources in the consumption balance (Aminjonov, 2016: 1).

Based on these explanations, it can be said that the main factor shaping the perception of energy security for each country is the "availability" dimension of energy security, which refers to having energy sources. Since the geographical distribution of resources is different in the world, while in some countries have energy resources, in some countries do not have these resources or are inadequate these resources. In other words, the status of in terms of "availability" dimension of energy security in any country, it also shapes the value and meaning of other dimensions of energy security, which affordability, accessibility and acceptability.

However, energy security is a multidimensional concept and the analysis of the effects of energy security on economic growth requires a holistic analysis of these dimensions of energy security. Accordingly, the aims of this study, which examines the causality relationship between economic growth and energy security in Turkey, are as follows:

- to perform the first empirical analysis on energy security for Turkey.
- to make an important contribution to the literature in this way, as there are few empirical studies on energy security in the literature.
- to analyse the causality relationship between energy security and growth by Asymmetric Causality that reported the effects of both positive shocks (increase in energy security risk level) and negative shocks (decrease in energy security risk

level); and thus, to offer policy recommendations in accordance with these results, which cannot be detected in the classical causality analysis.

- to demonstrate the importance of energy security in Turkey.

2. Energy Security in Turkey

In this section, in order to can be demonstrate the status of Turkey in terms of energy security, it is given to some statistical data within the framework of 4A of energy security for Turkey. Based on the definition of energy security, it can be said that the most important element of energy security is access to energy resources. This requires to have energy resources or to be able to import these resources as uninterrupted from the countries having these resources. In this context, first issue to be addressed in assessing the situation in terms of Turkey's energy security is the present situation of Turkey in terms of the "availability" dimension of energy security, which is the most important dimension of energy security. In this respect, Turkey is not a self-sufficient country in energy, is a dependence on external energy suppliers. Therefore, in order to able to assess the current situation in Turkey's energy security, appropriate statistical data were utilized in this case.

Although high dependence on external energy does not alone demonstrate that the country is a very risky country in terms of energy security, it is an important indicator. In this context, the ratio of energy-based imports in total imports significantly affects the current situation of a country in terms of energy security. In this direction, it is given in Table 1.

Table 1. Share of Fuels in Foreign Trade

	Export		Share of Fuels	Import		Share of Fuels
	(Total)	(Fuels)		(Total)	(Fuels)	
Turkey	177,169	5,810	3.28	231,152	43,613	18.87
World	19,324,248	2,504	12.96	19,690,568	2,629	13.35

Note: Export/import data is billions of dollars and fuel exports/imports include products with code number 27 in the Trade Map database. Data for 2018 are included in the table, since 1980-2018 data were used in the econometric analysis.
Source: UN (2021); Trade Map (2021).

When Table 1 is analysed, it is seen that the share of fuels in total imports in Turkey is above the world average with 18.87%. Being insufficient in terms of energy resources is not largely in the hands of country. Countries that are highly dependence on foreign in energy can reduce their energy security risk levels by making country diversification in energy imports. In this context, according to UN Comtrade Database (2021), as of 2018, within the total imports of 43 billion dollars (see. Table 1) the distribution of countries is as follows: Russia with 13.47 billion dollars (30.89% of total energy imports) and Iran with 10.98 billion dollars (25.18% of total energy imports) and, "Special Categories" with 5.71 billion dollars (13.09% of total energy imports). Russia and Iran realize approximately 56.07% of total energy imports with an approximately 24.45 billion dollars. This figure is approximately 10.58% of total imports. This situation for Turkey is leads to dependence on these two countries in energy and occurring an important energy security risk factor[1]. Because problems experiencing or likely to be experienced in relations between these two countries and Turkey (problems caused by in bilateral relations such as military, economic, political, etc.; problems caused by terrorist attacks on energy distribution channels and such as sabotage, assault; problems caused by natural causes such as earthquake, flood, landslide etc.) may restrict uninterrupted access to energy Turkey's.

Price fluctuations, which are another important element of the definition of energy security, and which directly affecting accessibility at affordable prices to energy, are also an important energy security risk factor for Turkey, which is high dependent on imports in energy, due to the fact that a shock in oil prices increase Turkey's energy imports in monetary terms. On the other hand, to performing the import of energy with ABD dollars are also affected accessibility to energy at affordable prices through exchange currency fluctuations and, are caused a significant energy security risk.

