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The Relationship Between Economic Growth And Environmental Pollution in D8 Countries: Panel Var Analysis

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Abstract

In this study D8 (Turkey, Indonesia, Iran, Egypt, Pakistan, Nigeria, Malaysia, Bangladesh) countries per capita in the real gross domestic product was examined by relations panel VAR analysis between carbon dioxide emissions and energy consumption. The data obtained from the World Bank Economic Indicators Database for the period 1990-2014 were analyzed with the annual data. As a result of this study, one-way Granger causality relationship was determined from real gross domestic product to energy use and carbon dioxide emission.

Keywords: Economic Growth, CO2 Emissions, Energy Use, VAR Analysis

Introduction

One of the most important goals of an economy is to maximize growth. However, with the recognition of some environmental changes in the growth process, the relationship between the environment and growth has started to be questioned. Since the early 1990s, environmental problems such as global warming, climate change and environmental degradation have been raised. In order to realize the economic growth of the countries, supplying energy demands from fossil based fuels such as coal, natural gas and oil causes an increase in greenhouse gas emissions, especially carbon dioxide (CO2) emissions (Topallı, 2016: 428). The source of environmental problems is stated as the increase of carbon dioxide gas in the air. For this reason, the increase in the amount of carbon dioxide was investigated and its possible relationship with the income was questioned. As a result, the relationship between environment and economic growth has taken its place in the field of environmental economics. Especially after World War II, the increase in economic growth has increased the environmental problems. From the 1960s onwards, negative externalities such as environmental pollution caused by growth, crowding of cities and increasing incidents of violence have come to the forefront.

In the first part of the study, the interaction between CO2 emission and economic growth will be explained. In the second part of the study, the literature among the related variables will be examined. Chapter 3 covers the years 1990 to 2014 period in my D8 countries (Turkey, Indonesia, Iran, Egypt, Pakistan, Nigeria, Malaysia and Bangladesh) to the effect of pollution on economic growth were examined in the framework of the panel VAR analysis. In the last part of the study, the analysis results are shared.

Co_2 Emission And Economic Growth

When the literature is examined, the relationship between economic growth and CO2 emission is widely explained within the framework of Environmental Kuznets Curve (EKC). Kuznets, in his study of 1955, suggested

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that there is an inverse U-shaped relationship between economic growth and income injustice (Kuznets, 1955: 1-28). According to the EKC hypothesis, as shown in Figure 1, environmental pollution increases initially with economic development, but environmental pollution begins to decrease after income reaches a certain level (Stern, 2004: 1419-1439).

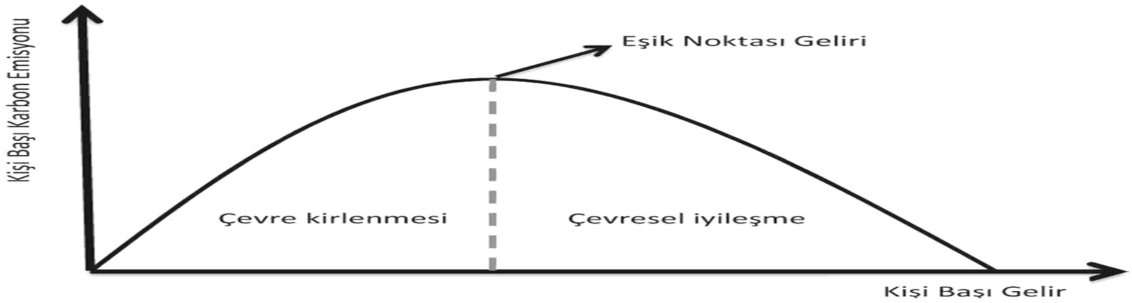


Figure 1. Environmental Kuznets Curve (EKC)

Grossman and Krueger's work in 1991 is considered to be the main study that explains how the relationship between EKC will occur. Grossman and Krueger discuss the impact of economic growth on the environment; scale, structural and technological impacts have stated that there are three different effects (Carson, 2010: 3-23).

The scale effect correlates the increase in production scale with the growth of economies and the amount of natural resources used and the amount of waste and emissions generated. While technology is data, the use of more natural resources in production leads to environmental degradation. In addition to the use of more natural resources, it increases the amount of waste and emissions with increasing production scale. This creates negative effects on the environment (Grossman and Krueger, 1991: 3-4).

