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DOES TRADE OPENNESS AFFECT ENERGY SECURITY? EMPIRICAL EVIDENCE FROM TÜRKİYE

Ticari Açıklık Enerji Güvenliğini Etkiler mi? Türkiye'den Ampirik Bulgular

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Abstract

Trade openness can create advantageous and disadvantageous situations for national economies. The impacts of trade openness on energy security are also crucial for policymakers, especially in countries dependent on fossil resources. This study aims to identify the link between trade openness and energy security and to prove that trade openness is one of the determinants of energy security for the Turkish economy. In the study, long-run analysis was carried out using cointegration analysis based on time series analysis. We used Türkiye's annual data for the period 1980-2018. Empirical findings point to a long-run relationship between the variables. According to the estimation results, trade openness increases the energy security risk. This result shows that increasing trade openness increases energy security risk due to the scale effect. We can say that the scale and composition effects dominate the relationship between openness and energy security for Türkiye. As can be seen from the study's empirical results, there is a significant relationship between trade openness and energy security in Türkiye, both in the short and long run. In this context, policymakers need to implement energy policies and trade policies simultaneously and with consideration for each other.

Anahtar Kelimeler:
Enerji Güvenliği
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Ticaret Politikaları

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Öz

Açıklık, ulusal ekonomiler için avantajlı ve dezavantajlı durumlar yaratabilir. Açıklığın enerji güvenliği üzerindeki etkileri, özellikle fosil kaynaklara bağımlı ülkelerde, politika yapıcılar için hayati öneme sahiptir. Bu çalışma, ticari açıklık ile enerji güvenliği arasındaki bağlantıyı belirlemeyi ve ticaret açıklığının Türkiye ekonomisi için enerji güvenliğinin belirleyicilerinden biri olduğunu kanıtlamayı amaçlamaktadır. Çalışmada, zaman serisi analizine dayalı eşbütünleşme analizi kullanılarak uzun vadeli analiz yapılmıştır. Türkiye'nin 1980-2018 dönemine ait yıllık verileri kullanılmıştır. Ampirik bulgular, kullanılan değişkenler arasında uzun vadeli bir ilişkiye işaret etmektedir. Tahmin sonuçlarına göre, ticari açıklık enerji güvenliği riskini arttırmaktadır. Bu sonuç, ölçek etkisi nedeniyle artan ticari açıklığın enerji güvenliği riskini artırdığını göstermektedir. Türkiye için açıklık ile enerji güvenliği arasındaki ilişkide ölçek etkisi ve bileşik etkinin baskın olduğu söylenebilir. Çalışmanın ampirik sonuçlarından görüleceği üzere, Türkiye'de ticari açıklık ile enerji güvenliği arasında hem kısa hem de uzun dönemde önemli bir ilişki mevcuttur. Bu çerçevede politika yapıcıların enerji politikaları ve ticaret politikalarını eşanlı ve birbirini gözeterek yürütmesi önem arz etmektedir.

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1. Introduction

Energy security has a critical role in sustainable economic development. Recently, energy security policies have gained remarkable importance all over the world. Energy security policies are carried out in parallel with sustainable development goals. The main reason is that energy has become one of the most crucial production factors. Energy security is defined as a country's ability to provide uninterrupted access to energy resources at affordable prices (Deese, 1979). As the level of development in economies increases, the energy demand also increases. With the increase in energy demand in countries that are not rich in energy resources, energy security risks also increase. An increase in energy security risk will negatively affect the macroeconomic balance of a country.

The stagflation periods that emerged after the two major oil shocks in the 1970s brought the importance of energy to the world's agenda. After the oil shocks, the concept of energy security began to be discussed frequently in the economic literature. The oil crises emphasized the central role of energy in economic, social, and military security. Ensuring a stable oil supply has become a national security issue for many countries (Le and Park, 2021). Energy security is closely related to countries' social, cultural, political, economic, and military security (Deese, 1979). Strategies for energy security may have consequences that will affect national and international security.

