COINTEGRATION BETWEEN CARBON EMISSION, ECONOMIC GROWTH, AND ENERGY CONSUMPTION: A COMPARATIVE STUDY ON GEORGIA AND TURKEY[1]

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Abstract

Energy is one of the most significant tools in the economic development of the countries. The energy required for the economic activities is derived from fossil-based sources that emit intense carbon dioxide. In today's world, carbon emissions, energy consumption, and economic growth are issues of interest for all countries that want to continue growing by establishing a balance between energy and carbon emissions because these fuels cause global warming due to climate change This brief research investigates the relationship between carbon emissions, energy consumption and economic growth using data between the years 1997-2014 period for Turkish and Georgian economies. Panel data cointegration tests are carried to analyze the relationship between the variables. The overall findings indicate that there is a significant relationship between the variables for the Georgian and Turkish economies. Moreover, the tests results are consistent with the general assumption of the Environmental Kuznets Curve hypothesis.

Keywords: *Energy consumption, carbon emission, economic growth, Turkey and Georgia*
JEL Classification: *Q43, Q53, Q56*

KARBON EMİSYONU, EKONOMİK BÜYÜME VE ENERJİ TÜKETİMİ ARASINDAKİ KOENTEGRASYON: GÜRCİSTAN VE TÜRKİYE ÜZERİNE KARŞILAŞTIRMALI BİR ÇALIŞMA

Öz

Enerji, ülkelerin ekonomik gelişmesinde yer alan en önemli araçlardan biridir. Ekonomik faaliyetler için gerekli olan kaynaklar karbondioksit salınımı yapan fosil temelli kaynaklardan elde edilmektedir. Bu kaynaklar iklim değişikliği nedeniyle küresel ısınmaya yol açmaktadır. Dolayısı ile günümüz dünyasında ekonomik büyüme, enerji tüketimi ve karbon emisyonları ilişkisi enerji ve karbon emisyonları arasında bir denge kurarak büyümeye devam etmek isteyen tüm ülkeler için bir çıkar konusudur. Bu araştırma, Türkiye ve Gürcistan ekonomileri için 1997-2014 yılları arasındaki verileri kullanarak karbon emisyonu, enerji tüketimi ve ekonomik büyüme arasındaki ilişkiyi incelemektedir. Değişkenler arasındaki ilişkileri analiz etmek için panel veri eş-bütünleşme testleri yapılmıştır. Genel bulgular, Gürcistan ve Türkiye ekonomileri için değişkenler arasında önemli bir ilişki olduğunu göstermektedir. Ayrıca, test sonuçları Çevresel Kuznet Eğrisi hipotezinin genel varsayımları ile tutarlıdır.

Anahtar Kelimeler: *Enerji tüketimi, karbon emisyonu, ekonomik büyüme, Türkiye ve Gürcistan*
JEL Sınıflandırması: *Q43, Q53, Q56*

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1. Introduction

Countries need energy sources in order to sustain their economic activities. Energy is one of the most significant tools in the economic development of the countries. The energy required for the economic activities is derived from fossil-based sources and sources that emit intense carbon dioxide (CO2). On the other hand, these fuels cause global warming due to climate change. In order to get rid of the damages of climate change and global warming and to ensure sustainable development, alternative renewable energy sources such as wind energy, solar energy, and hydropower should be used instead of using fossil fuels.

Carbon emission is the combustion of carbon-containing fossil fuels, resulting in the formation of carbon dioxide and mixing into the atmosphere. It is stated in the literature as emissions of greenhouse gases. Carbon emissions resulting from the burning of fossil fuels like oil and coal cause serious climate changes. The factors that determine carbon emissions are economic growth, energy consumption, deforestation, population growth and per capita national income. The population size is affecting economic output, economic output is affecting energy consumption, and energy consumption is affecting fossil-based carbon emissions and thus total carbon emissions. Fossil-based fuels used in the industry let off the most CO_2 emissions into the atmospheres. Monitoring and control of fuel-based CO_2 emissions are the key measures to be taken against global warming. Kuznets (1955) suggested that environmental pollution or environmental degradation would increase together with economic growth and then, however, pollution or degradation decline after a certain level of income. Therefore, the Environmental Kuznets Curve Hypothesis should be well analyzed in order to understand the relationship between growth and carbon emissions. This hypothesis determines the interrelation between economic growth and greenhouse gases which are elements of environmental pollution.

