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Economic Growth, CO_2 Emissions and Energy Consumption: The Turkish Case

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ABSTRACT: In recent years due to factors, such as increases in greenhouse and carbon dioxide (CO_2) emissions, global warming and climate changes has become a major threat for all countries. So in order to prevent this increased environmental pollution and degradation CO_2 emissions must be reduced. This study examines economic growth, CO_2 emissions and energy consumption relationship in Turkey by using cointegration test. For this purpose 1960-2010 periods taken and annual data of Gross Domestic Product (Y), Carbon Dioxide Emissions (CO) and Energy Consumption (EC) are used. The obtained empirical results from this paper indicated that CO_2 emissions effect negatively economic growth while energy consumption effect positively it.

Keywords: Economic Growth; CO_2 Emissions; Energy Consumption; Turkey; Cointegration Test.
JEL Classifications: F43; Q43; Q56

1. Introduction

The ultimate goal of an economy is to achieve the desired level of economic growth and development and to maintain at this level. Countries meet with a number of difficulties during economic growth and development. One of the most important of these is the damage on environment and environmental pollution. A large portion of the world's energy need is met through fossil fuels the reserve of which is rapidly running out. The gas emissions from these sources increase the amount of carbon dioxide which harms the green space as well as inflicting irreparable damages on the atmosphere. It in turn leads to extremely risky climate changes such as drought, floods, tornadoes, rising sea levels, and melting of glaciers. Global warming and climate change have been one of the most crucial environmental problems in recent years for both developed and developing countries. Increase in global trade and travel, and a rapid surge in economic activities all around the world have caused a significant increase in carbon dioxide (CO_2) emission. Heavy use of energy and other natural resources and waste cause environmental deterioration. There have been debates for quite some time on the relationship between economic growth and development and environmental quality. Experts have been trying to explain this relationship between economic growth and environmental pollution with the Environmental Kuznets Curve (EKC) in recent years. According to EKC hypothesis, the income growth from industrialization will cause both income inequality and environmental damage in the initial stage of the economic development process but this trend will be reversed in further phases when a certain income level is achieved.

This paper attempts to investigate empirically the long-run effect of carbon emissions and energy use on economic growth in Turkey over the period 1960-2010. The structure of this paper is organized as follows: In section II presents theoretical framework, literature and empirical studies. Section III presents the data and methodology used. Empirical results are discussed in Section IV. The final section draws some concluding remarks and suggestions.

2. Theoretical Framework and Literature

The status of natural resources and environment in a country depends on several factors (Panayotou, 1993:2): The size of economy or level of economic activity, sectoral structure of economy, level of technology, environmental characteristics, impacts of environmental preservation and environmental spending. A larger economy (when measured by Gross National Product –when other factors are equal-) leads to rapid depletion of natural resources and a higher level of pollution. The mode and level of the depletion and pollution of resources also depends on the sectoral structure of economy. Economies that are heavily dependent on agriculture and basic industry are prone to suffer damages due to factors causing rapid depletion of resources such as soil erosion and low industrial pollution rates. Industrial countries that had the problem of depleting their rural resources have gradually become places that suffer from urban pollution and density. However, this trend is affected by two factors (Panayotou, 1993:2):

- The unbalanced structural changes in employment in proportion to product that so majorly protects a large number of people in rural areas depend on sectors that emerge due to unsustainability of resource use and inflicted damage on forests and which have diminishing resources as a result.
- Materials both causing raw material and environmental pollution and the environmental shadow role of rural resources due to urban sectors (like acid rain inflicting damage on forestry and plants).

Energy production and consumption, energy density, the status and price of energy all play a crucial role in the development trend of CO_2 emission. In this sense, it acts as an engine of industrial development and economic growth. Therefore, a country with heavy consumption of energy is thought to also have a high life standard. However, high energy consumption causes high carbon emission which has a reverse effect on the environment (Alkhathlan and Javid, 2013:1525). The constantly rising amount of CO_2 and its repression on the greenhouse effect shows the gravity of this problem. Academicians and policy-makers have a consensus on the necessity of reducing the emission of greenhouse gas to mitigate global warming (Zhang and Cheng, 2009:2706).