In addition to country diversification, resource diversification is also an important issue in energy security. In this context, the use of renewable energy sources has a strong impact on energy security because of the fact that both providing to resource diversification in energy use and creating a positive impact on the environment, which lately become an important element of energy security. In this respect, some statistical data, which demonstrate the situation of Turkey, are given in Table 2.

Table 2. Distribution of Energy Consumption by Energy Resources

	Oil	Gas	Primary Energy (Total)	Renewables Energy	Solar	Wind	Other
Turkey	46.68 (1.059)	44.42 (1.243)	144.39 (1.089)	5.374 (0.001)	0.236 (0.000)	3.511 (0.002)	1.627 (0.001)
World	4.408,6	3.574,2	13.258,5	417.395	74.260	217.104	126.032

Note: Values in parentheses indicate Turkey's share of total world consumption. Oil Consumption: Million tonnes, Gas Consumption: Billion cubic metres, other data: Million tonnes oil equivalent.
Source: BP (2021)

When Table 2 is analysed, it is seen that the share of primary energy consumption in total energy consumption (by 97%) is very high. In order to able to demonstrate Turkey's place in the world in terms of the use of resources, it is given Table 2 that data showing the share of Turkey's in total world consumption in the parentheses below each source. When the data were analysed, while the share of Turkey in total primary energy resources consumption in the world is

[1] Furthermore, total imports from Middle East countries (including Iran, Algeria, Israel, Iraq, United Arab Emirates, Saudi Arabia, Libya, Tunisia, Qatar, Kuwait, Jordan, Lebanon, Morocco) are 8.30 billion dollars (19.03% of total energy imports).

approximately by 1.1%, the share of Turkey in total renewable energy resources consumption in the world is only approximately by 0.001%. It is quite thought-provoking to have a very small share of the total renewable energy consumption despite Turkey's high potential in terms of renewable energy. In this respect, if Turkey can effectively use this potential be existing in renewable energy sources, it may significantly decrease the energy security risk level. In addition, considering the fact that fossil fuel consumption causes environmental pollution, increasing the share of renewable energy sources in energy consumption will positively affect the environment, which is another important element of energy security, and hence the risk level of energy security.

Another important factor that determines the position of Turkey in terms of energy security is the geopolitical position of Turkey, in terms of having important transition points (straits and pipelines). Strategic geographical position of Turkey between producer countries and consumer countries provide safe and sustainable route, which contribute to energy security by transport the neighbouring resources to Turkey and to world markets through Turkey in a stable and secure way. Turkey's this potential is contained quite significant opportunities for energy security. For example, Turkey have the opportunity to provide energy security of both own and the countries it mediates in energy trade its position by making both country and crossing route diversification in energy imports. Thus, Turkey can both taking great strides towards be a strategic energy corridor and strengthen position in international political competition. For this purpose, projects which based on a win-win relationship and provided mutual benefits are being implemented (Republic of Turkey Ministry of Energy and Natural Resources, n.d.).

When Table 1 and Table 2 are evaluated together with the information given in Table 1, factors that increase the risk of Turkey's energy security can be summarized briefly as follows:

- Dependence on energy imports due to inadequate of energy resources.
- Risks caused by energy price fluctuations due to dependence on energy imports.
- Risks caused by high dependence on a few countries in energy exports.
- Environmental risks caused by the low share of renewable energy consumption in total energy consumption.

3. Literature Review

There is a wide empirical literature on the effects of energy on economic growth. In this direction, empirical literature generally focuses on a certain dimension of energy security, such as the effect of energy consumption on economic growth, the effects of energy price shocks on economic variables, the effect of energy consumption on carbon emissions and effects of renewable energy consumption on economic/environmental. The dominant view in the literature emphasizes that energy consumption affects economic growth, energy consumption increases carbon emissions, there is both economic and environmental positive effects of renewable energy consumption, and fluctuations in energy prices cause economic fluctuations. However, few studies focus on energy security, which meaning the uninterrupted availability of energy sources at an affordable price and covering also entire other study topics in the literature such as access to energy, energy consumption, carbon emissions, renewable energy, energy prices. The first of these studies is the study by Kartal (2018; 2020) that it was examined relationship among political instability, energy security and growth by using data obtained from fifteen Middle Eastern countries between the years 1996-2014. As a result of econometric analysis, the author stated that a long-term relationship between the variables was determined. The results from the FMOLS estimator demonstrate that while 1% increase in energy security risk was decreased GDP per capita by 0.41%, 1% increase in political stability was increased GDP per capita by 0.25%. The results obtained from the FMOLS estimator used in the study demonstrate that while 1% increase in energy security risk was decreased GDP per capita by 0.41%, 1% increase in political stability was increased GDP per capita by 0.25%. In addition, according to the results obtained from the Panel Granger Causality Analysis in this study, there are a bi-directional association between energy security and GDP per capita and, a one-way causality relationship from energy security to political stability and from GDP per capita to political stability.