Economic growth is determined as the rise in the gross domestic product (GDP) per capita. In other words, growth effect is measured by per capita economic output and is obtained by dividing GDP by the total population. World Bank describes GDP as *"the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products".* As the -economic output increases and the growth process starts in the economy, the amount of energy used will increase. So, meeting the amount of energy needed from fossil fuels will increase CO_2 emissions.

Energy use (oil equivalent) is the unit of energy that allows different energy resources to be expressed in a single unit. Energy sources are very diverse. Each form of energy such as primary energy sources and secondary energy sources has their own specific measures. All these different measures need to be transformed into a common measure. We use oil equivalent as a base measure for this convenience. In other words, an oil equivalent is a unit of measure used in energy production and consumption calculations. Each energy source has its own heat value and heat value unit. The heat values of the energy sources are determined by a conversion coefficient and a common unit of energy is obtained, which is oil equivalent.

The aim of this study is to test the effect of energy consumption and carbon emissions on the Turkish and Georgian economies. Thus, it is expected to contribute to policymakers by providing a projection on economic growth. The study also puts the output of relationship between carbon emission, economic growth, and energy consumption in these countries.

This paper analyzes the interrelation between energy consumption, carbon dioxide emissions, and economic growth using data from the 1997-2014 period. The conceptual framework and the empirical literature will be explained in the first part of the study. In the next section methodology and data set are introduced and the study will be terminated by evaluating the findings obtained.

2. Literature Review

There is an immense literature on the relationship between carbon emission, energy consumption, and economic development. Discussions on economic growth and environmental relations have continued since the 1980s on the concept of "sustainable development" (Cole, 1999). There are optimistic and pessimistic approaches to ecological limits of economic growth. In the discussion, economists adopt the approach of "economic growth is the solution of environmental problems" and the group of pessimists adopt the approach of "economic growth is one of the causes of environmental problems".

Economic growth is a fundamental goal, especially for the underdeveloped and developing countries. Economic development could be sustained in the long run depending on the conservation of natural resources such as air, water, forests, and land. With the protection of natural resources, economic growth can be achieved and development can be sustained (Munasinghe, 2001).

Empirical studies on economic improvement and environmental pollution are usually based on the validity of the "Environmental Kuznets Curve" and the "Pollution Haven Hypothesis". In this context, studies conducted on data such as CO_2, GDP, and energy consumption have been investigated whether these hypotheses are valid in the country or country groups concerned. The Environmental Kuznets Curve hypothesis argues that environmental degradation will rise in the first years of economic development and then environmental pollution decreases despite the increase in economic growth. "The idea is that as economic development growth occurs, the environment will worsen until a certain point where the country reaches a specific average income. Then money is invested back into the environment, and the ecosystem is restored". The root of empirical work on the hypothesis is based on the study of Grossman and Krueger (1991). In this study, an inverted U-shaped relationship between environmental pollutants and per capita income was obtained using horizontal cross-section analysis for 42 NAFTA countries. Keller and Levinson (1999) which covers the period of 1977-1994, has found that the pollution-intensive industries have some slight avoidance of environmental regulations. In another study of 24 transition economies, Smarzynska and Wei (2001) found that the pollution haven hypothesis is valid.

In the world, energy consumption is in a continuous upward trend in parallel with economic growth, technological development, and population growth. Carbon emissions from energy consumption are among the most important factors that pollute the environment. The relationship between economic growth and carbon emissions has been the subject of many researchers such as Arouri et al. (2012), Pao and Tsai (2011), Bastola and Sapkota (2014), Lotfalipour et al (2010), Jahangir et al. (2012), Kofi et al. (2012), Van and Limskul (2013), Özcan (2013), Shahbaz et al. (2013) and Dam (2014).

Menyah and Wolde-Rufael (2010) showed that the relationship between economic growth, carbon emissions, and energy consumption is the result of a one-way causality from energy consumption to carbon dioxide emissions. Al-Mulali and Sab (2012) found that energy consumption plays a major role in economic growth and financial progress. In the case of Saudi Arabia, for example, Alkhathlan and Javid (2013) for the years 1980-2011 came to the conclusion that carbon emissions increased as per capita income increased.

