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On the Causal Relationship between Economic Growth and Renewable Energy Consumption: The Case of Turkey

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Abstract: ***Energy is one of the major factor for the economic growth. Countries have to produce more in order to achieve sustainable growth target. Thus, they have to consume more energy. Developed economies are trying to minimize the ecological damage as they are achieving their target economic growth rate. Efficient usage of renewable energy sources is the corner stone of this effort. Turkey has planned to have high, sustainable economic growth rate. 21st century is the time that CO_2 emission has peaked. Hence, scientists have become more and more curious about high, sustainable and eco-friendly economic growth since the early days of 21stcentury. There are four hypothesizes regarding this matter. First hypothesis states that there are no causal relationship between economic growth and renewable energy consumption. Second hypothesis indicates that there is a unidirectional causality between economic growth and renewable energy consumption and causality runs from renewable energy consumption and economic growth. Third hypothesis stands for this; there is a unidirectional causality between economic growth and renewable energy consumption and it runs from economic growth and renewable energy consumption. Last hypothesis is called feedback hypothesis. It means that there is a bi-directional causal relationship between two variables. The current study investigates the causal relationship between economic growth and renewable energy consumption in Turkey between1980 and 2013. Granger causality test is used to examine the causal relationships between economic growth and renewable energy consumption. Empirical evidence shows that, based on the Granger Causality Test, there is bi-directional Granger causality exists between economic growth and renewable energy consumption, results indicate that the renewable energy consumption cause real GDP, which can explain the role of renewable energy in stimulating economic growth in Turkey.***

Keywords: Renewable energy, Economic growth, Granger Causality, Green economy, Environment

1. Introduction

In order to decrease ecological problems, many scientific studies have been conducted with the purpose of creating awareness. One of the most effective methods for the prevention of ecological prevention has been determined as the prevention of emission of harmful gases to the environment. Countries support the process of solving this problem through various laws and partnerships. Energy generation stands out as the most active factor in the emission of harmful gases to the environment. In order to minimize the harmful effects of energy generation on the environment, it has been an effective solution method to reduce the use of fossil and nuclear energy resources and adopt the use of new renewable energy resources in the energy generation. Therefore, countries are planning to gradually reduce the consumption of fossil resources and increase the renewable energy consumption. Effective use of renewable energy resources will create new business lines and accelerate the development of technology.

Countries with the highest ratio of renewable energy consumption to the primary energy consumption as of 2013 are shown in Table 1.

In the European Union countries, the share of renewable energy resources in electricity generation is 28%. Norway has the highest share of renewable energy resources in electricity generation with 97.9%, while Indonesia has the lowest ratio with 9.3%. In the European Union countries, the share of renewable energy resources in primary energy consumption is 13%. Norway has the highest share of renewable energy in primary energy consumption with 43%, while Russia has the lowest share with 3.3%.

Table1: Renewable Energy Consumption/Primary Energy Consumption by Country

Countries	*Renewable Energy Consumption / Primary Energy Consumption*	*Countries*	*Renewable Energy Consumption /Primary Energy Consumption*
1. Norway	43%	6. India	25,1%
2. Brazil	40.2%	7. Chile	24,8%
3. Sweden	34.2%	8. Indonesia	23,8%
4. Finland	27,5%	9. Colombia	22,5%
5. Portugal	26,7%	10. New Zealand	21,1%

Source*:* Enerdata [http://yearbook.enerdata.net/#renewable-data-in-world-primary-consumption-shares-by-region.htmlRetrieval date: (13.10.2014)]

The share of renewable energy resources in primary energy consumption for the period of 2000-2013 in Turkey is shown in Figure 1. According to this data, the share of renewable energy resources in energy consumption in Turkey was about 13% in the period of 2000-2004. From 2004 to

2013, this ratio had started to decrease and fluctuated around 9-10%. The data shows that energy consumption had increased gradually from 2000 to 2013 just like the amount of energy generated from renewable energy resources, but the share of such resources in final consumption was not as effective as it was in the early 2000s.

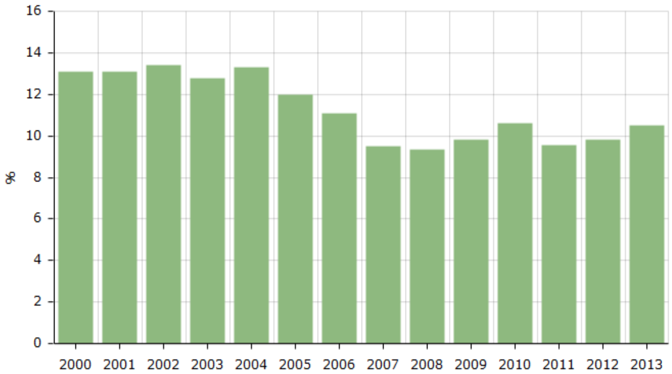


Figure 1: Share of Renewables in Primary Energy Consumption of Turkey in the period of 2000-2013
Source: Enerdata, 2014