The structural impact explains the structural changes and shifts in economic activities. The structural effect indicates that the economy will undergo a structural transformation with the ongoing growth process and that the impact of economic growth on the environment will be positive (Tsurumi and Managi, 2010: 19-36).

On the other hand, new technological processes will take place, as the technological impact will increase the welfare of countries and will be able to allocate more funding to research and development expenditures. Clean technologies as a result of technological advances will replace dirty technologies and environmental quality will begin to increase (Borghesi, 1999: 6-7).

The main reason underlying the problem of global warming and climate change is the production of industrial production facilities using fossil-based energy, heating activities in houses and the production of large amounts of greenhouse gases by motor vehicles (Kum, 2009: 208). The environmental impacts of CO2 emissions have reached significant levels today. Research and development activities (carbon capture and storage, clean coal technologies) are aimed at reducing gas emissions in order to achieve the goal of reducing these environmental hazards. CO2 emissions from fossil based sources increase carbon emissions as energy use increases. After the combustion of fossil fuels, it leaves solid and gas wastes to the environment. In addition to not being able to use these wastes left to the environment, it also causes environmental pollution (World Energy Council Turkish National Committee, 2010: 150-152).

The basic needs of people such as nutrition, warming and shelter must be met in order to survive. Population growth leads to more energy demand in transport, industry and energy sectors to meet these requirements. More energy demand also has an increasing effect on greenhouse gas emissions. Another impact of population growth on greenhouse gas emissions is deforestation. This deforestation effect increases greenhouse gas emissions due to urbanization and expansion of agricultural areas (Shi, 2001: 4). Population growth and greenhouse gas emissions tend to be in the same direction. A population increase of 1% increases greenhouse gas emissions by an average of 1.28% (Shi, 2001: 18).

The growth effect yields GDP per capita divided by the total population. The amount of energy consumed by the economies entering the growth process increases. This increase increases CO2 emissions (Karakaya and Özçağ, 2003: 13).

Energy density is defined as the amount of energy used per unit of production or the ratio of total primary energy consumption to GDP. The lower the rate of energy density, which is the most basic indicator of energy efficiency, the more efficient it is used. Mostly, energy densities of developed countries are lower than those of developing countries. The reason for being low is the fact that developed countries use technology more effectively and have a large share in the service sector (Karakaya and Özçağ, 2003: 13).

Carbon density is expressed as the fraction of fossil fuel consumption consumed by the total amount of CO2 emissions. The effect of carbon density measures the amount of CO2 emitted as a result of the energy consumed per unit, and its size depends on the rate at which fossil fuels are consumed in energy use (Hamilton and Turton, 2002, pp. 63-71). For the production of 1 unit of energy, the carbon emission produced by burning coal is about twice as high as natural gas (Zhang, 2000: 587-614).

The last factor affecting carbon dioxide emissions is deforestation. Deforestation is important in terms of controlling greenhouse gas emissions because it affects the storage of CO2 in the air through photosynthesis. Expansion of the settlement due to population growth, conversion of forest areas to various land use types, illegal reasons are considered among the factors that cause deforestation (Sedjo and Sohngen, 2000: 6).

As mentioned above, there are five important factors in CO2 emissions in a country. Reducing one or more of these five factors reduces CO2 emissions. However, no country will choose to reduce its economic growth. Therefore, other factors will need to be emphasized. Among other factors, the most important and effective will be to reduce the energy intensity and emission intensity. Because when these two factors are reduced, a significant reduction of carbon emissions may occur (Karakaya and Özçağ, 2003: 13).

Literature Review

There are many studies examining the relationship between CO_2 emissions and economic growth in the EKC approach.

In their study, Agras and Chapman (1999) analyzed panel data for 34 countries in the period 1971-1989. As a result of the study, the relationship between CSE was not supported (Agras and Chapman, 1999: 267-277).

Coondoo and Dinda (2002) conducted a Granger causality analysis for 88 countries in the period between 1960-1990. As a result of this study, one-way causality from CO2 emissions to income in North America and Western Europe; A one-way causality from revenue to CO2 emissions in Central Africa, South America, and Japan; In Asian and European countries, a two-way causality relationship has been identified (Coondoo and Dinda, 2002: 351 367).

Dijkgraaf and Vollebergh (2005) examined the relationship between CO2 emissions and per capita income for OECD countries in the period between 1960 and 1997. Panel data method was used. At the end of the study, they stated that there is an EEA relationship for CO2 emission in OECD countries (Dijkgraaf and Vollebergh, 2005: 229-239).