Park and Hong (2013) used the Markov Transition Model to analyze the relationship between South Korea's energy consumption, carbon emissions, and economic growth. Sarısoy and Yıldız (2013) examined the relationship between economic growth, carbon emissions and population density in their study and found that carbon emissions would increase with the increase in the economic development. Liao and Cao (2013) inferred that carbon dioxide emissions were affected by urbanization, population density, trade, energy and environmental factors. Salahuddin and Gow (2014), on the other hand, found no significant association between economic growth and carbon emissions in their study analyzing the relationship between economic growth, energy consumption

and carbon emissions for the Gulf Cooperation Council Countries. Cowan et al. (2014), using BRICS countries' electricity consumption, carbon emissions and economic growth data found that Russia and South Africa have unidirectional causality from economic growth to carbon emissions. However, any causality had not been found for India and China. Saboori et al. (2014) had searched the interrelations between economic growth, carbon emissions, and energy consumption in the transportation sector for OECD countries. As a result of the analysis, the existence of a positive and long-term relationship between carbon emissions and economic growth had been identified.

Halicioglu (2009), analyzed the relationship between energy use, carbon emission, foreign trade and income level variables with annual the data set covering the period of 1960-2005 in Turkish economy. The Granger causality test results of the study showed that the income variable is the most important factor that explains the carbon emission.

Öztürk and Acaravcı (2013) investigated the causality relationship between financial developments, economic growth, trade, and CO_2 emissions in Turkey between the years 1960-2007. According to the findings of the analysis, the increase in foreign trade, in the long run, increases the financial development and CO_2 emissions, but these findings are not statistically significant.

Yavuz (2014), tested the validity of Environmental Kuznets Curve Hypothesis for Turkey. In the study, the relationship between carbon emission, income, and energy consumption were analyzed for the period of 1960 – 2007. The test findings of the study proved the validity of the hypothesis. Another recent study testing the validity of the Environmental Kuznets Curve for Turkey done by Pata (2018) support the hypothesis validation both in the short term and long term.

Kızılkaya, Ay, and Sofuoğlu (2015) evaluate the relationship between energy consumption, carbon dioxide emissions, and foreign direct investment in Turkey. They investigated the relationship based on annual data covering the period of 1981- 2010 through the Pesaran et al. (2001), ARDL bounds testing as well as Johansen and Juselius (1990) maximum likelihood approaches to test for a long run relationship between variables and obtained cointegration relation.

The overall results of the studies prove a relation between energy use, carbon emission, and economic development. In light of the literature findings, the motivations of this study are to analyze the relationship between carbon emission, energy use and gross domestic product for Turkey and Georgia through a long time period of recent data and to help the policymakers grasp the characteristics and evolutions of carbon emission, energy use and gross domestic products. The policy makers aiming at economic growth should adopt legislative arrangements to ensure that the environment is not damaged while the country is progressing in development and country prosperity. Regulations taking only economic growth into consideration regardless of the environment will cause environmental degradation continue to increase in the future. Environmental degradation is not a problem in itself, but it will be a serious problem for the country's economy by affecting people's health, agricultural production, and natural life.

3. Data and Methodology

Time series and panel data analyses have been conducted for nearly all of the studies about the subject of the relationship between the carbon emissions, energy use, and economic growth. In most of the studies in general, cointegration and Granger causality tests have been adopted to search the direction and duration of the relationship between variables.

In this investigation, energy use (kg of oil equivalent per capita), carbon emissions (metric tons per capita), and GDP per capita (constant 2010 US$) variables of Turkish and Georgian economies are used covering the years between 1997 and 2014. Variables are acquired from the World Bank database in yearly frequency. The current study aims to analyze both the relations between the variables and make a comparison among these countries.

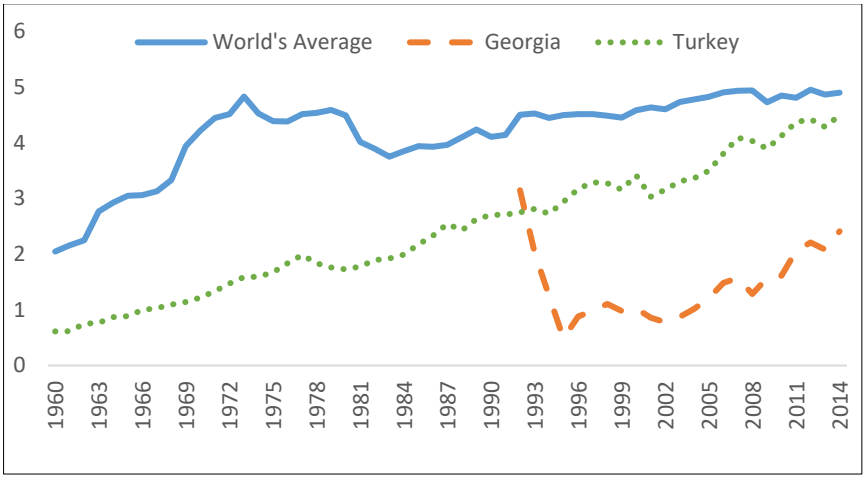
In the study, annual data between 1997 and 2014 for all of the variables and countries are considered separately. The reason for including these years was the common availability set of data. Panel data approach is used to investigate stationarity of annual variables and to track the changes separately in country basis. This empirical study is carried out for three reasons. First is to analyze the long-run link between the variables. The second aim is the examination of the dynamic relationship between the variables. And lastly, it is to take a comparative look at the Turkish and Georgian economies in country level. Results of the data analysis are categorized and compared between these two countries. All analyses are performed in EViews 9 program.