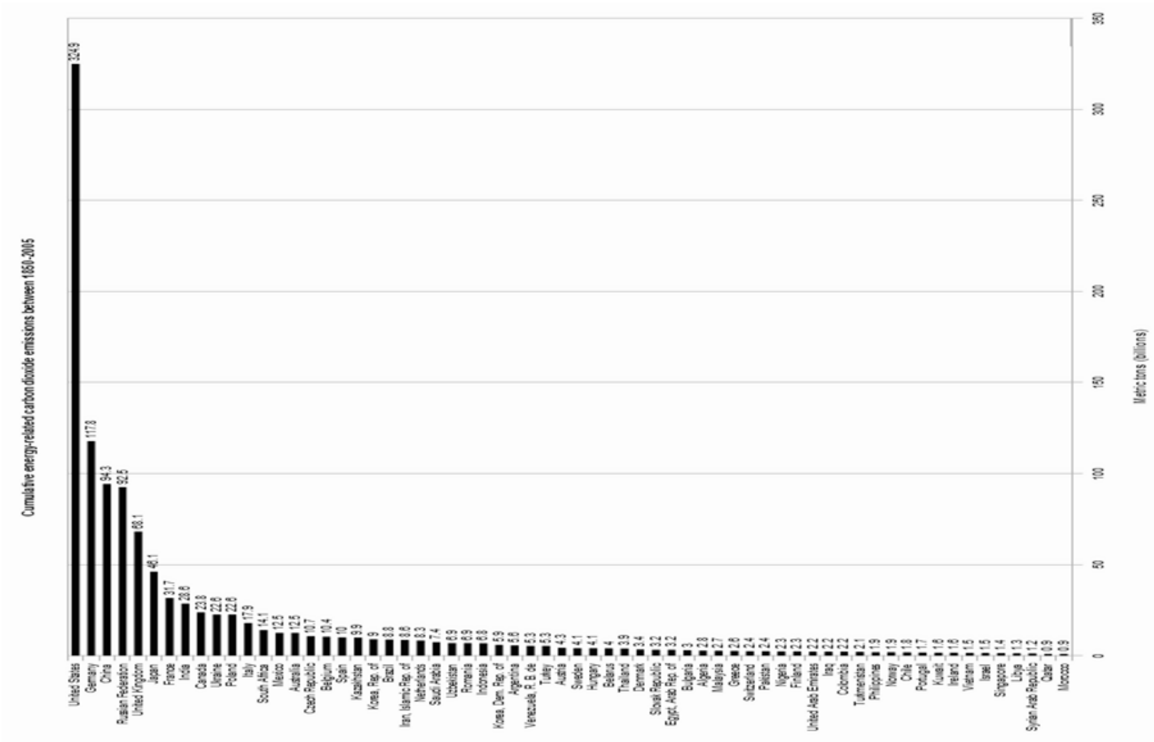


Figure 2: Carbon Emissions of Countries in the Period of 1850- 2005
Source: World Bank, 2010.

The most determinant and significant element of the world's energy policy is the reduction of CO_2 (emission CO_2 emission is the release of carbon dioxide to the atmosphere after the combustion of carbonaceous fuels (fossil fuels: oil, natural gas, coal etc.). CO_2 emission is considered the main responsible for the global warming and causes the formation of greenhouse gases) in order to reverse the climate change. In recent years, a substantial energy CO_2 savings have been made as a result of energy efficiency improvements in almost all regions of the world. Figure 2 shows the carbon emissions of countries in the period of 1850-2005. As is seen, the western countries are in the forefront when it comes to carbon emission. Based on various energy symposiums and roadmaps developed, it is decided to reduce the carbon-dioxide emissions. (http://unfccc.int/kyoto_protocol/items/3145.phpRetrieval date (15.09.14)) The U.S. and Germany, two countries with the highest amount of CO_2 emission, have completed their industrialization thanks to intensive coal consumption. The high amount of coal they consumed has caused climate changes and disturbed the balance of the nature. Although Canada has less population, it comes ninth in that list. When the countries are ranked based on the per capita consumption, Canada is near the top of the list. Currently, China makes the highest amount of carbon emission in the world. However, since China and other developing countries have recently started to make carbon emission, they are relatively towards the bottom of the list in these figures (World Bank, 2010). In the light of this data, it is seen that developed countries have reduced their carbon emissions while having an economic growth. Moreover, developed countries have decreased energy consumption and increased output rates by improving their energy efficiency. When the turning points of civilizations and the density of CO_2 in energy consumption are examined, Figure 2 shows a clear linear relationship between the two. After this transition in energy resources, gas emissions to the environment have increased gradually. After the scientists and environmental organizations started to raise concerns over these emissions and the amount of nonrenewable energy resources started to decrease, energy producers have tried to produce more energy with less emission. As a result, the amount of energy consumption has increased in developed countries, while the amount of gases such as CO2 has decreased compared with previous periods.

Energy is one of the basic elements of economic growth. In order to achieve the sustainable, steady and high growth target, it is necessary to increase production and thus energy consumption. Developed economies are trying to minimize the harm to the environment while maintaining their growth. In addition, effective use of renewable energy resources underlies this effort. The Republic of Turkey targets a sustainable and high growth. In the literature, there have been more studies conducted on this subject especially after the early 21st century, when the CO2 emission started to pose serious danger. Based on these studies, there are four main hypotheses. First, there is no relationship between economic growth and renewable energy consumption. Second, there is a causality relationship from renewable energy consumption to economic growth. Third, there is a causality relationship from economic growth to renewable energy consumption. Fourth and final hypothesis is called as feedback hypothesis. The feedback hypothesis states that there is a bidirectional causality relationship between economic growth and renewable energy consumption.