Economic growth has a balancing effect on air pollution, hence the devastating effects and adversities it causes on the environment. Certain materials that cause environmental pollution are at the same time a natural byproduct of economic activities such as electricity generation and use of motor vehicles. Emission of said pollution factors tend to increase with the expansion of economic activities. On the other hand, companies and households can control their own pollution to a certain extent with their choices of technology. Clean technologies generate less pollution per unit and members of society can focus their demands on a healthier and more sustainable environment. In this case, the government can resort to implementing more strict environmental controls (Grossman and Krueger, 1991:6-7).

As the economy grows, it is likely that environmental degradation and climate change will have detrimental effects on the natural order, people, economies, and infrastructure. The negative relationship between economic growth and environmental degradation necessitates environmental policy reactions and strategies on a local, regional, national, and global scale. The threat of climate change caused by the increased accumulation of greenhouse gas in the atmosphere has led to an increase in policy analyses on climate change as well as the amount of theoretical and empirical models that reveal the inverted-U relationship, namely EKC, between economic growth and pollution (Auci and Trovato, 2011:2).

There are three basic subjects being focused on in literature regarding the relationship between economic growth and environmental pollution. The first one focuses on the relationship between environmental pollution and economic growth and it is about the validation tests of the Environmental Kuznets Curve hypothesis. The second one concentrates on the relationship between economic output and energy consumption. The third and last one focuses on the output-energy or output-pollution relationship (Zhang and Cheng, 2009:2706; Acaravci and Ozturk, 2010).

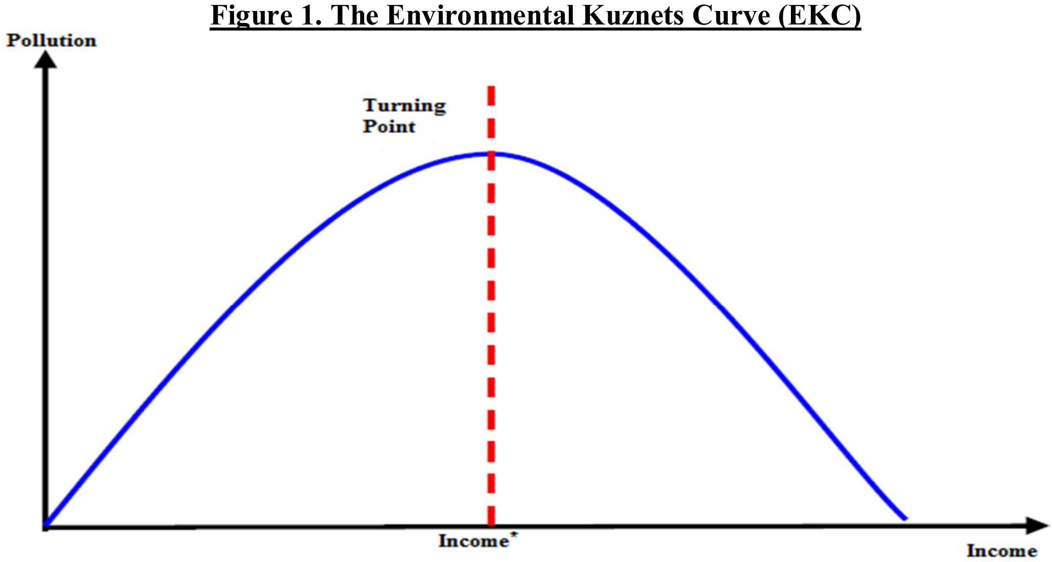
The inverted-U put forward by Grossman and Krueger (1991) in 1991 regarding the relationship on economic growth and environmental quality was named as the Environmental Kuznets Curve (EKC) by Panayotou (1993) and has been continued from then on (Chen, 2007:02). According to EKC, after economic growth reaches a certain level, it will remedy the environmental effects of the initial stages of economic development and compensate for it (Sun, 1999:692).

According to EKC hypothesis, the relationship between Gross Domestic Product (GDP) per capita and pollutant emissions per capita is in the shape of an inverted-U. It shows that economic growth may benefit environmental quality after a certain point (Niu and Li, 2014:318). EKC can also be explained with the following factors (Stern, 2003:3);

- Production scale input rates refer to production expanding with production range and status of technology.
- Different industries have different levels of pollution intensity and typically production range varies during the course of economic development.
- Changes in input variety lead to substitution of more harmful inputs by less environmentally harmful ones (or vice versa).
- Certain emission changes in input per unit may result with less pollution due to developments in technology.