In study by Le and Nguyen (2019), the relationship between energy security and growth was examined by using ten measures of energy security, which five aspects of energy security including availability, accessibility, affordability, and developability, with a data set covering 74 countries from 2002 to 2013. According to the authors, the results demonstrate that energy security increases economic growth for both all sample country and sub-samples. In addition, according to the authors, energy insecurity measured by the variables of energy density and carbon density, it negatively affects economic growth. The findings demonstrate that these three factors are interconnected in the economic development, energy security and climate change mitigation at global level, so integrated policies should be followed.

Another studies, which focus on energy security, is by Stavytsk et al. (2018). In this study, empirical analysis was performed for 29 European countries covering the years 1997-2016 with the help of an index (the New Energy Security Index) created by the authors. According to the findings obtained as a result of the study, it was stated by the authors that the increase of GDP positively correlated with NSI, and negatively with CPI.

Fang et al. (2018) was proposed five dimensions of energy security, which availability, accessibility, affordability, acceptability, and developability, to construct China's Sustainable Energy Security (CSES) evaluation index model. Moreover, in this study, an empirical study of China's energy security is carried out with data from 2005 to 2015 by using this proposed model, and dynamic changing trends are analysed. Based on the results obtained, the authors argue that availability and develop-ability are the most important weights in China's Sustainable Energy Security index system, where availability demonstrate a general downward trend, and develop-ability presents an inverted U-type trend, with its lowest point in 2011. In addition, the authors state that from 2008 to 2012, China's sustainable energy security had been at risk.

In this context, when the literature on the subject is evaluated in general, it is seen that the existing studies examine a narrow period of time. The longest data range is the study conducted by Kartal (2018; 2020), which covers the years between 1996-2014. In the studies, indices containing the dimensions of energy security were preferred as energy security variables. The countries/regions subject to the analysis are Middle Eastern countries, Europe and China. Although Turkey was included in the Middle East country group in the study conducted by Kartal (2018; 2020), the results were reported for the panel, while the results specific to Turkey were not reported. In this context, it can be stated that there is no study on Turkey among these studies. Entire of empirical methods used are methods that give symmetrical results for energy security, and there is no study examining the different effects of positive and negative shocks in energy security on economic growth. In addition, existing studies provide evidence that the energy security risk level significantly effects on the economic growth of countries.

As a result of the literature review carried out, it is determined that the data regarding the existing studies on the subject are short periods, there is not a study on Turkey, the possible different effects of positive and negative shocks in energy security on economic growth are not taken into account. In this direction, this study aims to eliminate these deficiencies stated in the literature.

4. Data and Methodology

In this manuscript, which examines the causality between energy security and growth in the Turkey, the International Energy Security Risk Index was used that published by the Global Energy Institute. This index, which consists of eight main themes and twenty-nine sub-themes covering many aspects of energy security, was preferred for contains information on many aspects of energy security. GDP data, another variable used in the study, was obtained from the Penn World Table (2020). In empirical analysis was used natural log transformations of variables. The research period covers between 1980 and 2018.