2. Literature Review

In the literature, there are many studies which examine the relationship between energy consumption and economic growth. When we look at these studies, Kraft and Kraft (1978) found a unidirectional causality relationship from energy consumption to the gross national product, as a result of their study conducted based on data in the period of 1947-1974 in the U.S. After this study, the subject of energy and economy has become highly popular. The scientists who recently examined the relationship between energy consumption and energy growth are as follows: Adjaye (2000), Lee (2005), Yoo (2006), Chenet al.(2007), Jinkeet al. (2008), Lee and Chang (2008), Narayan and Smyth (2008), Chontanawat et al.(2008), Apergis and Payne (2009), Akinlo (2009), Öztürk and Acaravcı (2010), and Menegaki (2011). The relationship between energy and income is considered worth studying by many scientists, including Apergis and Payne, (2009), Lee (2005), Lee and Chang (2008), Lee et al. (2008), Mahadevan and Asafu-Adjaye, (2007), Al-Iriani (2006), Narayan and Smyth (2007, 2008, 2009), Naryan et al. (2007), and Sadorsky (2009). The impact of energy policies and environmental measures on economy policies of counties has inspired scientists to examine this subject (Bobinaite et al., 2011: 1). However, the science world does not have a consensus on the direction of causality. Some scientists (Narayan and Smyth, 2008; Akinlo, 2009) agree on the idea that the causality relationship is from energy consumption to the economic growth. Economic growth depends on energy consumption. These scientists defend the argument that decrease in energy consumption because of energy policies will slow down the economic growth. This argument is valid for developing and developed countries. Others (Yoo, 2006; Chen et al., 2007, Jinke et al., 2008) defend a contrary argument. According to these scientists, economic growth originates from energy consumption. It is also found that there is a bi-directional causality between economic growth and energy consumption (Mahadevan and Adjaye, 2007; Paul and Bhattacharya, 2004). According to this view, an increase in energy consumption directly affects economic growth in a positive way. Then they argue that the impact of increase in economic growth will also increase the future energy consumption. This hypothesis is then confirmed by other scientists as well. Another hypothesis, called the neutrality hypothesis, suggests that no causality exists between energy consumption and economic growth (Öztürk and Acaravcı, 2010).

Macroeconomic effects of renewable energy consumption have been studied in recent times. The relationship between renewable energy consumption and electronic growth constitute the foundation of these studies. Empirical studies that are conducted in this area present different results. In the literature, there are four hypotheses about this causality relationship.

The first one is the feedback hypothesis. This hypothesis is valid if there is a bi-directional causality relationship between economic growth and renewable energy consumption. Therefore, they are complementary to each other. This hypothesis is confirmed by Apegris and Payne (2012), Tuğcu et al. (2012), and Sebri and Ben Salha (2013).

The second one is the growth hypothesis. This hypothesis suggests a unidirectional causality relationship from renewable energy consumption to economic growth. This means that policies that limit renewable energy consumption will make a negative impact on economic growth. The findings that are reported by Bildirici (2013), Yıldırım et al. (2013) and Ben Aïssa et al. (2013) support this hypothesis.

The third hypothesis is the conversation of natural resources. This hypothesis implies that economic growth increases renewable energy consumption and the contrary is not valid. Therefore, an increase in economic growth will lead to an increase in renewable energy consumption as well. This hypothesis is supported by many studies, including Menyah and Wolde-Rufael (2010), Sadorsky (2009)

Finally, the neutrality hypothesis suggests that a change in one or two variables does not affect other variables, as reported in many studies including Menegaki (2011) and Bowden and Payne (2010).

Table 2 shows the studies that have been conducted on the causality relationship between economic growth and energy consumption in Turkey.

Table 2: Studies Conducted on the Causality Relationship between Economic Growth and Energy Consumption in Turkey

EC → EG	EG→ EC	EC ↔ EG	EC x EG
Murray and Nan (1996)	Lise and Van Monfort (2007),	Erdal et al. (2008)	Altınay and Karagöl (2004)
Soytaş et al. (2001)	Karanfil (2008)		Jobert and Karanfil (2007)
Soytaş and Sarı (2003)			Karanfil (2008)
			Soytaş and Sarı (2009)
			Halıcıoğlu (2009)
EG → EC = There is causality from economic growth to energy consumption..			
EC → EG = There is causality from energy consumption to economic growth..			
EC ↔ EG= There is a bidirectional causality.			
EC x EG = No causality relationship is found between energy consumption and economic growth.			

Although most of the studies examine the relationship between GDP and electricity consumption or the relationship between oil consumption and GDP, relatively few studies examine the relationship between renewable energy and GDP. Chien and Hu (2007, 2008) examined renewable energy consumption and technical efficiency in developing and developed countries. As a result of this study, they found that renewable energy consumption increases technical efficiency. According to the 2007 report of International Energy Agency (IEA), renewable energy grows by an annual average of 6.7% and will become the fastest growing energy component in the period of 2005-2030.

Bowden and Payne (2009) believes that the countries needs to apply the following policies in order to promote renewable energy and accept it as an available component of energy portfolio: renewable energy production tax credits, installation rebates for renewable energy systems, renewable energy portfolio standards, and establishment of markets for renewable energy certificates. As pointed out by Kaygusuz(2007), renewable energy models indicate a model, which not only suggest restriction of current energy consumption, but also promise a more environment-friendly energy industry. In addition, they establish that an environment-friendly energy industry promotes sustainable development as well.