The EKC hypothesis suggests that increase in pollution will initially develop a country's industry and then it will be reduced after a certain economic development level is reached. Therefore, environmental damage is inevitable at the first stages of economic development and for this reason countries are obliged to endure it until the reversing effect. This situation is seen in Figure 1 below (Shahrin and Halim, 2007:2):

Figure 1. The Environmental Kuznets Curve (EKC)



Source: Shahrin and Halim (2007:2)

The level of environmental pollution in a region is affected by both the pollution emitted throughout that region and by natural factors like the status of soil, topography, and air. These factors can be named as the sub-determinants of environmental quality. Pollution intensity of GDP depends of two impacts. Pollution-generating works on the one hand and reducing and cleaning works on the other. Actual emission and thus the pollution intensity of GDP emerge as a result of these two opposite effects. While the rate of emission generation depends on reduction efforts, the generation pollution depends on GDP composition. Therefore, these two terms can be referred to as Composition Effect (C) and Abatement Effect (A). It is obvious that GDP per unit area represents Scale Effect (L) (Islam et al., 1999:3-4).

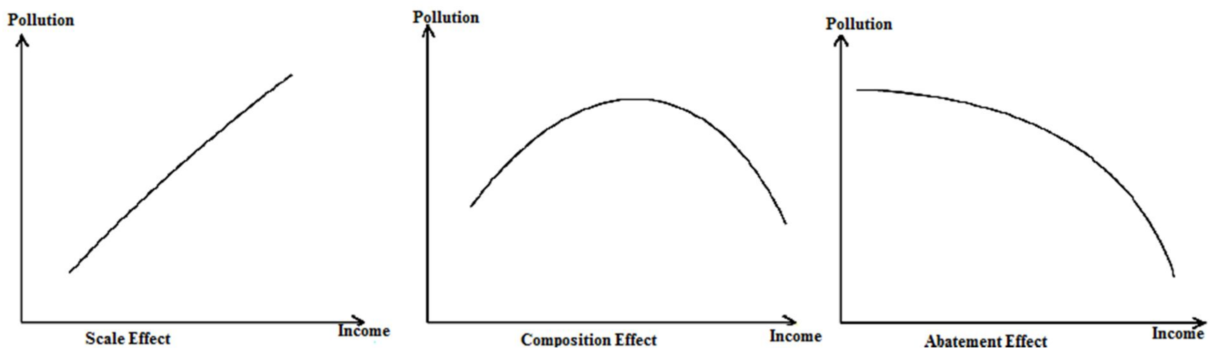
There are three crucial impacts on determination of environmental pollution levels and use of resources (Tsurumi and Managi, 2010:19-20): The first one is the case that increase in output will require more entry and more emission as a byproduct. For this reason, economic growth acts as a scale and creates a negative effect on the environment. Economic growth may have positive or negative effects on the environment with a technical impact. Changes in income or preferences cause policy differences that bring out changes in production methods and later in per unit emission of the output. It shows that the relationship between income and pollution will be different with pollutants. Because they do not inflict the same perceived damage. Economic growth may have a positive or negative impact on the environment through a composition effect. As the income increases, the structure of economy may change and consequently there may emerge an increase in the activities of cleaners or pollutants. The net effect of these three impacts raises the EKC.

Scale Effect represents income as an indicator level of economic activities. Higher economic activity per capita or per region will likely cause a higher level of pollution. It manifests a monotone increasing relationship between income and pollution (Islam et al., 1999:4-5). When a country industrializes, the scale effect will take place and pollution will increase (Shahrin and Halim, 2007:3). As the accordingly increasing production and consumption will cause a rise in damages on the environment, the economic growth will have a negative environmental impact (Everett et al., 2010:20).

The production composition changes over the course of the growth path. Initially, economic growth leads to industrialization and balance of goods switches from agriculture to manufactured goods which increases environmental damage. However, this balance later switches from production of manufactured goods to services. The level of environmental damage reduces due to both demand-side and supply-side changes (Everett et al., 2010:20). The Composition Effect is based on the relationship between economic structure and income level. The studies led by Kuznets and further developed by others have shown that an economic structure bounded by the sectoral composition of output and employment develops predictably with a rise in income. A country's income scale also increases with the transformation of its economy's structure. This transformation represents the basic process of industrialization. It is usually revealed through the share of industry in the country's production. This share may increase or decrease the levels in initially from pre-industry to industry and then in phases of post-industry development. Secondly, industry as a production sector may lead to more pollution and more resource consumption than agriculture or service sector. When we combine these narratives, we can have the inverted-U curve that puts forward the relationship between pollution and income level (Islam et al., 1999:5).