Say and Yücel (2006) studies the period covering the years 1970 to 2002, the relationship between total energy consumption and total CO2 emissions are studied within the framework of Turkey for regression analysis. They found a strong relationship between the variables stated in the result of the study (Say and Yücel, 2006: 3870 3876).

In his study Ang (2007) analyzed the relationship between EKC for CO2 emissions, income and energy consumption for France in the period between 1960 and 2000. According to the results of the analysis, support for the relationship between EKC has emerged findings (Ang, 2007: 4772-4778).

Fodha and Zaghdoud (2010) examined the relationship between CO2 and per capita income for Tunisia during the period 1961-2004. As a result of the study in which cointegration and causality analysis was conducted, no relationship was found between the CCE and a linear relationship between CO2 and per capita income (Fodha and Zaghdoud, 2010: 1150-1156).

In their study, Saboori et al. (2012) analyzed the EKC hypothesis for Malaysia in the period covering 1980-2009 with ARDL method. As a result of the study, they demonstrated the existence of a long-term relationship between CO2 emission per capita and GDP per capita. In both the short and long term, they found an inverse U-shaped relationship between CO2 emission and economic growth, which confirmed the EKC hypothesis. According to the results of the Granger causality analysis based on the VECM model, no relationship was found between CO2 emission and economic growth in the short term, but a one-way causality relationship from economic growth to CO2 emission in the long term (Saboori et al., 2012: 184-191).

In the study of Hamit-Hagar (2012), panel vector error correction model and Granger causality test were applied for Canada during the period of 1970-2007. As a result of the study, a unidirectional causality relationship was found from income to CO2 emission in the short and long term (Hamit-Hagar, 2012: 358-364).

Methods (2013) study, long-term CO2 emissions from economic growth for Turkey stated that there is a relation. In addition, it has identified a one-way causality relationship from economic growth to CO2 emission (Method, 2013: 1-8).

Güllü and Yakışık (2017) examined the relationship between CO2 emissions, energy consumption and GDP per capita for MIST (United Mexican States, Republic of Indonesia, South Korea-Republic of Korea, Republic of Turkey) countries in the period covering 1971-2010. As a result of the study, MIST countries stated that there is a one-way causality relationship from economic growth to CO2 emission and energy consumption (Güllü and Yakışık, 2017: 239-253).

Dumrul and Kılıçarslan (2018) studies, for the period covering the years 1970 to 2013, Turkey has studied the relationship between economic globalization and CO2 emissions. As a result, both economic globalization and economic growth lead to an increase in CO2 emissions. In addition, they found that there is a one-way causality relationship from economic globalization to environmental pollution (Dumrul and Kılıçarslan, 2018).

Külünk (2018) study, a period covering the years 1960-2013, examines the relationship between economic growth and CO2 emissions for Turkey. As a result of the study, he stated that there is a one-way causality relationship from CO2 emission to economic growth (Külünk, 2018: 193-205).

Data Set And Model

In this study, the relationship between economic growth and CO2 emission for D8 countries is examined. In the analysis, seasonally adjusted annual data for the period 1990-2014 compiled from the World Bank Economic Development Indicators Database were used. The econometric model used in Panel VAR analysis with E-views 10 econometrics program is shown below.

$$\Delta GDP = \alpha + \sum_{i=1}^{n} \mu CO2_{t-i} + \sum_{i=1}^{n} \theta \, ENERGYUSE_{t-i} + \varepsilon_{1,t}$$

GDP variable refers to real gross domestic product per capita, CO2 variable refers to CO2 emission amount, ENERGYUSE variable refers to energy use.

Empiric Findings

In order to be reliable in VAR analysis, the model should be stable. Firstly, the logarithm of the variables was taken. Unit root test results are shown in table 1 below.