In recent times, many studies have also been conducted to examine the causality relationship between energy consumption and economic growth. In their study, Sarı and Soytaş (2004) aims to examine to what extent the change in the increase of GDP can be explained with the consumption of different energy resources and employment in Turkey and contribute to the literature in relation to the impact of these factors on energy consumption and economic growth. In this study, where different energy consumption measures are examined in Turkey in the period of 1969-1999, the authors applied the general forecast error variance analysis. They concluded that considering the renewable energy resources the waste, hydraulic power and wood consumption explain approximately 17.3%, 10.6% and 3.5% of the variation in real GDP, respectively.

In subsequent studies, Ewing andSarı et al. (2007) examined monthly data for the United States over the period of 2001:1–2005:6 and used industrial production, employment, total energy consumption, fossil fuels, coal, conventional hydroelectric power, solar energy, wind energy, natural gas, wood, alcohol, geothermal and waste consumption data to estimate an ARDL model. In this study, they suggested that industrial production makes a positive impact on employment and a negative impact on the hydroelectric power, waste and wind energy consumption. On the other hand, solar energy consumption has a negative impact on industrial production and a positive impact on employment. The biomass energy makes no statistically significant impact on industrial production or employment.

In his study that covered annual data from the period of 1994–2003 in 18 developing countries, Sadorsky (2009) showed the bidirectional causality between renewable energy and economic growth by using a bivariate panel error correction model. They added renewable energy consumption and real GDP per capita to the model as variables.

Payne (2009) used the Toda–Yamamoto causality test within a multivariate model framework by including measures of capital and employment and analyzed the causal relationship between renewable and non-renewable energy consumption and real output in the US over the period 1949–2006. Upon the analysis of causality relationship between sectoral consumption of renewable energy and real output in the United States over the period 1949–2006, Bowden and Payne (2009) found that a unidirectional causality exists from residential renewable energy consumption to real output and there is no causality relationship between renewable energy consumption in the commercial and industrial sectors and real output. They used energy consumption, real GDP, employment, primary energy consumption in commercial sector and primary energy consumption in transport sector. The information that obtained about the estimated adjustment rate and demand management covering the behaviors of short-term fluctuations for all energy sectors offers a direct opportunity for producers and lawmakers who play a role in the energy market.

Apergis and Payne (2011) used a data of six Central American countries for the period of 1980–2006 to examine the renewable energy and economic and found that there is a bidirectional causality between growth and renewable energy in the short- and long-run. They used panel cointegration test in their model. They also used real GDP, renewable energy consumption, employment and real gross fixed capital formation as variables. They concluded that a 1% increase in renewable energy consumption increases real GDP by 0.244%; a 1% increase in real gross fixed capital formation increases real GDP by 0.194%; and a 1% increase in the employment increases real GDP by 0.783%. Another finding of this study is that there is a bidirectional causality relationship between renewable energy consumption and economic growth. As reported by Kaygusuz (2007), this proves that renewable energy serves as a catalyzer and promises not only decreasing the consumption, but also an environment-friendly energy sector that contributes to sustainable development.

3. Econometric Model

This study examines the relationship between renewable energy consumption and economic growth in Turkey. In their study, Soytaş et al. (2001) state that it is more appropriate to use the GDP value instead of the GNP as an indicator of economic growth since energy consumption is related to the goods and services that are produced within the borders of the country. In this study, they used the GDP values measured in constant 2005 US dollars based on the data set of World Bank (World Bank, 2014). The figures of combustible renewable energy resources and waste energy are also obtained from the data set of World Bank (World Bank, 2014). The data is annual and belong to the period of 1980-2013.

In this study, the "Granger Causality Test" is used in order to examine the causality relationship between economic growth and renewable energy consumption in Turkey (Granger, 1969). The Granger Causality Test is one of the most preferred methods in scientific studies due to its ease of implementation.

In the first stage of analyses conducted as part of this study, the authors made stationary tests and decided whether there is a time effect on the variables examined.

3.1. Unit root tests

In the analyses where time series is used, it is not true to start first with the solution of series directly. It is necessary to test in advance whether the series is stationary. A time series is stationary if its mean and variance do not vary over time and its common variance between two periods is dependent on the distance between these two periods only, not the period when this common variance is calculated (Gujarati, 1999, p. 713). In the study where they suggest that nonstationary time series which consistently deviates from its long-term mean generates standard deviation errors and has an infinite variance, Granger and Newbold (1974) emphasize that variables that are subject to a causality analysis are required to have a stationary structure (free from the time effect) (Granger and Newbold, 1974, p. 111-120). In this case, a result obtained through a regression analysis does not reflect the actual relationship. The studies that are conducted using nonstationary time series reflect the actual relationship only when there is a cointegration relationship between these series (Gujarati, 1999, p. 726). The unit root test is the most valid method that is used to determine the stationary level of a variable or whether or not it is stationary (Gujarati, 2001). In practice, the most commonly used unit root tests are the Dickey Fuller (DF), the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests. In this study, the Augmented Dickey-Fuller Test (ADF), developed by Dickey and Fuller in 1981, and the Phillips-Perron (PP) tests are used in order to determine whether or not the variables are stationary. The Akaike Information Criterion is used when determining the optimal lag number in the GDF method and the Newey-West Bandwidth is used in the PP test. For the ADF test, the following equation should be estimated:

$$\Delta \boldsymbol{Y_t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 t} + \boldsymbol{\delta Y_{t-1}} + \boldsymbol{a_i} \sum_{i=1}^{m} \Delta \boldsymbol{Y_{t-i}} + \boldsymbol{\varepsilon_t} \quad \textbf{(1)}$$

where Δ is the first difference operator, t is the time trend, $\boldsymbol{\varepsilon_t}$is the error term, and $\boldsymbol{Y_t}$ is the series used. Also, m is the number of lags of the dependent variable that is determined by the Akaike Information Criterion to eliminate consecutive dependency of the error term. Here the null hypothesis is set up as $\boldsymbol{\delta = 0}$, meaning that unit root exists and time series is not stationary. The null hypothesis is rejected if the $\boldsymbol{\delta}$ statistic is non-zero in a statistically significant way (M. Mucuk and V. Alptekin, 2008: 164).

Significance of the $\boldsymbol{\delta}$ coefficient is tested through t coefficients. However, the t values obtained here do not have traditional normal distribution. To that end, critical values developed by MacKinnon can be used. If the t values obtained are smaller than absolute value of MacKinnon's critical values in terms of absolute value, the null hypothesis is not rejected. In other words, the series has a unit root and therefore is not stationary. This shows us that there is no stability in the levels of series and the same test is applied to the first difference of the series or if necessary to the difference at higher levels. If the results we obtained are greater than the absolute value of such critical values, then the null hypothesis is rejected and this represents that the series is stationary.

3.2. Cointegration Test

The second stage, which is commonly seen in time series analyses, is the cointegration test where the existence of long-term relationship between the examined variables is questioned.

The concept of cointegration is the long-term common movement between economic variables. Technically, it can be seen that the variables have unit root, i.e. I(1), according to Engle-Granger (1987). Despite being nonstationary in their levels, linear combination of the series can be stationary. Thus, linear combination of two series eliminates the stochastic process in the series. In this case, the obtained regression is not a spurious regression, but a significant one (Çetintaş, 2004, p.26).

In order to be able to form cointegration relationship, each variable should be subject to integration from the same level. If the mean, variance and autocovariance of a time series are time invariant and finite, this time series is called autocovariance stationary. If variable becomes stationary after being differenced *d* times, such variable is integrated of order *d*. When at least one cointegration relationship is obtained in the cointegration analysis, stability of coefficients that are estimated from such cointegration relationship is significant to show whether such relationships are always valid (Doğan, 2005: 113).

Since it is possible to determine n-1 cointegrated vectors in the systems of equations, here is the question: Is it better to have more or less cointegrated vectors? It is not easy to find a general answer to that question. Cointegrated vectors can be considered as "representing the constraints placed by the economic system on the long-term movements of variables in the system". Therefore, the more cointegrated vectors exist, the more steady the system is (Şıklar, 2000, p.29).

In this study, the Johansen Cointegration, developed by Johansen (1988) and Johansen and Juselius (1990), is used in order to test whether there is a cointegrated relationship between the GDP and renewable energy consumption series.

3.3. Causality test

If there is cointegration between the series, then there exists causality between these variables at least in one direction (Granger, 1988). In this study, The Granger Causality Test, developed by Granger (1986) and Engle and Granger (1987), is used in order to analyze the direction of relationship between the series.

The Granger Causality Test is one of the most preferred methods in scientific studies due to its ease of implementation. The Granger Causality is used in order to establish the existence of relationship between the variables that are questioned on whether they have a relationship, and to determine the direction of relationship, if any, and it is tested through the following equations.

$$\boldsymbol{Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_{1t}} \quad \textbf{(2)}$$

$$\boldsymbol{X_t = \sum_{i=1}^{m} \theta_i X_{t-i} + \sum_{i=1}^{m} \gamma_i Y_{t-i} + \varepsilon_{2t}} \quad \textbf{(3)}$$

where $\boldsymbol{\alpha_i}$, $\boldsymbol{\beta_i}$, $\boldsymbol{\theta_i}$ and $\boldsymbol{\gamma_i}$ represent lagged coefficients, m is the common lagged level for all numbers, and $\boldsymbol{\varepsilon_{1t}}$ and $\boldsymbol{\varepsilon_{2t}}$ are the uncorrelated white noise processes. (White noise: This process has zero mean, a constant variance of $\boldsymbol{\delta}^2$and autocorrelation)