In the classical causality analysis put forward by Granger (1969), it have been investigated whether there is a causal relationship between the two variables. This test requires that the variables be cointegrated and therefore cointegration and unit root analyses are performed. Accordingly, different methods, such as Toda and Yamamoto (1995) causality test, have been developed to perform causality analysis without the need for tests such as unit root and cointegration. In the study of Toda and Yamamoto (1995), it was stated that if the variables used in the causality analysis proposed by Granger (1969) were not stationary, the results of this test would not be valid by suggesting that traditional F statistics would not have a standard distribution. In addition, they stated that even if the series are not stationary, the standard MWALD test could be used by estimating the VAR model with the level values of the series and by accurately determining the maximum integration degree and lag length of the variables in the model. Accordingly, it suggests that a causality test based on a lag(s) augmentation of the VAR (p + d) model by Toda and Yamamoto (1995)[2]. This test is a quite handy causality test, because the variables do not have to be integrated to the same degree and there is no loss of data because the level values are used. But Hacker and Hatemi-J (2006) argue that if error terms of MWALD test based on VAR modelling are not normally distributed, it may give erroneous results. Therefore, it proposed by Hacker and Hatemi-J (2006) that another causality analysis based on the Toda and Yamamoto Causality Test[3]. Granger (1969), Toda and Yamamoto (1995) and Hacker and Hatemi-J (2006) causality tests are symmetrical causality tests, and they accept that the effects of positive and negative shocks are the same. Hatemi-J (2012) argued that the results obtained from symmetric causality tests can be misleading, since asymmetric information is found and economic units are not homogeneous, economic units react differently to positive and negative shocks. To eliminate this deficiency, it have been developed Asymmetric Causality Test by Hatemi-J (2012). (Hacker & Hatemi-J, 2006; Hatemi-J, 2012; Şanlısoy, 2020: 100; Toda & Yamamoto, 1995).

The idea of transforming data into both cumulative positive and negative changes originates that approach to test for cointegration, which they entitled as hidden cointegration by Granger and Yoon (2002). Hatemi-J (2012) extend their work to causality analysis and refer to it as asymmetric causality testing. This test is based on the separation of the positive and negative shocks of the Hacker and Hatemi-J (2006) causality test. Assuming that the causal relationship between the two series has been investigated y_{1t} and y_{2t} defined as the following random walk processes below (Hatemi-J, 2012):

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{10} + \sum_{i=1}^{t} \varepsilon_{1i} \qquad (1)$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{20} + \sum_{i=1}^{t} \varepsilon_{2i} \qquad (2)$$

In equations (1) and (2), t = 1,2,…T, the constants $y_{1,0}$ and $y_{2,0}$ are the initial values, and the variables ε_{1i} and ε_{2i} signify white noise disturbance terms. Positive and negative shocks are defined as in equations (3), (4), (5) and (6):

$$\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0) \qquad (3)$$

[2] For the mathematical form, see Toda & Yamamoto (1995) and Hacker & Hatemi-J (2006).
[3] For the mathematical form, see Hacker & Hatemi-J (2006).

$$\varepsilon_{2i}^{+} = \max(\varepsilon_{2i}, 0) \tag{4}$$

$$\varepsilon_{1i}^{-} = \min(\varepsilon_{1i}, 0) \tag{5}$$

$$\varepsilon_{2i}^{-} = \min(\varepsilon_{2i}, 0) \tag{6}$$

Cumulative shocks are defined as in equations (7) and (8):

$$\varepsilon_{1i} = \varepsilon_{1i}^{+} + \varepsilon_{1i}^{-} \tag{7}$$

$$\varepsilon_{2i} = \varepsilon_{2i}^{+} + \varepsilon_{2i}^{-} \tag{8}$$

It follows that equations (1) and (2) can be rearranged:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-} \tag{9}$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{10}$$

Finally, the positive and negative shocks of each variable can be defined in a cumulative form as:

$$y_{1t}^{+} = \sum\nolimits_{i=1}^{t} \varepsilon_{1i}^{+} \tag{11}$$

$$y_{1t}^{-} = \sum\nolimits_{i=1}^{t} \varepsilon_{1i}^{-} \tag{12}$$

$$y_{2t}^{+} = \sum\nolimits_{i=1}^{t} \varepsilon_{2i}^{+} \tag{13}$$

$$y_{2t}^{-} = \sum\nolimits_{i=1}^{t} \varepsilon_{2i}^{-} \tag{14}$$

It should also be noted that both positive and negative shock has a permanent impact on the underlying variable by construction. The next step is to test the causal relationship between these variables. In the following, we will focus only on the case of testing for causal relationship between positive cumulative shocks. Given that only the causal relationship between positive shocks has been tested, assuming that $y_t^{+} = \left(y_{1t}^{+}, y_{2t}^{+}\right)$ the test for causality can be implemented by using equation (15) vector autoregressive model of order p, VAR (p):

$$y_t^{+} = v + A_1 y_{t-1}^{+} + \ldots + A_p y_{t-1}^{+} + u_t^{+} \tag{15}$$

In equation (15), y_t^{+} is the 2×1 vector of the variables, v is the 2×1 vector of intercepts, and u_t^{+} is a 2×1 vector of error terms (corresponding to each of the variables representing the cumulative sum of positive shocks). The matrix Ar is a 2×2 matrix of parameters for lag order r(r = 1 ,..., p).