Abatement Effect, on the other hand, reveals both the supply-side and demand-side impacts. In low income levels, people are more concerned with obligatory material needs and have less interest in environmental quality. However, as the income level rises they undertake less responsibility with the repression of material needs and assess the value of environmental quality better and then demand it later. This effect gives us the relationship between pollution and income after income reaches a certain level and a curve in the shape of an inverted-U emerges (Islam et al., 1999:5). Abatement effect comes in when advanced companies invest in equipment and technology that will reduce pollution (Shahrin and Halim, 2007:3). These varied impacts of income on pollution are shown in Figure 2:

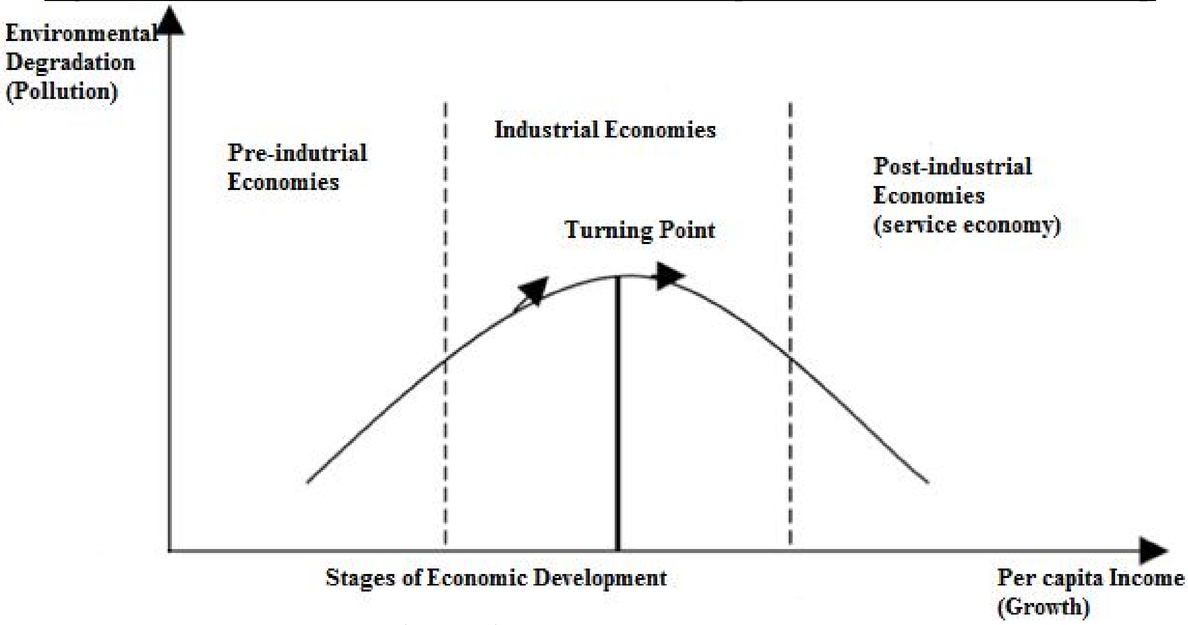
Figure 2. Different Effects of Income on Environment



Source: Islam et al. (1999:36).

Both the extent and intensity of environmental degradation in lower stages of development is confined with the impact of economic activities on resource demand and the amount of recycled waste. Depletion of resources and waste production increases as industrialization decreases and resource discovery and agricultural activities intensify. In higher stages of development, structural changes towards knowledge-based industry and services as well as more efficient technologies and demand for environmental quality become horizontal and the reduction in environmental degradation takes on a more stabilized course. This is shown in Figure 3 (Panayotou, 2003:45-46).

Figure 3. The Environmental Kuznets Curve: A Development-Environment Relationship



Source: Panayotou (2003:46).

Upon examination of Figure 3, it can be seen that the issue of environmental degradation first goes through a monotone increase and then decreases in the same monotonic way. Seen in the development path of a country, it has grave effects on policy. The monotone increase in environmental degradation brought on by economic growth requires strict environmental regulations. On the other hand, the monotone decrease in environmental degradation requires policies that accelerate economic growth which does not necessitate open environmental policies and leads to rapid environmental improvement. If economic growth actually slows down, it may cause adverse effects which may slow down environmental development.