Table 1. Unit Root Test Results

Değişkenler	**Genişletilmiş Dickey Fuller**	**Phillips Perron**	**Levin, Lin ve Chu**	**Im, Pesaran ve Shin**
GDP	I_0: 0.2002 I_1: 0.0006	I_0: 0.9954 I_1: 0.0000	I_0: 0.2950 I_1: 0.0051	I_0: 0.8431 I_1: 0.0004
CO2	I_0: 0.8227	I_0: 0.7358	I_0: 0.4791	I_0: 0.7546

	I_1: 0.0000	I_1: 0.0000	I_1: 0.0000	I_1: 0.0000
ENERGYUSE	I_0: 0.7899 I_1: 0.0000	I_0: 0.1059 I_1: 0.0000	I_0: 0.0870 I_1: 0.0000	I_0: 0.8463 I_1: 0.0000

According to the results of the extended Dickey Fuller test, Phillips Perron test, Levin Lin and Chu Test and Im, Pesaran and Shin stationarity tests, the hypothesis that a = 0.05 significance level is stable when all first-order differences are taken. In order to determine whether the model as a whole is stationary, the reverse roots of the characteristic polynomial are shown in Figure 2 below.

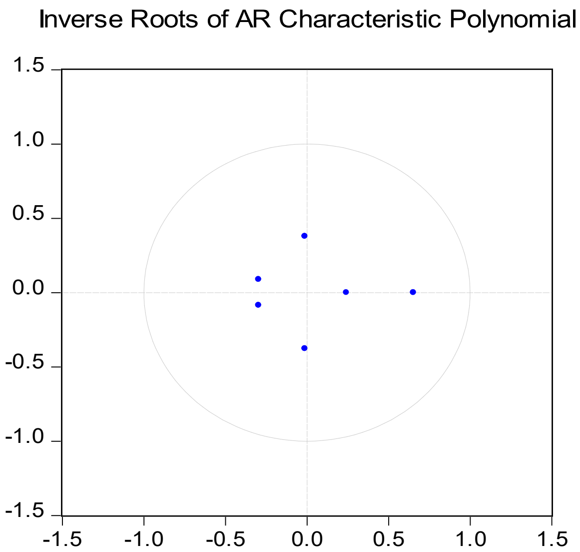


Figure 2. Inverse Roots of AR Characteristic Polynom ial

As shown in Figure 2, all the inverse roots of the characteristic polynomial are in the unit circle. With this result, it is seen that the whole model is stationary.

Table 2. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	504.9138	NA	1.25e-07	-7.381085	-7.316835	-7.354976
1	539.3641	66.87414	8.60e-08	-7.755354	-7.498355*	-7.650916
2	556.8909	33.24945	7.59e-08*	-7.880749*	-7.431001	-7.697983*
3	564.5680	14.22515	7.74e-08	-7.861294	-7.218797	-7.600199
4	573.7615	16.62939	7.73e-08	-7.864139	-7.028893	-7.524716
5	581.9976	14.53424	7.83e-08	-7.852905	-6.824909	-7.435154
6	592.1456	17.46053*	7.71e-08	-7.869788	-6.649042	-7.373708
7	595.4804	5.590778	8.41e-08	-7.786477	-6.372982	-7.212068

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Determining the lag length in VAR models is one of the major problems. Criteria such as Sequential Modified Probability Ratio (LR) test statistics, Final Forecast Error Criteria (FPE), Akaike Information Criteria (AIC), Schwarz Information Criteria (SC) and Hannan-Quin Information Criteria (HQ) were used to find the appropriate lag length. Table 2 shown above shows that the appropriate delay length is 2. Once the appropriate delay length has been determined, the estimated VAR model results will be interpreted using that delay length. Cointegration is performed to test whether there is a long-term relationship between the series. For this purpose, Pedroni Cointegration test analysis was performed.

Table 3. Pedroni Residual Cointegration Test

Series: GDP CO2 ENERGYUSE				
Sample: 1990 2014				
Included observations: 200				
Cross-sections included: 8				
Null Hypothesis: No cointegration				
Trend assumption: No deterministic trend				
User-specified lag length: 2				
Newey-West automatic bandwidth selection and Bartlett kernel				
Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	-1.402265	0.9196	-1.397065	0.9188
Panel rho-Statistic	-3.061000	0.0011	-0.840223	0.2004
Panel PP-Statistic	-4.164084	0.0000	-1.637299	0.0508
Panel ADF-Statistic	3.054522	0.9989	2.759036	0.9971
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	0.340359	0.6332		
Group PP-Statistic	-0.776883	0.2186		
Group ADF-Statistic	3.564855	0.9998		

As it is seen in Table 3, when the p values obtained from the analysis are considered as greater than 0.05, the null hypothesis that there is no cointegration is accepted. So there is no cointegrated vector. Since the series are not cointegrated, Vector Autoregressive Models (VAR) will be used. The results of the cointegration test provide information about whether there is a long-term relationship between the related variables but not the direction of the variables. In order to determine the direction of the relationship between these variables, the variables should be grouped as internal and external (Bozkurt, 2007: 91). Granger developed the Granger Causality test to determine the direction of the relationship between these variables (Granger, 1969: 424-438). Table 4 below shows the results of the Granger Causality Test.