3.1. Description of variables

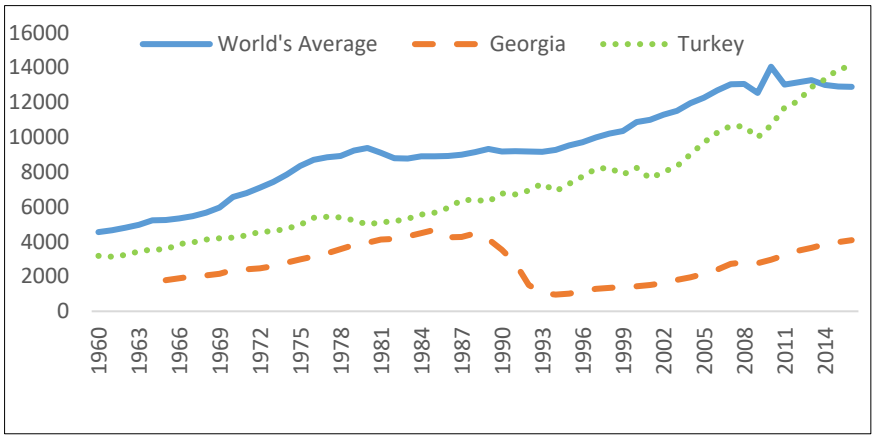
According to the World Bank's indicators, the rank of Turkey's and Georgia's share of carbon emissions in the world were 98th and 138th orders respectively as end of 2014.

Graph 1 shows the carbon emissions in terms of metric tons for Georgia and Turkey and world's average. Available data for Georgia starts with 1992, a sudden decrease realized in carbon emissions during 1992 – 1996 but then again an increasing trend is observed. Over the half century period, world's average carbon emission is realized approximately 4.1 metric tons per capita. While carbon emission was 2 – 2.5 in the 1960s, it reached nearly double after 2000. In the 1960s, GDP per capita was between 4,500 -5,000 U.S dollar and during over half-century period, it was realized approximately 9,500 dollars. In this period Turkish economy GDP per capita nearly increased 7,000 dollars on average and has exceeded the world's average in 2014 as shown in Graph 2 below.

Graph 1: **CO2 Emissions (metric tons per capita)**

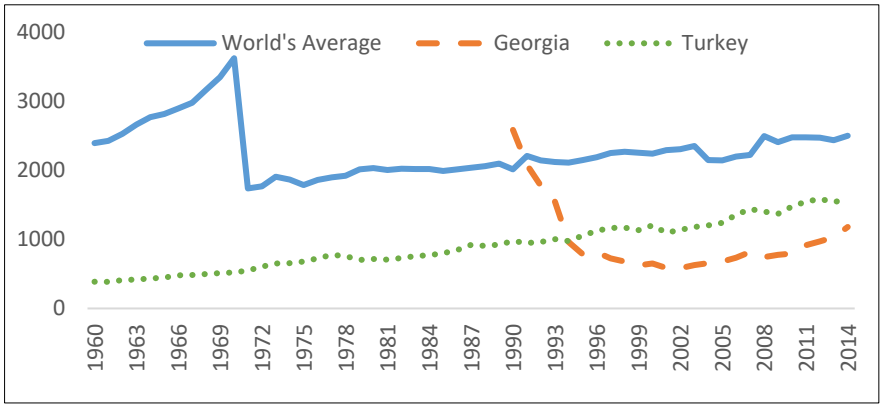


Graph 2: **GDP Per Capita (constant in 2010 U.S. $)**



In 2014, while the world average GDP was 13,000 dollars, Turkish GDP was 13,300 dollars per capita. On the other hand, Georgian economy has realized roughly 2,700 dollars GDP per capita on average and reached over 4,000 dollars in 2016.