Jaunky (2011) examines the relationship between the EKC hypothesis test and carbon dioxide emission and income, using data from 1980-2005 on 36 countries with high income levels. The study applies panel data, unit root, and co-integration tests and concludes that there is a unidirectional causation in both long and short term from per capita reel GDP to CO_2 emission. Consequently, a 1% increase in GDP causes a 0.68% rise in CO_2 in the short term and 0.22% in the long term. Alarm et al. (2012) researched into the existence of a dynamic causation between energy consumption, electricity consumption, carbon emission and economic growth in Bangladesh using the bivariate Johansen co-integration model and Granger causation tests. According to results, there is a bidirectional lo9ng-term causation relationship between electricity consumption and economic growth while there is a unidirectional causation relationship between energy consumption and economic growth both in the long and short terms yet there is no short term causation relationship. Karakas (2014) researched into the relationship between the national income and CO_2 emission of 44 countries, 22 in OECD and 22 outside OECD, using data from 1990-2011. In consequence of the panel data analysis, it has been concluded that there is a strong relationship between national income, CO_2 emission and the inverted-U EKC of these 44 countries.

Boopen and Vinesh (2011) examined the relationship between CO_2 emission and economic growth for the Republic of Mauritius. According to the research, the CO_2 curve and GDP time path present a strong similarity. Flexibility of emission on income increases over time. The EKC test for 1975-2009 could not prove any existence of a reasonable turning point and hence any existence of an inverted-U shaped EKC. It has been asserted that with the increase in GDP; degradation costs, economic activities and human activities have increasingly negative environmental effects on the country. Using energy use, economic growth and carbon emission data from 1985-2010, He et al. (2012) examined the direction and existence of the Granger causation relationship between energy consumption, economic growth, and direct foreign investments in China. Accordingly, there is a unidirectional causation from GDP to energy use and direct foreign investments and also a unidirectional causation from energy consumption to direct foreign investments. Necessity has been emphasized on policies that will provide guidance for domestic and foreign capital flows, technological advances, and the optimization of industrial structure. Using the limit test, Zhai and Song (2013) researched the causation relationship in China between economic growth, energy structure, R&D investments, and carbon emission. According to the findings, the impact of economic growth and R&D investments on carbon emission is statistically insignificant both in the long term and short term. Carbon emissions have a positive impact on economic growth in short-term and long-term relationships. However, the decrease in energy structure will lead to a reduction of carbon emission which will increase economic growth both in the long term and short term. Using a panel, Zeshan and Ahmed (2013) examined the relationship between energy, environment, and growth in 1980-2010 for 5 South Asian countries consisting of Bangladesh, India, Pakistan, Sri Lanka, and Nepal. The conclusion they reached shows that a 1% rise in energy consumption increases economic growth by 0.81% while a 1% rise in CO_2 increases growth by 0.17% in the long term. Ozturk and Uddin (2012) examined the long-term Granger causation relationship between energy consumption, carbon emission, and economic growth in 1971-2007. They reached the conclusion that a high level of economic growth will lead to a high level of energy consumption (or vice versa) due to the causation relationship between energy consumption and economic growth. Azomahou and Phu (2001) examined the empirical interaction between economic growth and greenhouse gas emission using panel data. The findings showed that the process of economic growth has a negative impact on greenhouse gas emissions particularly in later stages of the development.

Ozturk and Acaravci (2010) examined the long-term Granger causation relationship between economic growth, carbon emissions, energy consumption and employment in Turkey in 1968-2005 by using lag bounds testing. According to the their research, existence and direction of Granger causality show that neither carbon emissions per capita nor energy consumption per capita cause real GDP per capita but employment ratio causes real GDP per capita in the short run and EKC hypothesis at casual framework is not valid in Turkish case. Kaplan et al. (2011) examined the casual relationship between energy consumption and economic growth in Turkey in 1971-2006 by using two multivariate models and Granger causality tests. According to their results, an increase in energy consumption directly affects economic growth and that vice versa. Ozturk and Acaravci (2013) examined the causal relationship between financial development, trade, economic growth, energy consumption and carbon emissions in Turkey in 1960-2007. According to their results, an increase in foreign trade to GDP ratio results an increase in per capita carbon emissions and financial development variable has no significant effect on per capita carbon emissions in the long-run. These results also support the validity of EKC hypothesis in Turkey. Shahbaz et al. (2013) examined an empirical investigation between carbon emissions, energy intensity, economic growth and globalization in Turkey in 1970-2010. According to the results of this paper, economic growth can be boosted at the cost of environment. The results also validated the presence of EKC. Ozturk et al. (2013) examined the short-run and long-run relationship and causality between energy consumption and economic growth in Turkey in 1960-2006 by using Johansen and Juselius cointegration method and vector error correction models. According to the results of this paper, there is no short-run causality in both energy consumption and GDP models. The results also confirmed that there is unidirectional long-run causality among variables of interests and the direction of long-run causality is running from per capita GDP to per capita energy consumption. Gojayev et al. (2012) researched the relationship between economic growth, carbon emission, and energy consumption in Turkey in 1970-2007. The findings revealed that energy saving policies would have an opposite effect on economic growth and are not enough for reduction of environmental pollution in a setting where reductions on energy consumption hamper economic growth. However, controlling carbon emissions is likely to have the desired effect on real growth.