In the literature, the "four A's of energy security (availability, accessibility, affordability, and acceptability" are often used when explaining the concept of energy security (Cherp and Jewell, 2014). However, the factors determining energy security are i) supply-demand balance, ii) prices, iii) accessibility, and iv) sustainability. The first of these is the element that creates the energy security problem. The energy security problem that arises in countries that consume much more energy than they produce is one of the most critical security problems in the country. According to the data of the Energy Institute (2023), only 15 to 20 countries in the world export energy, primarily oil and gas, while the rest depend on imports. Affordability, accessibility, and sustainability form a trilemma. Problems in these three elements increase the risk of energy security.

While per capita energy consumption in Türkiye was 37.2 Gj in 1990, it reached 68.4 Gj in 2012 and 82.2 Gj in 2022 (Energy Institute, 2023). However, Türkiye's dependency on energy imports is around 75%. As a developing economy, Türkiye's energy demand is expected to increase rapidly in the coming period. Within the framework of numbers, the concept of energy security is one of Türkiye's priorities.

Energy demand has increased rapidly in the last 50 years due to the increase in the world population, technological advancement, liberalization of trade, rapid growth of developing Asian countries, etc. It is expected that this value will continue to increase in the future. The notion of energy security, about the reliable supply of energy, has gained significant traction in academic circles. Numerous investigations have been undertaken to explore the elements that influence energy security.

Many studies in the literature examine the effects of trade openness on energy consumption. Although this effect is significant, the energy security risk that this effect poses is another critical point that should be emphasized for developing countries. Does this relationship between energy consumption and trade openness also exist between energy security and trade openness? This

question needs to be investigated. Although the relationship between energy consumption and trade openness is essential, the direct relationship between energy security and trade openness will produce more meaningful results in terms of policymaking. The distinctive contribution of this study, in comparison to existing literature, lies in its empirical demonstration of the relationship between energy security and trade openness.

It is stated in the literature that trade openness affects energy demand through scale effect, technical effect, and composition effect (Nasreen and Anwar, 2014; Qamruzzaman and Jianguo, 2020). Trade openness also impacts energy security through similar channels. One of these is the increase in production brought about by trade openness to the outside world (Shahbaz et al., 2014). This situation is called the scale effect. If greater trade openness stems from the export channel, it means more production of export goods. More production means more energy consumption and impacts energy security. If this channel works through imports, imports have various effects on energy consumption and energy security. If the increase in imports is directed towards imports of intermediate goods, it will lead to a rise in domestic production and will impact energy security. If the increase in imports is due to a surge in consumer goods, it will directly affect energy consumption and security. If trade openness causes technology transfer to the country, this effect is called the technical effect (Zeren and Akkuş, 2020). As a result of the technical effect, energy consumption may decrease, or renewable energy consumption may increase with the decrease in energy intensity and increase in energy efficiency in the country. This effect will have a positive impact on energy security. The composition effect refers to the phenomenon whereby a shift from the agricultural sector to the industrial sector leads to an initial rise in energy consumption, as the industrial sector is characterized by its high energy demands during the process of economic development. The composition effect causes a decrease in energy consumption when the transition from the industrial sector to the service sector is made (Arrow, 1962).

Due to the composition effect, the relationship between trade openness and energy security differs across developed and developing countries. There are also different impacts on energy exporting and energy importing countries. For example, if increasing trade openness in energy-exporting countries leads to more energy exports, it can positively affect energy security. In energy-importing countries, increasing trade openness may negatively affect energy security as it will mean more energy imports.

Another channel through which trade openness impacts energy security is the price channel. In countries with high trade openness, foreign prices directly affect domestic prices. In countries with high trade openness favoring imports, macroeconomic problems may arise due to foreign price fluctuations. Especially in recent times, fluctuations in energy prices have played a destabilizing role in economic stability.

Within the framework of these explanations, the primary purpose of this study is to prove the link between trade openness and energy security. We also argue that trade openness is one of the determinants of energy security. The subsequent sections of the study are structured as follows. The second section will present a review of the existing literature, followed by model specification in the third section, empirical findings in the fourth section, and concluding remarks in the final section.