Graph 3: **Energy Use (kg of oil equivalent per capita)**



World Bank database defines the energy use as; "*Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport".*

From 1960 the world energy consumption was realized as 2,300 kg of oil equivalent per capita on the average. There is a sharp decrease after 1970 and then energy use follows a steady straight line until today. During this period Turkey's energy use was just over 900 kg on the overage. On the other hand, energy use of Georgia was higher than the world's average in 1990 (over 2,500 kg per capita) but then there was a sudden decrease during the following years. The average values of the graphs are summarized in Table 1 below.

Table 1**: Descriptive Statistics**

Indicator /Country	CO2 emissions (metric tons per capita)	GDP ($ per capita)	Energy use (kg oil equivalent per capita)
World's Average	4.18	9,295.73	2,282.34
Georgia	1.43	2,780.05	972.97
Turkey	2.42	6,960.23	909.51

Results of these three figures show that energy use, carbon emissions, and GDP move and rise in the same direction in the emerging economies. It will be proper to examine the correlation between these variables then.

3.2. Unit Root Test Results

The natural logarithms of all the variables are used in the analyses. Before modeling the data, unit root tests were applied to check and to analyze time series structure of the data whether the data is stationary or not. As it is known that stationary data is very important, because of if the trend exists in data, spurious results produce. Hence, to avoid spurious results in the study unit root tests had been applied.

Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003), and Fisher-type tests are computed for each variable to test the unit root (Maddala and Wu, 1999 and Choi, 2001). Variables are tested

in level and the first difference with intercept, intercept and trend or none of them included in the test equation separately.

Table 2: **Unit Root Test of Carbon Emission Variable (C02)**

	Level			1st difference		
	Intercept	Intercept & Trend	None	Intercept	Intercept & Trend	None
Levin, Lin & Chu t*	1.181 (0.8813)	-1.222 (0.1107)	1.679 (0.9535)	-2.703 (0.0034)	-1.818 (0.0345)	-3.296 (0.0005)
Im, Pesaran and Shin W-stat	2.069 (0.9808)	-0.730 (0.2326)	-	-2.052 (0.0201)	-1.084 (0.1391)	-
ADF - Fisher Chi-square	0.256 (0.9924)	5.416 (0.2471)	0.347 (0.9865)	11.286 (0.0235)	6.956 (0.1382)	14.873 (0.0050)
PP - Fisher Chi-square	0.248 (0.9929)	3.885 (0.4217)	0.266 (0.9919)	21.485 (0.0003)	16.923 (0.0020)	28.642 (0.0000)

Probabilities are given between parentheses.

Table 3: **Unit Root Test of Energy Use Variable (EU)**

	Level			1st difference		
	Intercept	Intercept & Trend	None	Intercept	Intercept & Trend	None
Levin, Lin & Chu t*	2.026 (0.9786)	-0.925 (0.1774)	2.280 (0.9887)	-3.085 (0.0010)	-2.977 (0.0015)	-2.795 (0.0026)
Im, Pesaran and Shin W-stat	2.772 (0.9972)	-0.172 (0.4316)	-	-1.790 (0.0367)	-1.384 (0.0831)	-
ADF - Fisher Chi-square	0.166 (0.9967)	3.850 (0.4266)	0.126 (0.9981)	9.994 (0.0405)	8.045 (0.0899)	12.062 (0.0169)
PP - Fisher Chi-square	0.125 (0.9981)	3.313 (0.5068)	0.109 (0.9986)	17.835 (0.0013)	17.793 (0.0014)	23.302 (0.0001)

Probabilities are given between parentheses.

Table 4: **Unit Root Test of GDP Variable (EU)**

	Level			1st difference		
	Intercept	Intercept & Trend	None	Intercept	Intercept & Trend	None
Levin, Lin & Chu t*	0.244 (0.5965)	-0.701 (0.2415)	2.909 (0.9982)	-1.857 (0.0316)	-0.978 (0.1640)	-1.469 (0.0709)
Im, Pesaran and Shin W-stat	2.153 (0.9843)	-0.736 (0.2307)	-	-1.550 (0.0605)	-0.433 (0.3325)	-
ADF - Fisher Chi-square	0.267 (0.9918)	5.451 (0.2440)	0.053 (0.9996)	8.730 (0.0682)	4.402 (0.3542)	6.324 (0.1762)
PP - Fisher Chi-square	0.132 (0.9979)	2.683 (0.6122)	0.015 (1.0000)	12.365 (0.0148)	8.499 (0.0749)	12.156 (0.0162)

Probabilities are given between parentheses.