In addition, the information criterion given in Equation (16) is proposed for determine the optimal lag order (p) by Hatemi-J (2012):

$$HJI = \ln\left(\left|\hat{\Omega}_j\right|\right) + j\left(\frac{n^2 \ln T + 2n^2 \ln(\ln T)}{2T}\right), \quad j = 0, \ldots, p. \tag{16}$$

In Equation (16), $\left|\hat{\Omega}_j\right|$ is the determinant of the estimated variance–covariance matrix of the error terms in the VAR model based on lag order j, n is the number of equations in the VAR model and T is the number of observations. After selecting the optimal lag order, the null hypothesis given in Equation (17) is test that kth element of y_t^+ does not Granger-cause the ωth element of y_t^+.

H_0 : the row ω, column k element in Ar equals zero for r = 1,..., p. (17)

To obtain the Wald statistics to be used to test the basic hypothesis, the VAR model, which given in Equation (15), is redefined in Equation (18):

$$Y = DZ + \delta \tag{18}$$

Explanation of the terms in Equation (18) is as in Equation (19).

$$Y := \left(y_{1t}^+, ..., y_T^+\right) \ (n\,x\,T)\,matrix$$

$$D := \left(v, A_1, ..., A_p\right) \ (n\,x\,(1+np))\,matrix$$

$$Z_t := \begin{bmatrix} 1 \\ y_t^+ \\ y_{t-1}^+ \\ \vdots \\ y_{t-p+1}^+ \end{bmatrix} \left((1+np)\,x1\right) matrix,\, for\, t = 1,...,T \tag{19}$$

$$Z := \left(Z_0, ..., T_{T-1}\right) \ \left((1+np)\,x\,T\right) matrix, and$$

$$\delta := \left(u_1^+, ..., u_T^+\right) \ \ (n\,x\,T) \ matrix$$

The null hypothesis of non-Granger causality (H_0: Cβ = 0), have been tested by test method given in Equation (20):

$$Wald = (C\beta)' \left[C\left((Z'Z)^{-1} \otimes S_U \right) C' \right]^{-1} (C\beta) \tag{20}$$

In Equation (20), β = vec(D) and vec indicates the column-stacking operator; ⊗ represents the Kronecker product, and C is a p × n(1 + np) indicator matrix with elements ones for restricted parameters and zeros for the rest of the parameters. SU is the variance– covariance matrix of the unrestricted VAR model estimated as $S_U = \frac{\hat{\delta}_U' \hat{\delta}_U}{T-q}$ where q is the number of parameters in each equation of the VAR model.

Test statistics given above can use when the assumption of normality is fulfilled. However, financial data does not usually follow a normal distribution. To remedy this problem, it is proposes by Hatemi-J (2012) that the bootstrapping simulation technique[4].

5. Empirical Results

In this study, asymmetric causality relationship between energy security and growth for Turkey will be examined with the Asymmetric Causality Test proposed by Hatami-J (2012). In addition, Standard Granger Causality and Toda and Yamamoto Causality tests will be also performed as well as the Hatemi-J Asymmetric Causality Test and thanks to this, the results obtained will be able to compared. To perform these causality tests, it is necessary to determine the optimal lag length (p) and the degree of integration (dmax) of variables. In this regard, the VAR analysis results that performed for determining the maximum lag length are given in Table 3. According to the results obtained, the optimal lag length (p) was determined as 1.

Table 3. Determination of the Optimal Lags Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	26.70350	NA	0.000869	-1.372417	-1.284444	-1.341712
1	119.2522	169.6726*	6.35e-06*	-6.291789*	-6.027869*	-6.199674*
2	121.4991	3.869713	7.02e-06	-6.194397	-5.754530	-6.040871
3	122.2663	1.236041	8.46e-06	-6.014796	-5.398983	-5.799861

Note: * indicates lag order selected by the criterion.