The Granger Causality Test is made by testing whether the coefficients of lagged values of independent variable that is before the error terms in equations **(2)** and **(3)** are equal to zero. The hypothesis is set up in a bilateral way and whether the causality is reciprocal or unilateral is determined (Uzunöz and Akçay, 2012: 8 – 9). In case the $\boldsymbol{\beta_i}$ values are significantly different from zero, it is stated that $\boldsymbol{X_t}$causes$\boldsymbol{Y_t}$and expressed as "$\boldsymbol{X_t}$is the Granger cause of $\boldsymbol{Y_t}$". This situation is defined as "unidirectional causality from $\boldsymbol{X_t}$to $\boldsymbol{Y_t}$". In case the $\boldsymbol{\gamma_i}$ value is significantly different from zero, it is considered as "$\boldsymbol{Y_t}$causes$\boldsymbol{X_t}$". This situation is explained as "$\boldsymbol{Y_t}$is the Granger cause of $\boldsymbol{X_t}$" and defined as "unidirectional causality from $\boldsymbol{Y_t}$to$\boldsymbol{X_t}$". If both conditions are available and both $\boldsymbol{\beta_i}$ and $\boldsymbol{\gamma_i}$ are significantly different from zero, it is expressed as "$\boldsymbol{X_t}$is the Granger cause of $\boldsymbol{Y_t}$and vice versa". This expression is defined as "*bidirectional causality*". If both conditions are not available and both $\boldsymbol{\beta_i}$ and $\boldsymbol{\gamma_i}$ are not significantly different from zero, this means that the two variables are not the cause of each other. This is explained as "$\boldsymbol{X_t}$and $\boldsymbol{Y_t}$ are independent of each other".

3.4. Estimation Results

The data used in this study are obtained from the World Bank. The Granger Causality Test is performed using the GDP data measured in constant 2005 US dollars over the period 1980-2013 and the data of combustible renewable energy resources and waste energy consumption over the period 1980-2013.

In the study, the minimum Akaike Information Criterion (AIC) is considered when determining the lag length for the Granger Causality Test. The analyses are performed using the E-views 7.0 software package.

3.4.1. Unit root test

Table 3: ADF Test Results for Level Values

	CRITICAL VALUES			ADF(t)	LAG
Variables	Significance Level of 1%	Significance Level of 5%	Significance Level of 10%	ADF (prob)	Length
loggdp	-3.646.342	-2.954.021	-2.615.817	-0.683234	0
(intercept)				0.8374	
loggdp	-3.048.514	-3.552.973	-3.209.642	-4.262.735	0
(trendand				0.1351	
intercept)					
loggdp	-3.653.730	-2.957.110	-2.617.434	-6.307.423	1
(intercept)				0.0000	
loggdp	-4.273.277	-3.557.759	-3.212.361	-6.230.929	1
(trendand				0.0001	
intercept)					
logren	3.417.722	-3.661.661	-2.960.411	-2.619.160	0
(intercept)				1	
logren	-4.284.580	-3.562.882	-3.215.267	0.445626	0
(trendand				0.9986	
intercept)					
logren	-3.661.661	-2.960.411	-2.619.160	-5.328.278	1
(intercept)				0.0001	
logren	-4.284.580	-3.562.882	-3.215.267	-7.324.457	1
(trendand				0.0000	
intercept)					

The logarithm of the gross domestic product (GDP) is taken. Similarly, the logarithm of the data of combustible renewable energy and waste energy, which is used instead of renewable energy consumption, is taken. No seasonality problem is experienced since the data that is obtained for two variables used are annual data. Both variables are nonstationary at their levels. First difference of both series is taken. The lag length is determined using the Akaike Information Criterion.

Table 4: ADF Test Results for First Difference Values

	CRITICAL VALUES			ADF(t)	LAG
Variables	Significance Level of 1%	Significance Level of 5%	Significance Level of 10%	ADF (prob)	Length
Δloggdp	-3.653.730	-2.957.110	-2.617.434	-6.307.423	0
(intercept)				0.0000	
Δloggdp	-4.273.277	-3.557.759	-3.212.361	-6.230.929	0
(trendand				0.0001	
intercept)					
Δloggdp	-3.661.661	-2.960.411	-2.619.160	-9.644.502	1
(intercept)				0.0000	
Δloggdp	-4.273.277	-3.557.759	-3.212.361	-6.230.929	1
(trendand				0.0001	
intercept)					
Δlogren	-3.661.661	-2.960.411	-2.619.160	-5.328.278	0
(intercept)				0.0001	
Δlogren	-4.284.580	-3.562.882	-3.215.267	-7.324.457	0
(trendand				0.0000	
intercept)					
Δlogren	-3.679.322	-2.967.767	-2.622.989	-6.808.111	1
(intercept)				0.0000	
Δlogren	-4.309.824	-3.574.244	-3.221.728	-6.727.033	1

(trendand				0.0000	
intercept)					

Table 5: The Table of Statistics Created for Determining Appropriate Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	80.69187	NA*	4.87e-06*	-6.557656*	-6.459484*	-6.531611*
1	81.44610	1.319907	6.39e-06	-6.287175	-5.992662	-6.209041
2	84.76937	5.261838	6.83e-06	-6.230781	-5.739925	-6.100556
3	86.84646	2.942556	8.20e-06	-6.070539	-5.383341	-5.888225
4	89.90404	3.821968	9.25e-06	-5.992003	-5.108463	-5.757600
5	94.28572	4.746826	9.62e-06	-6.023810	-4.943928	-5.737317
6	98.37832	3.751545	1.07e-05	-6.031527	-4.755302	-5.692944
7	101.1594	2.085817	1.40e-05	-5.929951	-4.457383	-5.539278
8	111.6276	6.106422	1.07e-05	-6.468963	-4.800054	-6.026201

***** The lag length selected by criteria
LR: LR test statistic
FPE: Final PredictionError
AIC: Akaike Information Criterion
SC: Schwarz Information Criterion