Levin, Lin, and Chu (2002) assume common unit root process and the others suppose individual unit root process. For the tests, null hypothesis indicates the existence of unit roots whereas alternative hypothesis means there are no unit roots. Outcomes of the unit root analyses demonstrate that all variables at the level order have unit roots. On the other hand, the null hypothesis could be rejected when the variables are converted to their first difference. All variables, in general, do not have significant unit roots at their first difference order. In other words, the output of the unit root test results indicates that all the variables are stationary at the 1st difference. The characteristics of the time series data for the variables used in the study – no being stationary at the level but being stationary at the first difference- are familiar with the unit

root test results of the studies such as Jahangir et al. (2012), Arouri et al. (2012), Bastola and Sapkota (2014), and others mentioned in the literature review.

3.3. Panel Cointegration Test

Current literature has concentrated on the tests of cointegration in a panel setting which is measuring Fisher-type test of Pedroni (1999), Kao (1999), and Pedroni (2004) applying Johansen (1988) methodology. The maximum likelihood estimation approach suggested by Johansen (1988) has been commonly preferred predicting long-run equilibrium relationships. In contrast to single-equation methods, the procedure efficiently includes the short-run dynamics in the estimation of the long-run model structure. The main advantage of the Johansen's methodology is the ability of testing and estimating the multiple long-run equilibrium relationships.

It is assumed that all the variables are non-stationary but when they are converted to the first difference, then they become stationary. So Johansen test can be applied. That is to say, in Johannsen, variables must be non-stationary and must be integrated at the same level. The unit root tests results show that the variables are not stationary on their level but they are all stationary at the first difference order. So panel cointegration tests could be applied.

In this examination, Johansen Fisher Panel cointegration test is conducted. The outputs of the analysis are given tables below. Fisher (1932) conducts a joint test that drives the outcomes of the individual independent tests. Maddala and Wu (1999) drive Fisher's conclusion to suggest an alternative method of cointegration test in panel data by connecting tests from individual cross-sections to acquire at test statistic for the whole panel.

Table 5: **Johansen Fisher Panel Cointegration Test**

Series: CO2 EU GDP				
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	37.54	**0.0000**	20.07	**0.0005**
At most 1	23.33	**0.0001**	23.66	**0.0001**
At most 2	4.952	0.2923	4.952	0.2923

Table 6: **Individual Cross Section Cointegration Results**

Cross Section	Trace Test Statistics	Prob.**	Max-Eign Test Statistics	Prob.**
Hypothesis of no cointegration				
GEO	44.061	0.0006	26.569	0.0078
TUR	55.859	0.0000	27.450	0.0056
Hypothesis of at most 1 cointegration relationship				
GEO	17.491	0.0247	17.299	0.0161
TUR	28.408	0.0003	26.082	0.0005

Both common test results and individual cross-section results of trace tests and eigenvalue statistics show that there is at most one cointegration equation. When considering the individual results they are statistically significant at the level of 5 % significance level. In other words, a substantial relationship between the variables is detected for the Georgian and Turkish economies. The reveal of cointegration between variables pointed by statistics makes it possible to run dynamic ordinary least square estimation. In contrast to the study results of Salahuddin and Gow (2014), the cointegration findings between the variables are in line with the study results of Saboori et al. (2014) and the outcomes of the studies, which identify the existence of a positive and long-term relationship between carbon emissions and economic growth, reviewed in the literature part.

3.4. Panel Dynamic Ordinary Least Squares

One of the measurement tools for predicting a particular cointegrating vector in panel settings is Dynamic Ordinary Least Square (DOLS). If the variables are cointegrated, DOLS model could be applied otherwise not. Country-specific values were interpreted separately to clarify influencing factors whereas common group values were compared to identify general affecting components.

Table 7: **Panel Dynamic Least Squares (DOLS)**

Dependent Variable: CO2					
Variables (common and individual)		Coefficient	Std. Error	t-Statistic	Prob.
EU		1.032	0.395	2.613	0.0204
GDP		0.143	0.272	0.526	**0.6067**
	EU_GEO	1.156	0.210	5.508	0.0000
	EU_TUR	0.348	0.561	0.621	**0.5389**
	GDP_GEO	0.672	0.082	8.149	0.0000
	GDP_TUR	**-1.584**	0.492	-3.219	0.0029