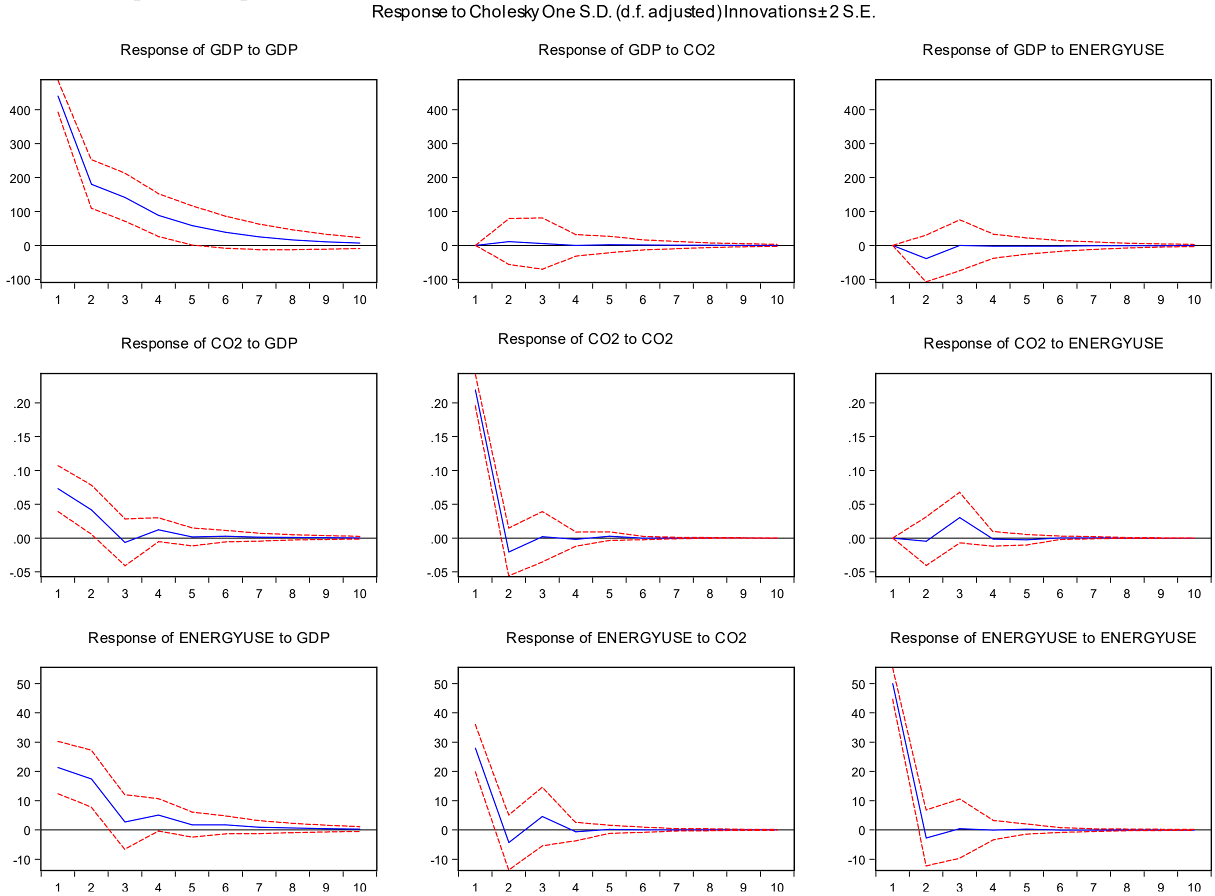
Table 4. Granger Causality Test results

Dependent variable: GDP			
Excluded	**Chi-sq**	**df**	**Prob.**
CO2	0.808481	2	0.6675
ENERGYUSE	1.456781	2	0.4827
All	1.587824	4	0.8110
Dependent variable: CO2			
Excluded	**Chi-sq**	**df**	**Prob.**
GDP	7.005684	2	0.0301
ENERGYUSE	3.517435	2	0.1723
All	9.319421	4	0.0536
Dependent variable: ENERGYUSE			
Excluded	**Chi-sq**	**df**	**Prob.**
GDP	14.50325	2	0.0007
CO2	0.501044	2	0.7784
All	15.39391	4	0.0040

Looking at the Granger Causality test results shown in Table 4, a unidirectional causality relationship was found between GDP and CO2 from real gross domestic product to carbon dioxide emissions. Saboori et al. (2012), Hamit-Hagar (2012), Methods (2013), Güllü and Yakışık (2017) are examples of the studies supporting the findings. A one-way causality relationship between GDP and ENERGYUSE has been identified from real gross domestic product to energy use. Kraft and Kraft (1978), Aqeel and Butt (2001), Uzunöz and Akçay (2012) are examples of the studies supporting the findings.