3.4.2. Cointegration test

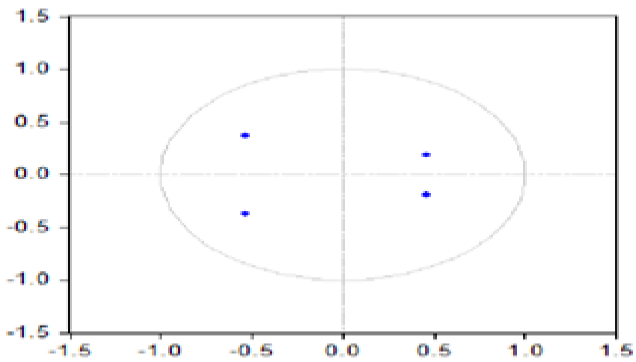
After the appropriate lag length is determined, the Johansen Cointegration Test is applied in order to examine long-term relationships of the series. Table 6 shows the test results. According to the trace statistics in the top panel and Max-Eigen statistics in the bottom panel of Table 6, two cointegrated relationships are identified between these two series. Accordingly, there are two cointegration vectors between the gen and ren series. In other words, the series moves together towards two balance values in the long term.

Table 6: Results of Cointegration Test

Hypotheses	Eigenvalue	Trace Statistic	Critical Value AT 0,05	Prob Value**
NONE*	0.661630	5.990.132	1.839.771	0.0000
AT MOST 1	0.572022	2.630.920	3.841.466	0.0000
The trace statistic indicates 2 cointegration at the 0.05 level.				
* denotes rejection of the hypothesis at the 0.05 level.				
** MacKinnon-Haug-Michelis (1999) p-values				
Hypotheses	**Eigenvalue**	**Trace Statistic**	**Critical Value AT 0,05**	**Prob Value****
NONE*	0.661630	3.359.212	1.714.769	0.0001
AT MOST 1	0.572022	2.630.920	3.841.466	0.0000
The Max-eigenvalue statistic indicates 2 cointegration at the 0.05 level.				
* denotes rejection of the hypothesis at the 0.05 level.				
** MacKinnon-Haug-Michelis (1999) p-values				

3.4.3. Eigenvalue test

Once the model is estimated, it is required to perform tests of error terms and to test whether the estimated model has a stable structure (Uzunöz and Akçay, 2012: 8 – 10). The stability of the model depends on eigenvalues of the coefficient matrix. If all eigenvalues of the coefficient matrix are inside the unit circle, the system is stable (Hendry and Juselius, 2000: 10). Graphic 1 shows the eigenvalues and the unit circle and it is observed that all eigenvalues are inside the unit circle. Accordingly, the established system is stable.



Graphic 1: Eigenvalue Graphic

Table 7: Eigenvalue Test

Root	Modulus
-0.531028 - 0.369352i	0.646847
-0.531028 + 0.369352i	0.646847
0.458387 - 0.190395i	0.496356
0.458387 + 0.190395i	0.496356
No rootliesoutsidetheunitcircle.	
VAR satisfiesthestabilitycondition.	

3.4.4. Grangercausality test

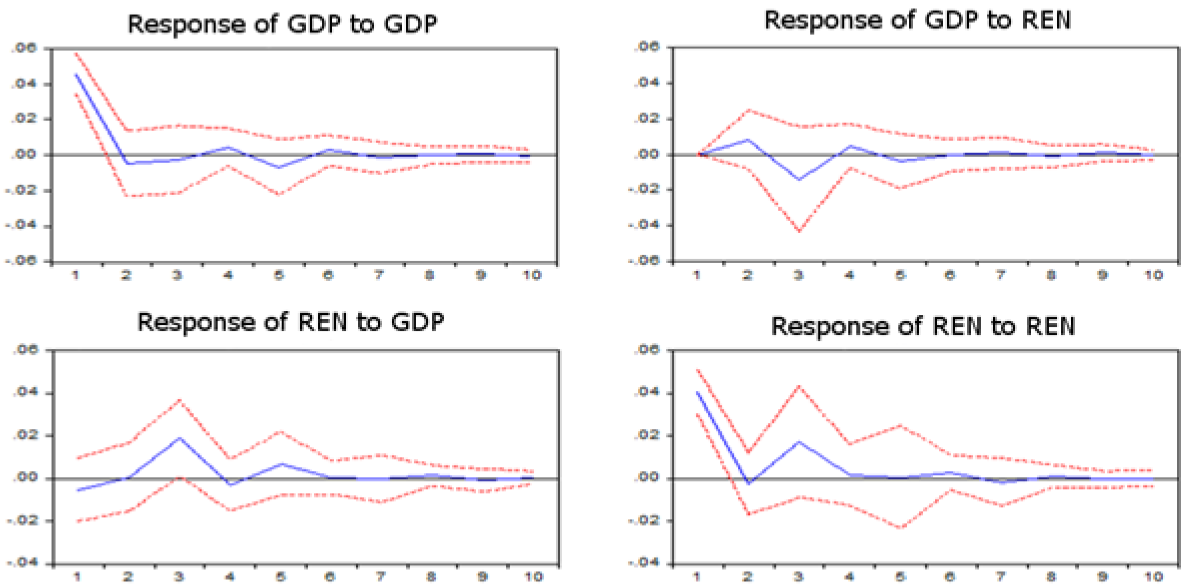
The results of Causality Test in the Table 8 show that there is a unidirectional causality between GDP and REN. Considering the probability values, the probability of REN being the Granger cause of GDP is greater than the critical value, 5% and thus the null hypothesis is accepted. Since the probability of GDP not being the Granger cause of REN is smaller than the critical value, 5%, the null hypotheses is not accepted. According to this result, an increase in the gross national product increases the renewable energy consumption.