Table 7 above shows the results from DOLS. According to the table the coefficient for energy use is statistically significant in carbon emission whereas GDP does not have a significant impact on carbon emission as a whole. On the other hand, the country-specific based findings show statistically significant effects on carbon emission except for energy use variable in Turkey. The findings of the DOLS model are consistent with the general assumption of the Environmental Kuznets Curve hypothesis that suggests that economic development initially causes to a deterioration in the environment, but after a specific level of economic growth levels of environmental degradation start decreasing. This evidence could be seen in Table 7 above as one unit increase change in Turkish economic growth results in a 1,585 decrease in carbon emission. Also as shown in the Figures 1 and 2, increase in GDP is greater than the increase in carbon emission, a steeper economic growth. The results are also consistent with other studies (Al-Mulali and Sab, 2012; Alkhathlan and Javid 2013; Yavuz, 2014; Pata, 2018), which stated that carbon emissions increased as per capita income increased, in the literature. Also, Saboori et al. (2014) have drawn the similar conclusions for the relationship between carbon emission, energy consumption and gross domestic product in OECD countries.

4. Concluding remarks

The environment is one of the striking topics with the significance of the protection of it for future generations. Recently, greenhouse gas emissions are risky hazards for the environment. CO_2 emissions take crucial place within greenhouse gas emissions.

This study examines the interrelation between energy consumption, carbon dioxide emissions, and economic development using data from the 1997-2014 period. The overall findings demonstrate that there is a significant interrelation between the variables for the Georgian and Turkish economies. Moreover, the findings of the DOLS model are consistent with the general assumption of the Environmental Kuznets Curve hypothesis which suggests that economic development initially causes to a deterioration in the environment, but levels of environmental degradation start decreasing soon afterward a specific level of economic growth. The panel data results show that as economic expansion increases the countries emit much carbon dioxide. However, the effects of the growth on carbon emission is negative for the Turkish economy since Turkey has achieved its economic improvement better than Georgia.

References

Alkhathlan, K., and Javid, M. (2013). Energy Consumption, Carbon Emissions and Economic Growth in Saudi Arabia: An Aggregate and Disaggregate Analysis. *Energy Policy*, 62, 1525-1532.

Al-Mulali, Usama, and Sab, Che Normee Binti Che. (2012). The Impact of Energy Consumption and CO2 Emission on the Economic Growth and Financial Development in the Sub Saharan African Countries. *Energy,* 39(1), 180-186.

Arouri, M. E. H., Ben Youssef, A., M'henni, H. and Rault, C. (2012). Energy Consumption, Economic Growth and CO2 Emissions in Middle East and North African Countries. *Energy Policy*, 45: 342–349.

Bastola, U. and Sapkota, P. (2014). Relationships among Energy Consumption, Pollution Emission, and Economic Growth in Nepal. *Energy*, 1–9.

Choi, I. (2001). Unit Root Tests for Panel Data. *Journal of International Money and Finance*, 20: 249–272.

Cole, M. A. (1999). Limits to Growth, Sustainable Development and Environmental Kuznets Curves: An Examination of the Environmental Impact of Economic Development. *Sustainable Development*, 7: 87-97.

Cowan, Wendy N.; Chang, Tsangyao; Inglesi-Lotz, Roula and Gupta, Rangan (2014). The Nexus of Electricity Consumption, Economic Growth and CO2 Emissions in the BRICS Countries. *Energy Policy*, 66(C), 359-368.

Dam, M. M. (2014). *Sera Gazı Emisyonlarının Makroekonomik Değişkenlerle İlişkisi: OECD Ülkeleri İçin Panel Veri Analizi* (Doctoral Dissertation, Adnan Menderes Üniversitesi).

Fisher, R. A. (1932). *Statistical Methods for Research Workers (4th Edition)*. Oxford, England: Oliver and Boyd.

Grossman, G. M. and Krueger, A. B. (1991). *Environmental Impacts of a North American Free Trade Agreement*. NBER Working Paper Series, 3914.

Halicioglu, F. (2009). An Econometric Study of CO2 Emissions, Energy Consumption, Income and Foreign Trade in Turkey. *Energy Policy*, 37(3), 1156-1164.

Im, K. S., Pesaran, M. H., and Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, 115(1), 53-74.

Jahangir Alam, M., Ara Begum, I., Buysse, J. and Van Huylenbroeck, G. (2012). Energy Consumption, Carbon Emissions and Economic Growth Nexus in Bangladesh: Cointegration and Dynamic Causality Analysis. *Energy Policy*, 45, 217–225.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12(2-3), 231-254.

Johansen, S., and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration—With Applications to the Demand for Money. *Oxford Bulletin of Economics and statistics*, 52(2), 169-210.