The degree of integration of the variables have been determined by Augmented Dickey-Fuller (ADF) Unit Root Test and Phillips-Perron (PP) Unit Root Tests, and the results obtained are given in Table 4. According to the results obtained, it was found that while both variables contains unit root at the level, they are stationary when the first differences of the variables are taken. Thus, it has been determined that the maximum integration degree (dmax) to be used in Toda-Yamamoto and Hatemi-J Asymmetric Causality test is 1. In addition, the results demonstrate that the first difference of the variables must be used in the Standard Granger Causality test.

Table 4. Unit Root Test Results

Tests	Variables	Constant		Constant and Trend	
		Level	First Difference	Level	First Difference
ADF	lngdp	0.372	-6.355***	-1.366	-6.454***
	lnesri	-1.385	-5.741***	-2.192	-5.663***
PP	lngdp	0.405	-6.348***	-1.384	-6.446***
	lnesri	-1.214	-6.600***	-2.128	-6.828***

Note: The optimal lags length has been determined by the max 3 lag and SIC for the ADF unit root tests. It has been used the Kernel Newey-West Bandwidth criterion for PP unit root tests. ***, **, * indicates statistical significance at 1%, 5% and 10%; respectively -3.616, -2.941 and -2.609 for constant; -4.219, -3.533 and -3.198 for constant and trend.

[4] For obtaining the bootstrap critical value, see Hatemi-J (2012).

The results of the Standard Granger Causality test carried out taking into account the results given in Table 3 and Table 4 are given in Table 5. According to the results obtained from the Standard Granger Causality test, causality relationship between the variables could not be determined.

Table 5. Standard Granger Causality Test Results

Direction of Causality	F-Statistic	Asym. p-val	Bootstrap p-val
GDP→ESRI	0.341	0.559	0.565
ESRI→GDP	2.416	0.120	0.130

Note: The optimal lag was selected as 1.

In accordance with the results given in Table 3 and Table 4, Toda-Yamamoto Causality test have performed by taking both optimal lag and maximum degree of integration as 1. The results obtained in this direction are given in Table 6 and, this results demonstrate that there is a one-way causality relationship from energy security to growth. As you can see, both analysis, which without causing data loss, have been conducted and the causality relationship, which could not be detected in Standard Granger Causality test, have determined.

Table 6. Toda and Yamamoto Causality Test Results

Direction of Causality	lag (p)	lag (p+dmax)	Chi-sq	Asym. p-val	Bootstrap p-val
GDP→ESRI	1	1+1	0.321	0.571	0.572
ESRI→GDP*	1	1+1	3.709	0.054	0.062

Note: ***, **, * indicates statistical significance at 1%, 5% and 10%. The (p+dmax) denotes VAR order.

Both Standard Granger Causality test and Toda-Yamamoto Causality Tests are a symmetrical causality test and they do not demonstrate the effect of positive and negative shocks. However, most economic data are affected in different ways by positive and negative shocks. Therefore, to determine how positive and negative shocks affect the causality relationship between energy security and growth, it carried out Asymmetric Causality Test proposed by Hatemi-J (2012), and results obtained are given in Table 7.

Table 7. Hatemi-J Asymmetric Causality Test Results

Direction of Causality	MWALD	p-value (Asymptotic χ^2)	Bootstrap MWALD		
			1%	5%	10%
GDP+→ESRI+	1.231	0.267	9.220	5.154	3.436
GDP+→ESRI-	0.054	0.817	23.003	7.462	3.368
GDP-→ESRI+	0.240	0.624	13.158	5.626	3.322
GDP-→ESRI-	0.018	0.893	17.024	6.365	3.365
ESRI+→GDP+	0.749	0.387	10.143	4.382	3.054

Direction of Causality	MWALD	p-value (Asymptotic χ^2)	Bootstrap MWALD		
			1%	5%	10%
ESRI+→GDP-	5.18**	0.023	8.588	4.737	3.452
ESRI-→GDP-	0.414	0.520	18.887	6.310	3.735
ESRI-→GDP+	0.087	0.769	9.902	5.365	3.740

Note: ***, **, * indicates statistical significance at 1%, 5% and 10%. Both maximum degree of integration (dmax) and lag length (p) have been selected as 1.

When the results obtained from the Asymmetric Causality are examined, it seems that there is only a causality relationship from a positive shock in energy security (that is, an increase in the energy security risk level) to negative shock in economic growth. The results mean that a negative shock in energy security does not caused a positive or negative shock in economic growth and, also a positive or negative shock in economic growth does not caused a positive or negative shock in energy security.