3. Data and Methodology

The variables used in this study are Energy Consumption (EC) which is measured in kg of oil equivalent per capita, CO2 emissions measured in metric tons per capita and GDP per capita measured in constant US$. These variables come from the World Development Indicators of World Bank (WDI, 2010). The annual data are selected to cover the period from 1960 to 2010.

In this study we employ the Augmented Dickey-Fuller (hereafter, ADF) unit root test to examine for the stationarity of variables. The regression models of the ADF unit root test below:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

where a_0 is intecept, t is linear time trend, k is the number of lagged first differences, and ε_t is error term. The null hypothesis is unit root and the alternative hypothesis is level stationarity. (Enders, 2004:183). If the coefficient of the lag of y_{t-1} (γ) is significantly different from zero, then the null hypothesis is rejected.

Johansen (1988) and Johansen and Juselius (hereafter, JJ) (1990) maximum likelihood (ML) procedure is a very popular cointegration test and useful method to determine the long-run relationship among nonstationary variables. The model is based on the error correction representation given by

$$\Delta X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t$$

where X_t is an (nx1) column vector of p variables, μ is an (nx1) vector of constant terms, Γ and Π represent coefficient matrices, Δ is a difference operator, k denotes the lag length, and ε_t is p-dimensional Gaussian error with mean zero and variance matrix (white noise disturbance term). The coefficient matrix Π is known as the impact matrix and it contains information about the long-run relationships. This Equation resembles a vector autoregressive (hereafter, VAR) model in first differences, except for the inclusion of the lagged level of X_{t-1}, an error correction term (hereafter, ect), which will contain information about the long run among variables in the vector X_t. The vector error correction (hereafter, VEC) method equation above allows for three model specifications:

(a) If Π is of full rank, then X_t is stationary in levels and a VAR in levels is an appropriate model. (b) If has zero rank, then it contains no long run information, and the appropriate model is a VAR in first differences. (c) If the rank of Π is a positive number, r and is less than p (where p is the number of variables in the system), there exists matrices α and β, with dimensions (p x r), such that βα′=Π. In this representation β contains the coefficients of the r distinct long run cointegrating vectors that render $\beta' X_t$ stationary, even though X_t is itself non-stationary, and α contains the short-run speed of adjustment coefficients for the equations in the system (see Awokuse, 2003).

Johansen's methodology requires the estimation of the VAR equation (2) and the residuals are then used to compute two likelihood ratio (LR) test statistics that can be used in the determination of the unique cointegrating vectors of X_t. The first test which considers the hypothesis that the rank of Π is less than or equal to r cointegrating vectors is given by the trace test below:

$$Trace = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i)$$

The second test statistic is known as the maximal eigenvalue test which computes the null hypothesis that there are exactly r cointegrating vectors in X_t and is given by:

$$\lambda \max = -T \ln(1-\lambda_r)$$

The distributions for these tests are not given by the usual chi-squared distributions. The asymptotic critical values for these likelihood ratio tests are calculated via numerical simulations (see Johansen and Juselius, 1990; and Osterwald-Lenum, 1992).