Table 8: Table of Granger Causality Test

Null Hypothesis (H0)	Number of Observations 30	F-Statistic Value	Probability Value
REN is not the Granger cause of GDP		0.71201	0.5003
GDP is not the Granger cause of REN		3.52774	0.0447

3.4.5. Impulse-Response Functions

The impulse-response functions allow us to determine the effects on other variables of any standard deviation shocks that will occur in any variables that are included in the VAR model and considered internal for the model. The graphics of impulse-response graphics that are defined for each variable are provided in Graphic 2. The Cholesky decomposition, which is used in the estimation of models, is provided at the top of figures. The standard error bands of ±2 are included in the projections for the change that each shock will create.



Graphic 2: Graphics of Impulse-Response Functions

Table 9: Tables of Impulse-Response Functions

	Responses of GDP	
Period	Response of GDP to GDP	Response of GDP to REN
1	0.045531	0.000000
	(0.00588)	(0.00000)
2	-0.004907	0.008221
	(0.00918)	(0.00821)
3	-0.002573	-0.013928
	(0.00951)	(0.01473)
4	0.004410	0.004563
	(0.00529)	(0.00622)
5	-0.006727	-0.003963
	(0.00774)	(0.00765)
6	0.002532	-0.000561
	(0.00432)	(0.00449)
7	-0.001643	0.000850
	(0.00436)	(0.00444)
8	-0.000254	-0.001250
	(0.00250)	(0.00309)
9	0.000532	0.000784
	(0.00235)	(0.00242)
10	-0.000617	-0.000339
	(0.00168)	(0.00141)
	Responses of REN	
Period	Response of REN to GDP	Response of REN to REN
1	-0.005245	0.040206
	(0.00737)	(0.00519)
2	0.000549	-0.002455
	(0.00806)	(0.00725)
3	0.018846	0.016979
	(0.00893)	(0.01303)
4	-0.003208	0.001677
	(0.00606)	(0.00726)
5	0.006895	0.000557
	(0.00745)	(0.01199)
6	0.000249	0.002761
	(0.00397)	(0.00407)
7	-0.000240	-0.001775
	(0.00553)	(0.00562)
8	0.001283	0.001006
	(0.00239)	(0.00270)
9	-0.000941	-0.000415
	(0.00267)	(0.00189)
10	0.000478	-0.000130
	(0.00142)	(0.00192)
Cholesky Decomposition: DLOGGDP DLOGREN		
Standard Errors: Analytical		

Graphic 2 shows the response of GDP and REN to a standard deviation shock in GDP in the section "Responses of GDP. Likewise, the section "Responses of REN" shows the response of GDP and REN to a standard deviation shock in REN.

4. Conclusion

Economic growth occurs through production. Energy is the most important component required to make production. The energy resources are not equally distributed in the world. Therefore, some countries are in an advantageous position due to their geographical location. Fossil energy resources are the most used energy resource in the world. Fossil energy resources are finite, nonrenewable and harmful to the environment. Countries have become dependent on other countries due to excessive use of fossil energy resources. In order to achieve their steady economic growth target, the countries need to diversify their energy resources. On the other hand, ecological problems that occur because of over-use of fossil energy resources have led the countries to find new, local and clean resources and get higher efficiency from their currently used energy resources.

Turkey is a foreign-dependent country in terms of energy. The most important reason for this dependency is the energy. In Turkey, the approximate share of local resources in total energy consumption is only 26%. Although recent steps have increased the share of local resources, this increase is not significant. As a foreign-dependent country, ever-increasing energy need of Turkey necessitates energy import. The share of natural gas in electricity generation is greater than 47%. Foreign dependency rate in natural gas is around 98%. A portion of the imported natural gas is offered for public use. The energy demand increases, while local energy demand does not increase. Thus, this situation poses problems in macroeconomic and microeconomic aspects. Also, heavy use of fossil resources may cause penal economic sanctions that may be imposed on carbon emissions in following years. With the effective use of renewable energy resources, new business lines will be created, dependency will be decreased, potential penal economic sanctions related to carbon emissions will be prevented and it will be possible to establish a ground to present renewable energy resources as an alternative to fossil resources.

This study empirically examines the causality relationship between economic growth and renewable energy. In this study, the GDP figures measured in constant 2005 US dollars based on the data set of World Bank (World Bank, 2013) are used. The figures of combustible renewable energy resources and waste energy are also obtained from the data set of World Bank (World Bank, 2013). The data is annual and belong to the period of 1980-2013. The finding of this study suggests that there is a causality relationship running from renewable energy consumption to economic growth. This relationship is accepted as the growth hypothesis. This hypothesis implies that policies that limit renewable energy consumption will make a negative impact on economic growth. Bildirici (2013), Yıldırım et al. (2013) and Ben Aïssavd (2013) reached similar findings that support this hypothesis.

5. Conflict of Interest

This article is derived from the master's thesis written by second author under the counseling of first author.

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