Within the framework of VAR analysis, impact response function analysis should be used to see the impact of one of the variables on the current terms and the current values of the other variables. Impact response function analysis is a method based on structural shocks and it is important to have causality in this method. According to the Granger causality test, the variables were ordered from the most external to the internal and the effect response functions were analyzed. ± 2 standard errors were determined when calculating effect response functions for the variables in the model. The dashed lines in the graph give confidence intervals, while the dashed lines give the response of a standard error shock dependent variable that occurs in the error terms of the model over time (Bozkurt, 2007: 95). It is important to show whether the results of the analysis are within the confidence interval in terms of statistical significance. Table 5 below examines how the dependent dependent variables are affected over time when a positive shock is applied to variables based on a lag length of the VAR model.

Table 5. Impact - Response Functions



When the effect response functions are examined in Table 5, it is seen that the shock effects in the model approach to zero over time. So the system is stationary. The approaching of the system towards zero indicates that the econometric model is stable. The responses of a standard error shock dependent variable are within confidence intervals. As can be understood from this, it can be said that the analysis results are statistically significant.

The purpose of variance decomposition is to explain the estimated error variance of one variable by other variables. Econometric model of the variables themselves and other variables of the percentage of a shock caused by itself and other variables is to show (Enders, 2004: 280). The variance decomposition of the GDP dependent variable obtained as a result of the analysis is shown in Table 6 below. The effects are shown as a percentage.

Table 6. Variance Decomposition of GDP

Period	S.E.	GDP	ENERGYUSE	CO2
1	0.075274	100.0000	0.000000	0.000000
2	0.078369	99.83472	0.003085	0.162194
3	0.082408	97.69500	0.082765	2.222235
4	0.085957	95.11063	2.840890	2.048479
5	0.089534	91.91597	3.394591	4.689439
6	0.093021	90.06032	5.396478	4.543206
7	0.094029	90.19954	5.350352	4.450104
8	0.094332	90.21587	5.357688	4.426444
9	0.094561	90.09458	5.377640	4.527776
10	0.095045	89.90081	5.488368	4.610825
11	0.095273	89.81394	5.596567	4.589488
12	0.095437	89.77710	5.585972	4.636926

Looking at Table 6, when the first three periods are defined as short-term, a large proportion of the change in real GDP per capita is due to it, followed by CO2 emission and energy use, respectively. In the long run, however, the ranking after real GDP per capita changes. In the long run, energy use is seen to have a 1% greater impact on CO2 emissions.

Conclusion

In this study, the relationship between real gross domestic product, CO2 emission and energy use was examined by using the data for D8 countries covering the period of 1990-2014. Pedroni Cointegration test was used to determine whether cointegration was used among the variables used in the analysis. In addition, since these variables are stationary at the same level as a result of unit root tests and the inverted roots of the characteristic polynomial of the econometric model are included in the unit circle, it was not objected to use Panel VAR analysis. Granger causality test was performed among the variables mentioned. According to the causality, a one-way causality relationship was determined from real gross domestic product to carbon dioxide emission and energy use. According to the results of variance decomposition, 98% of the change in real GDP per capita in the short term is caused by itself, followed by CO2 emission and energy use, respectively. In the long term, while 90% of the change in real GDP per capita is due to itself, approximately 5.5% is due to energy use and approximately 4.5% is due to CO2 emission.

When the results of the analysis are examined, it is seen that energy use and CO2 emission have a long-term effect on economic growth. CO2 emissions and energy use in D8 countries, namely Turkey, Indonesia, Iran, Egypt, Pakistan, Nigeria, the lack of long-term energy policy for the public and private sectors of Malaysia and Bangladesh stands out as a major shortcoming. In these D8 countries, a long-term energy policy should be established and implemented with determination.

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