6. Conclusions

In this study, it was examined that 1980-2018 years between the causality relationship between energy security and growth in Turkey by using three different causality methods including Standard Granger Causality test, Toda-Yamamoto Causality test and Hatemi-J Asymmetric Causality. It was determined that according to the Standard Granger Causality test, there was no causality relationship between variables, while according to the Toda-Yamamoto Causality test, there was a one-way causality relationship from energy security to growth. These two tests are a symmetrical causality analysis that cannot distinguish between the different effects of positive and negative shocks, which exist in economic life. Moreover, in this study, by considering also that there are different economic effects of positive and negative shocks in order to can be determine the most appropriate policies for energy security in Turkey, Asymmetric Causality Test proposed by Hatemi-J (2012) was also performed causality analysis. The results obtained from the Asymmetric Causality Test demonstrate that there is only a causality relationship from a positive shock in energy security to negative shock in economic growth. That is, the results obtained demonstrate that a negative shock in energy security does not caused a positive or negative shock in economic growth, also a positive or negative shock in economic growth does not caused a positive or negative shock in energy security.

When the results obtained from these three tests were compared, if only the Standard Granger Causality test results were taken into consideration, since there is no causal relationship between energy security and growth, in this case it could be made a misleading assessments expressing such as the policy implementations on the energy security risk level are not affects for economic growth. However, both Toda-Yamamoto Causality Test and Hatemi-J Asymmetric Causality Test results reveal that changes in energy security risk level affect economic growth and therefore policies to be applied towards energy security are important. When the results obtained from these two tests are compared, the results of the Hatemi-J

Asymmetric Causality Test allow for an important policy conclusion in terms of showing that there is only a causality relationship from a positive shock in energy security to negative shock in economic growth. In this context, this conclusion obtained from Asymmetric Causality test for Turkey, it demonstrate the necessity of implementing policies, which prevent the emergence of these factors before factors that increase the energy security risk level appear. Decreases in energy security risk levels did not affect economic growth can be explained with the fact that while economic actors take a new position according to this situation when the energy security risk level increases, they do not return to their previous positions when the energy security risk level decreases. As an example of this situation can be demonstrated that while producers who use energy as input in production increase the sales price of their products in a situation that energy prices increase, they are quite reluctant to decrease the sales price of their products in a situation that energy prices decrease.

In this regard, the results obtained from this study for Turkey demonstrate that energy security in Turkey an important factor of economic growth and, the importance of policies (especially preventive policy implementations, which prevent the emergence of these factors before factors that increase the energy security risk level appear) to be implemented in this direction.

When Turkey's condition in terms of energy security risk evaluated, three important elements stand out including dependence on energy imports due to inadequate in terms of energy resources, risks to arising from energy price fluctuations due to dependence on energy imports and increase to environmental risks due to the low share of renewable energy consumption in total energy consumption. In this context, the policy implementations for energy security in Turkey should be determined in accordance with these three main axes. For this purpose, policies featured for energy security can be summarized as follows:

- Country and crossing route diversification in energy imports (for reduce risks in energy imports)
- Identifying new energy sources (for reduce import dependency in energy sources).
- Implementation of pipeline strategies (for providing easier access to alternative energy sources and also become a regional power in energy)
- Increasing the share of renewable energy use in total energy consumption and implementing the policies on energy saving and the energy efficiency (for reduce both the dependency on imports and the environmental adverse effects of fossil fuel consumption as well as providing resource diversification)
- Ensuring stability in the exchange rate and, trading with local currencies by strengthening to mutual trade relations with energy importer countries where mutual commercial relations (for accessibility to energy at affordable prices)
- Looking as issue of national security to energy security (for raising awareness of energy efficiency)

Existence of the limited number of studies on the economic effects of energy security demonstrate that the empirical literature on the subject is quite open to improvement. In this context, there are many countries/regions that are not yet subject to empirical literature. In this direction, thanks to future studies, the current literature can be developed by examining the effects of energy security on different countries using different econometric models. Thus, with the assist of different results arising from differences between countries/regions, different policy proposals can be developed and the importance of energy security can be understood better.