2. Literature Review

There is a complex relationship between energy security, energy consumption, and renewable energy consumption. Trade openness is related to all of these. The interplay between energy consumption and energy security can yield two distinct results. An escalation in energy consumption that relies on fossil fuels will adversely impact energy security for nations that depend on energy imports. Conversely, an increase in energy consumption derived from renewable sources is likely to enhance the energy security of countries that rely on energy imports. The effect of trade openness varies in these two cases. Enhancing trade openness could lead to a rise in energy consumption as a result of the scale effect, potentially undermining energy security. The rise in trade openness has the potential to positively impact energy security by increasing renewable energy production through technical effects. In their study, the relationship between renewable energy - energy security and trade openness - renewable energy was proven by Ibrahiem and Hanafy (2021). Renewable energy plays a multidimensional role in the economy. Certain measures contribute to energy security; promote diversification in energy consumption, and lower production expenses by decreasing the costs associated with fossil fuels utilized in the production process (Qamruzzaman and Jianguo, 2020).

We describe the literature review in two categories. The first is studies on the relationship between energy security and trade openness. Studies generally focus on the relationship between energy consumption/demand and trade openness. However, some studies focus on the relationship between different types of security and trade openness. Examples of studies focusing on the relationship between food security and trade openness include Dithmer and Abdulai (2017); Fusco et al. (2020); Sun and Zhang (2021); and Gnedeka and Wonyra (2023).

Numerous studies exist in the literature examining the correlation between trade openness and energy consumption. However, there is no consensus in these studies. We categorize these studies into three groups. Examples of studies that find that trade openness positively affects energy consumption/demand are Sadorsky (2011), Nasreen and Anwar (2014), Shahbaz et al. (2015), Sohag et al. (2015), Koengkan (2018), Topcu and Payne (2018), Alkhateeb and Mahmood (2019), Qamruzzaman and Jianguo (2020), Zeren and Akkuş (2020). In their study, Qamruzzaman and Jianguo (2020) found that the relationship between trade openness and energy consumption was positive in some country groups and negative in some country groups. Examples of studies that found that the relationship between trade openness and energy consumption/demand is negative are Managi et al. (2009), Shahbaz et al. (2013b), Sbia et al. (2014), Al-Mulali and Ozturk (2015), Qamruzzaman and Jianguo (2020). Examples of studies that identify a causal relationship between trade openness and energy consumption are Dedeoğlu and Kaya (2013), Shahbaz et al. (2013a), Sebri and Ben-Salha (2014), Shahbaz et al. (2014), Yang and Zhao (2014), Shahbaz et al. (2015), Rasoulinezhad and Saboori (2018), Tiba and Frikha (2018), Nepal et al. (2021), Odhiambo (2021). Shahbaz et al. (2015) found a positive and bidirectional causality relationship between trade openness and energy consumption in their study.

Only a single study was identified in the existing literature that specifically examined the connection between energy security and trade openness. Le and Park (2021) state that trade openness is among the factors determining energy insecurity. Le and Park (2021) use the concept of energy insecurity, the opposite of energy security, in their study of 139 countries. They find that trade openness has a negative effect on energy insecurity. This research posits that the degree

of trade openness serves as a significant factor influencing energy security. We use energy security variables to support this claim. Although this is not the focus of their study, Ibrahiem and Hanafy (2021) note that there is causality from trade openness to energy security. The research centers on examining how energy security and environmental quality influence the adoption of renewable energy sources. However, they used trade openness as a control variable and found a causal relationship between energy security and trade openness.

The second group is the literature on the determinants of energy security. Examples of literature on the determinants of energy security include Kruyt al. (2009); Erdal (2015); Franki and Viskovic (2015). When examining these studies, the determinants of energy security include economic factors such as energy prices, energy supply and demand, energy imports, renewable energy consumption, and factors such as CO2 emissions, global climate deterioration, and low-carbon generation technologies. Our study argues that trade openness is one of the determinants of energy security. One of the studies claiming that trade openness is one of the determinants of energy security is the article by Akinyemi et al. (2017). However, Akinyemi et al. (2017) claim this relationship without using an energy security variable in their study.