This study examines the long-run relationship between carbon dioxide emissions, energy consumption and economic growth in Turkey. Data used in this study is composed of energy use (kg of oil equivalent per capita), CO_2 emissions (metric tons per capita) and real GDP (constant 2005 US dollars per capita) for the period of 1960-2010. We use annual data and obtained the data from World Development Indicators of World Bank. This study follows closely the methodology of Soytas et al.(2007), Soytas and Sari(2009) and Zhang and Cheng(2009). The model is as the following:

$$V_t = \alpha + \beta_1 V_{t-1} + \beta_2 V_{t-2} + \ldots + \beta_p V_{t-p} + \ldots + \beta_{p+d} V_{t-p-d} + \varepsilon_t$$

Here, α : vector of constant, β : coefficient matrix, *d*: maximal order of integration of variables, *p*: optimum lag length of a VAR and ε_t: white noise residuals.

4. Empirical Results

The integration analysis of variables was examined using of ADF unit root test. The optimal lags for unit root tests are to include lags sufficient to remove any serial correlation in the residuals. The optimal lags for unit root tests are determined according to the Schwarz Criterion. Results from the ADF unit root tests are presented in Table 1. These results show that the null hypothesis of a unit root in each time series were failed to reject at 5 percent significance level but strongly rejected at their first difference. This implies that all variables are non-stationary at levels but stationary at the first differences.

Table 1. ADF Unit Root Test Results

Variable	Level	First Difference	Result
Y	-2.9941 (-3.5024) [0, c+t]	-7.2744 (-2.9224) [0, c]	**I (1)**
EC	-2.3259 (-3.5024) [0, c+t]	-6.9429 (-2.9224) [0, c]	**I (1)**
CO	-2.4803 (-3.5024) [1, c+t]	-7.0024 (-2.9224) [0, c]	**I (1)**

Notes: MacKinnon critical values at 5% are in ( ) and number of lags, and model specification, are in [ ], respectively. The optimal lags for unit root tests are determined according to the Schwarz Criterion. Models **c+t**, **c** and **none c+t** contain constant and trend; only intercept, and none of constant and trend, respectively.

The results from JJ cointegration tests indicate that there is a unique long-term or equilibrium relationship between variables. Both trace statistics and λ-max statistics show that there exist two cointegrating vectors at 5% significance level (see Table 2). The long-run coefficients are obtained from VEC model. The long-run coefficients for the variable EC is positive while variable CO are negative. The long-run coefficients are strongly statistically significant in all models. The estimated model that has passed several diagnostic tests those residuals has no evidence of serial correlation and heteroskedasticity; are multivariate normal distributions (see Table 3).

Table 2. Johansen-Juselius Cointegration Tests Results

Trend assumption: Linear deterministic trend
Sample (adjusted): 1960 - 2010
Included observations: 51 after adjustments

H_0	H_1	Trace Statistics	5 % Critical Value	p-value	λ-max Statistics	5 % Critical Value	p-value
r=0	r=1	53.1144	29.7971	0.0000	41.9578	21.1316	0.0000
r≤1	r=2	11.1566	15.4947	0.2021	11.0653	14.2646	0.1510
r≤2	r=3	0.0913	3.8415	0.7625	0.0913	3.8415	0.7625

Notes: Number of optimal lags, 3 based on FPE, AIC, SIC and HQ information criteria's results. r is # of cointegrating vectors. Critical values used are taken from Osterwald-Lenum (1992).