REFERENCES

[1] **Aminjonov, F. (2016),** ***Limitations of the Central Asian Energy Security Policy: Priorities and Prospects for Improvement***. Centre for International Governance Innovation, Canada, Ontario, Waterloo;

[2] **BP.(2021),** ***Statistical review of world energy.*** Retrieved July 31, 2021, from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html;

[3] **Çelikpala, M. (2014),** ***Enerji güvenliği: NATO'nun yeni tehdit algısı***. *Uluslararası İlişkiler*, *10*: 75–99;

[4] **Fang, D., Shi, S. & Yu, Q. (2018),** ***Evaluation of sustainable energy security and an empirical analysis of China***. *Sustainability*, *10*: 1685;

[5] **Global Energy Institute. (2018),** ***International Index of Energy Security Risk 2018 Edition***; Retrieved January 27, 2019, from https://www.globalenergyinstitute.org/sites/default/files/2019-10/Final2018Index.pdf;

[6] **Global Energy Institute. (2020),** ***International energy security risk index 2020 edition***; Retrieved July 16, 2020, from https://www.globalenergyinstitute.org/energy-security-risk-index;

[7] **Granger, C. J. W. (1969),** ***Investigating Causal Relations by Econometric Models and Cross-spectral Methods***. *Econometrica*, *37*: 424–438;

[8] **Hacker, R. S. & Hatemi-J, A. (2006),** ***Tests for Causality between Integrated Variables Using Asymptotic and Bootstrap Distributions: Theory and Application***. *Applied Economics*, *38*: 1489–1500;

[9] **Hatemi-J, A. (2012),** ***Asymmetric Causality Tests with an Application***. *Empirical Economics*, *43*: 447–456;

[10] **Kartal, G. (2018),** ***Orta Doğu ülkelerinde politik istikrarsızlık, enerji güvenliği ve ekonomik büyüme ilişkisi***. Nevşehir Hacı Bektaş Veli University, Institute of Social Sciences Department of Economics, PhD Thesis;

[11] **Kartal, G. & Öztürk, S. (2020),** ***Politik istikrarsızlık, enerji güvenliği ve ekonomik büyüme ilişkisi: Orta Doğu ülkeleri üzerine ampirik bir inceleme***.

Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, *8*: 65–78;
[12] **Le, T. H. & Nguyen, C. P. (2019),** ***Is Energy Security a Driver for Economic Growth? Evidence from a Global Sample***. *Energy Policy*, *129*: 436–451;
[13] **Pasqualetti, M. J. & Sovacool, B. K. (2012),** ***The Importance of Scale to Energy Security***. *Journal of Integrative Environmental Sciences*, *9*: 167–180;
[14] **Penn World Table (2020),** ***Penn World Table*;**
https://doi.org/doi.org/10.15141/S50T0R;
[15] **Republic of Turkey, Ministry of Energy and Natural Resources**. **(**n.d.**),** ***Transit Pipelines and Projects***; Retrieved May 30, 2020, from https://www.enerji.gov.tr/en-US/Pages/Transit-Pipelines-and-Projects;
[16] **Şanlısoy, S. (2020),** ***Türkiye'de politik istikrarsızlık ile ekonomik büyüme ilişkisi: Bir nedensellik analizi***. *Bilig*: 85–114;
[17] **Stavytskyy, A., Kharlamova, G., Giedraitis, V. & Šumskis, V. (2018),** ***Estimating the Interrelation between Energy Security and Macroeconomic Factors in European Countries***. *Journal of International Studies*, *11*: 217–238;
[18] **Toda, H. Y. & Yamamoto, T. (1995),** ***Statistical Inference in Vector Autoregressions with Possibly Integrated Processes***. *Journal of Econometrics*, *66*: 225–250;
[19] **Trademap (2021),** ***Trede Map***; Retrieved March 18, 2021, from https://www.trademap.org;
[20] **United Nations (UN), (2021),** ***Comtrade Database***; Retrieved March 18, 2021, from https://comtrade.un.org;
[21] **Voser, P. (2012),** ***Energy: The Oxygen of the Economy***. In *World Economic Forum Energy for Economic Growth Energy Vision Update 2012*;
[22] **World Bank (2021),** ***World Development Indicators***; Retrieved March 18, 2021, from https://databank.worldbank.org;
[23] **Yergin, D. (2006),** ***Ensuring Energy Security***. *Foreign Affairs*, *85*: 69–82;