Studies in the literature examine the relationship between trade openness and energy consumption in Türkiye. However, no study has been found that focuses directly on the relationship between trade openness and energy security. Examples of studies examining the relationship between trade openness and energy consumption in Türkiye are Korkmaz (2018), Zeren and Akkuş (2020), Emeç and Yarbaşı (2018), and Çetin and Çınar (2021). Korkmaz (2018) concluded that trade openness for Türkiye and financial openness for Italy positively affect energy consumption. Zeren and Akkuş (2020) and Çetin and Çınar (2021) confirmed the positive relationship between trade openness and energy consumption in their studies. Emeç and Yarbaşı (2018) found bidirectional causality between trade openness and energy consumption in their study. These studies examined the relationship between energy use and trade openness. It can be said that this study is the first study focusing on the relationship between trade openness and energy security for Türkiye.

3. Model Specification

The annual data set used in econometric estimations covers the period between 1980 and 2018, depending on the data availability. Information about the variables used in the models is given in Table 1.

Table 1. Summary Explanations of Variables

	Definition	Explanation	Source
ensec	Energy Security Risk	Energy security risk index (Taking the natural logarithm)	Global Energy Institute
enpri	Crude Oil Price	(Taking the natural logarithm)	Energy Institute
open	Trade Openness	Ratio of export and import to GDP	World Bank
gdp	Per capita GDP	(Taking the natural logarithm)	World Bank

ensec is an index calculated by the Global Energy Institute (2024) that shows the energy security risk. The increase in the values of this index indicates that the energy security risk increases. *enpri* shows the price of a barrel of crude oil in dollars at current prices, representing

energy prices. *enpri* were obtained from the Energy Institute (2023), Statistical Review of World Energy report. *open* and *gdp* were sourced from the World Bank's World Development Indicators (World Bank, 2024). Trade openness is defined here as the ratio of the sum of imports and exports to GDP. *gdp* represents GDP per capita in $ at current prices.

The descriptive statistics of the variables are reported in Table 2. The Jarque-Bera test shows all variables are normally distributed at a 5 % level. In Table 3, the Variance Inflation Factor (VIF) values were calculated to detect the multicollinearity problem between the independent variables. Generally, a VIF value exceeding 10 indicates a multicollinearity problem between the variables (Gujarati and Porter, 2009: 340). The VIF values reported in Table 3 indicate that there is no multicollinearity problem in the model.

Table 2. Summary Statistics

	ensec	enpri	open	gdp
Mean	6.98	3.53	0.44	8.44
Median	6.96	3.34	0.50	8.36
Maximum	7.14	4.71	0.60	9.43
Minimum	6.79	2.54	0.30	7.12
Std. Dev.	0.08	0.69	0.09	0.73
Skewness	0.13	0.36	-0.40	-0.11
Kurtosis	2.29	1.71	2.01	1.66
Jarque-Bera	0.83	3.21	2.37	2.68
Probability	0.65	0.20	0.30	0.26
Obs.	39	39	39	39

Table 3. Multicollinearity Test Results

Variables	Coefficient Variance	Uncentered VIF	Centered VIF
gdp	0.000930	579.9856	4.970945
open	0.029832	49.97436	2.891889
enpri	0.000675	77.84541	2.551070

The models to be used in econometric analyses are shown below.

$$ensec_t = \alpha_1 + \beta_1 enpri_t + \beta_2 open_t + \beta_4 gdp_t + \varepsilon_t \quad (1)$$

The first step in assessing the relationship between trade openness and energy security is determining whether the series has unit roots. We use the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests to determine whether the series in question has a unit root (Dickey and Fuller, 1979, 1981; Phillips, 1987; Phillips and Perron, 1988). If the series is found to have a unit root or be I(1), we will continue our investigation by applying cointegration tests. We employ the Johansen multivariate cointegration technique, as Johansen (1988) and Johansen and Juselius (1990) suggested. In this study, we employ a vector error correction model to estimate the model's short-run and long-run coefficients.