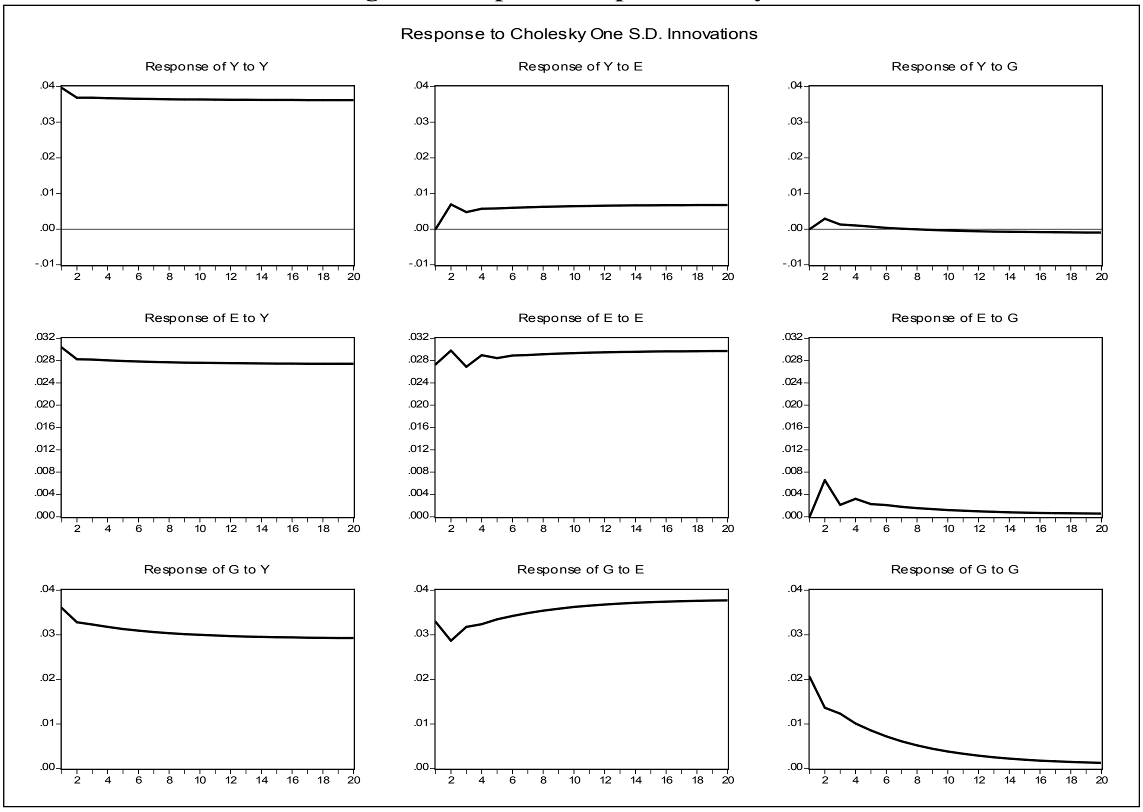
Table 3. The Estimated Long-run Coefficients

Variables	Coefficients	Standard Errors	t-Statistics
Constant	-33.3959		
EC	6.7916	1.3912	4.8817
CO	- 5.1447	1.0253	-5.0176
Diagnostic Tests			
	Statistics	**P-Value**	
LM	8.8237	0.4537	
HET	57.5650	0.1623	
NORM	5.5320	0.4776	

LM, HET and NORM are the Lagrange multiplier statistics for serial correlation, heteroskedasticity and normality of residuals, respectively.

The obtained empirical results from this paper indicated that carbon dioxide (CO_2) emissions effect negatively economic growth while energy consumption effect positively it. 1% increases in energy consumption raises economic growth of about 6,5%. At the same time 1% increases CO_2 emissions reduces economic growth of about 5%. Impulse-response analysis employed the response to Cholesky one standard deviation innovations. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. While the responses of per capita income to per capita energy consumption are positive, the responses of per capita income to per capita carbon emissions are positive during first years and then its responses are negative. The responses of per capita energy consumption to per capita income and per capita carbon emissions are positive. The responses of per capita carbon emissions to per capita income and per capita energy consumption are also positive (see Figure 4).

Figure 4. Impulse-Response Analysis



5. Conclusion

The purpose of this study is to examine the relationship between economic growth, CO_2 emission, and energy consumption for Turkey in 1960-2010. The findings obtained show that energy use has a positive impact on economic growth while carbon emission has a negative effect. This conclusion is similar to those reached by Gojayev et al. (2002) and Zeshan and Ahmed (2013). Economic growth and development inevitably lead to depletion of natural resources and degradation of the ecosystem despite increasing life standards and life quality. In this sense, it must be the ultimate goal to achieve a sustainable economy by less CO_2 emission and consuming less energy. This can be done by more effective and efficient use of resources and utilization of renewable energy sources.

Implementation of renewable energy by making investments at once in this area is necessitated by the fact that a large portion of energy is supplied through coal, petroleum and their derivatives which are rapidly being depleted and have adverse effects on environment and that forests are destroyed or swept away with deforestation. Because it takes long years to remedy the damages inflicted on the environment and bring back its old condition, which is often impossible. All segments of society must act with responsibility and show due sensibility in order to pass on a cleaner environment and living space to future generations. The increased demand for energy in Turkey's growth and development process requires that the path must be cleared for clean and renewable energy sources like wind farms, solar power, and natural gas with long-term investments on technology despite their serious economic cost. The regulations to be arranged and policies to be implemented must aim to reduce our dependency on foreign energy sources and eliminate it over time in a way to avoid slowing down the economy.

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