4. Empirical Findings

The prominent research question of this study is, "Is trade openness a determinant of energy security?" Based on this research question, the first of the main results we expect to obtain from the empirical application of the study is to determine that trade openness is one of the determinants

of energy security. The second main result we expect to obtain is the direction of the relationship between trade openness and energy security. As we stated before, these two variables have many channels of influence. We are looking for an answer to the question: which is more dominant in Türkiye: scale effect, technical effect, and composition effect? If trade openness increases energy security risk, the scale effect will dominate. Because increasing trade in developing countries brings economic growth, energy demand increases with increasing economic growth, and rising energy demand increases the risk of energy security. If trade openness reduces energy security risks, the technical effect dominates. The energy efficiency of developing countries increases with technology transfer from developed countries. Thus, energy demand decreases, and decreasing energy demand reduces energy security risk. In addition, energy consumption is likely to increase in industrializing economies, which is likely to increase the risk of energy security. This result is referred to as the composition effect in the literature. The positive relationship between trade openness and energy security risk may arise due to the scale effect and composition effect, and there is no clear way to separate the two, as in Cole's (2006) study.

Before the estimation of equation 1, we applied the unit root tests. Table 4 presents the unit root test results of the variables used in the model. The ADF unit root test shows that all variables are not stationary at their levels but stationary at first differences, implying all variables are integrated of order one, i.e., I(1). According to Perron (1989), the power of ADF tests decreases in the presence of structural breaks.

Table 4. Unit Root Tests

Series	ADF	PP
ensec	-1.38(0)	-1.21(6)
Δensec	-5.74(0)***	-6.59(18)***
enpri	-0.96 (0)	-0.96 (0)
Δenpri	-5.67 (0)***	-5.66 (2)***
open	-1.82 (0)	-1.60 (13)
Δopen	-7.67 (0)***	-10.95 (16)***
gdp	-0.77 (0)	-0.76 (1)
Δgdp	-6.09 (0)***	-6.09 (1)***

*** indicates rejection of the null hypothesis of non-stationary at the 1% level.
PP is the Phillips-Perron, and ADF is the Augmented Dickey-Fuller tests. The proper lag order for the ADF test is chosen by considering Akaike Information Criteria (AIC) and white noise of residuals, represented in parenthesis. The bandwidth is chosen for PP tests using the Newey–West method, and spectral estimation uses the Bartlett kernel, represented in parenthesis.

Zivot and Andrews (1992) criticized Perron's (1989) exogenous breakpoint assumption and developed a new unit root testing procedure that allows for an estimated break in the trend function (Zivot and Andrews, 1992). Table 5 shows the Zivot-Andrews (ZA) unit root test results. Three models are used in this test: Model A contains a single break in level, Model B contains a single break in slope, and Model C contains a single break in both slope and level. Test results indicate that all series are integrated in the same order, I(1).

Table 5. Zivot-Andrews Unit Root Test

	Level			First Difference		
Series	**ZA_I**	**ZA_T**	**ZA_B**	**ZA_I**	**ZA_T**	**ZA_B**
ensec	-4.159	-3.422	-4.604	-6.457***	-6.034***	-6.332***
Time Break	1990	1999	1990	1989	1991	1999
Lag Length	0	0	0	0	0	0
enpri	-3.53	-2.987	-2.987	-6.418***	-6.168***	-6.303***
Time Break	2004	2004	2004	2009	2006	1999
Lag Length	0	0	0	0	0	0
open	-4.869*	-3.937	-4.849	-5.269**	-4.571**	-5.305**
Time Break	1994	2002	1994	1998	1997	1994
Lag Length	0	0	0	2	3	2
gdp	-2.943	-3.203	-3.412	-6.648***	-6.737***	-7.289
Time Break	2003	2012	2004	2009	2006	2003
Lag Length	0	0	0	0	0	0

*, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. ZA_I represents the model with a break in the intercept; ZA_T is the model with a break in trend; ZA_B is the model with a break in both the trend and intercept.
The 1%, 5%, and 10% critical values for the Model A are -5.34, -4.93, -4.58, respectively.
The 1%, 5%, and 10% critical values for the Model B are -4.80, -4.42, -4.11, respectively.
The 1%, 5%, and 10% critical values for the Model C are -5.57, -5.08, -4.82, respectively.
The 1%, 5%, and 10% critical values for the ADF and PP tests are -3,61, -2,94, and -2,60, respectively.

According to unit root test results, the condition for the Johansen cointegration technique is satisfied, and therefore, short and long-run analyses can be performed. Performing the cointegration tests, we determined the lag length as 2 according to the AIC criterion and used the model that includes the constant. In the cointegration test, we used the dummy variable we created for 1994 and 2001 to account for the structural break. The crises of 1994 and 2001 are the biggest crises seen in the Turkish economy. Due to the failure to ensure monetary and fiscal discipline, high inflation, and high interest rates, along with the deterioration of the balance of payments and exchange rate shocks, these crises brought about significant changes in the Turkish economy. Many institutional arrangements, especially the central bank's independence, were made after the 2001 crisis, and structural measures were taken to control inflationary trends. The trace and max eigen statistics results for the dependent variable, *ensec, are* presented in Table 6.

Table 6. Cointegration Test Results

Hypothesized No. of CE(s)	**Trace Statistic**	**0.05 Critical Value**	**Prob.**	**Hypothesized No. of CE(s)**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.**
r = 0*	57.157	47.856	0.005	r = 0*	29.382	27.584	0.029
r ≤ 1	27.774	29.797	0.084	r ≤ 1	16.088	21.132	0.220
r ≤ 2	11.687	15.495	0.172	r ≤ 2	8.265	14.265	0.352
r ≤ 3	3.422	3.841	0.064	r ≤ 3	3.422	3.841	0.064

*denotes rejection of the hypothesis at the 5% level
The model that includes the constant in the cointegration equation was used. The optimum lag length was determined as 2 according to the AIC criterion.

Cointegration test results show that there is a cointegration relationship between the variables. Therefore, a vector error correction model will be estimated to investigate short-run and long-run relationships between variables. The prediction results of the ECM model are shown

in Table 7. In Table 7, it is estimated that 23.9 percent of the short-run imbalance will be eliminated in the long-run. Table 7 also presents the cointegration equation showing the long-run coefficients of the variables affecting energy security. Accordingly, *open, enpri* and *gdp* have a positive impact on *ensec*. The positive relationship between trade openness and energy security risk indicates that the scale effect and composition effects are more dominant in Türkiye. This result has been realized within the framework of our expectations for Türkiye. In Türkiye, where the industrialization process continues and has rapid growth potential, the increasing energy demand due to increasing trade negatively affects energy security. The positive relationship between energy prices and energy security risk is an expected result, too. Increases in energy prices make energy imports more complex, and the energy security risk increases. The positive relationship between income and energy security risk confirms the dominance of the scale effect channel. With increasing trade, economic growth occurs, energy demand increases, and energy security risk increases with growing energy demand.

Table 7. Short-Run and Long-Run Test Results

	Short-Run Estimates		**Long-Run Estimates**
$\Delta(ensec_{t-1})$	0.313*	$open_{t-1}$	1.083***
	(0.169)		(0.364)
$\Delta(ensec_{t-2})$	0.098	$enpri_{t-1}$	0.124***
	(0.172)		(0.042)
$\Delta(open_{t-1})$	-0.377**	gdp_{t-1}	1.010***
	(0.151)		(0.057)
$\Delta(open_{t-2})$	-0.920***		
	(0.154)		
$\Delta(enpri_{t-1})$	-0.043		
	(0.026)		
$\Delta(enpri_{t-2})$	-0.034		
	(0.032)		
$\Delta(gdp_{t-1})$	0.059		
	(0.054)		
$\Delta(gdp_{t-2})$	-0.113*		
	(0.066)		
Error Correction Term	-0.239***		
	(0.074)		
Constant	0.017		7.309
	(0.009)		
Dum1994	0.054		
	(0.034)		
Dum2001	0.020		
	(0.042)		
Obs.	36		
R^2	0.731		
F Test	5.944		
Autocorrelation LM Test (2) (p-value)	0.165		
Breusch-Pagan-Godfrey Test (p-value)	0.525		

*, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Standard errors are represented in parentheses

As a result of the empirical findings, we prove that trade openness is one of the determinants of energy security for Türkiye. No other study has proven the relationship between trade openness

and energy security for Türkiye. We develop the findings of Korkmaz (2018), Zeren and Akkuş (2020), and Çetin and Çınar (2021), who examined the relationship between trade openness and energy consumption for Türkiye and found a positive relationship to include energy security. We also contribute to the work of Akinyemi et al. (2017) by including the energy security variable.

Contrary to the finding of Le and Park (2021), who used the concept of energy insecurity, that trade openness negatively affects energy insecurity, the finding that trade openness increases energy security risk is essential for this study. We also improve the work of Ibrahiem and Hanafy (2021), which identified causality from trade openness to energy security in terms of the degree and direction of the relationship.

The diagnostic test results reported at the bottom of Table 7 show that the residuals are not serially correlated and heteroscedastic at the 5 percent level. Cusum and Cusum of square tests shown in Figure 1 and Figure 2 show the parameter stability in the models.

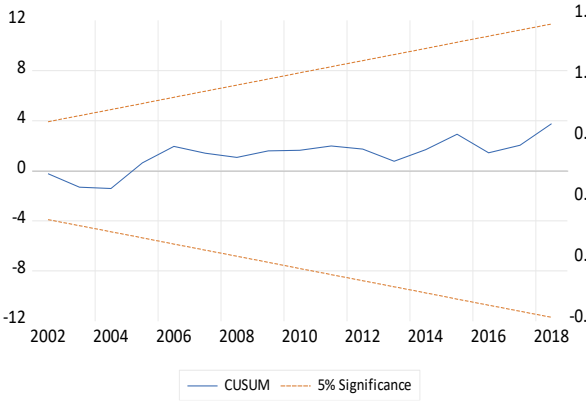

Figure 1. CUSUM test.

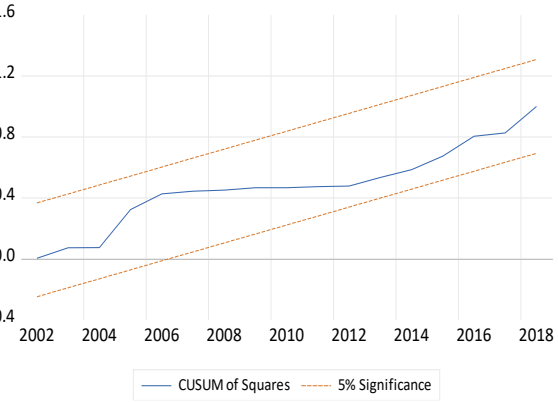

Figure 2. CUSUM of squares test.

5. Conclusion

Energy security has a critical role in sustainable economic growth and development. For this reason, energy policies should be designed within the framework of sustainable development goals. In recent years, many studies have emerged in the literature investigating the relationship between trade openness and energy consumption or demand. In addition, examining the impact of trade openness on energy security, which is a direct policy indicator, will guide policymakers.

In this study, we examined whether trade openness impacts energy security in the Turkish economy. We used time series analysis to explore the relationship. In the study, we took into account structural breaks for Türkiye. We analyzed the impact of trade openness on energy security in Türkiye with the cointegration and error correction model. The study's findings highlight that trade openness significantly influences energy security in Türkiye.

This study used an econometric model for variables assumed to be effective in determining energy security. Energy security was taken as a dependent variable in econometric model estimations. Empirical results show that there is a long-run relationship between energy security and the explanatory variables, which are trade openness, GDP per capita, and energy price.

The estimation results of the error correction model created to analyze the short and long-run dynamics between the variables show that an increase in trade openness, energy prices, and GDP per capita positively affects energy security. According to the error correction term, 23.9 percent of the short-run imbalance will be eliminated in the long-run. This result shows that the error correction mechanism is working.

This study indicates a significant relationship between trade openness and energy security in the short and long run, and the permeability between energy and trade policies is relatively high. According to these results, policymakers should simultaneously design energy and trade policies.

The limitation of this study is the short period during which the analysis was conducted. This situation is due to the restrictions on the accessibility of the data. Another limitation of the study is that the results obtained are valid within the method's scope. Future studies can conduct analyses with more extended data sets and methodological developments.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement

The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest

There is no potential conflicts of interest in this study.

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