Kao, Chinwa D. (1999). Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. *Journal of Econometrics*, 90, 1–44.

Keller, W. and Levinson, A. (1999). *Environmental Compliance Costs and Foreign Direct Investment Inflows to U.S. States.* NBER Working Paper Series, 7369.

Kızılkaya, Oktay, Ahmet Ay and Emrah Sofuoğlu (2015). Türkiyede Karbondioksit Emisyonları, Doğrudan Yabancı Sermaye Yatırımları ve Enerji Tüketimi İlişkisi: Eşbütünleşme ve

Nedensellik Analizi, *IV. Anadolu International Conference in Economics*, June 10-12, Eskişehir, Turkey.

Kofi Adom, P., Bekoe, W., Amuakwa-Mensah, F., Mensah, J. T. and Botchway, E. (2012). Carbon Dioxide Emissions, Economic Growth, Industrial Structure, and Technical Efficiency: Empirical Evidence from Ghana, Senegal, and Morocco on the Causal Dynamics. *Energy*, 47(1), 314–325.

Kuznets, S. (1955). Economic Growth and Income Equality. *American Economic Review*, 45(1), 1-28.

Levin, A., Lin, C. F., and Chu, C. S. J. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of econometrics*, 108(1), 1-24.

Liao, H. and Cao, H. S. (2013). How Does Carbon Dioxide Emission Change With The Economic Development? Statistical Experiences from 132 Countries. *Global Environmental Change,* 23(5), 1073–1082.

Lotfalipour, M. R., Falahi, M. A. and Ashena, M. (2010). Economic Growth, CO2 Emissions, and Fossil Fuels Consumption in Iran. *Energy*, 35(12), 5115–5120.

Maddala, G. S. and S. Wu (1999). A Comparative Study of Unit Root Tests with Panel Data and A New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61, 631–52.

Menyah, Kojo and Wolde-Rufael, Yemane (2010). CO2 Emissions, Nuclear Energy, Renewable Energy and Economic Growth in the US. *Energy Policy*, 38, (6), 2911-2915.

Munasinghe, M. (2001). Sustainable Development and Climate Change: Applying the Sustainomics Transdisciplinary Meta-framework. *International Journal of Global Environmental Issues,* 1(1), 13-55.

Özcan, B. (2013). The Nexus between Carbon Emissions, Energy Consumption and Economic Growth in Middle East Countries: A Panel Data Analysis. *Energy Policy*, 62, 1138–1147.

Öztürk, I. and Acaravcı, A. (2013). The Long-Run and Causal Analysis of Energy, Growth, Openness and Financial Development on Carbon Emissions in Turkey. *Energy Economics*, 36, 262-267.

Pao, H. T. and Tsai, C. M. (2011). Multivariate Granger Causality between CO2 Emissions, Energy Consumption, FDI (Foreign Direct Investment) and GDP (Gross Domestic Product): Evidence from a Panel of BRIC (Brazil, Russian Federation, India, and China) Countries. *Energy*, 36, 685-693.

Park, J. and Hong, T. (2013). Analysis of South Korea's Economic Growth, Carbon Dioxide Emission, and Energy Consumption Using The Markov Switching Model. *Renewable and Sustainable Energy Reviews*, 18, 543-551.

Pata, U. K. (2018). The effect of urbanization and industrialization on carbon emissions in Turkey: evidence from ARDL bounds testing procedure. *Environmental Science and Pollution Research*, 25(8), 7740-7747.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1), 653-670.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis. *Econometric Theory*, 20(3), 597-625.

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16(3), 289-326.

Saboori, B., Sapri, M. and bin Baba, M. (2014). Economic Growth, Energy Consumption and CO2 Emissions in OECD (Organization for Economic Co-operation and Development)'s Transport Sector: A Fully Modified Bi-directional Relationship Approach. *Energy*, 66 (1), 150-161.

Salahuddin, M. and Gow, J. (2014). Economic Growth, Energy Consumption and CO2 Emissions in Gulf Cooperation Council Countries. *Energy*, 73: 44-58.

Sarısoy, S. ve Yıldız, F. (2013). Karbondioksit (CO2) Emisyonu ve Ekonomik Büyüme İlişkisi: Gelişmiş ve Gelişmekte Olan Ülkeler İçin Panel veri Analizi. *Namık Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* No 2.

Shahbaz, M., Solarin, S. A., Mahmood, H. and Arouri, M. (2013). Does Financial Development Reduce CO2 Emissions in Malaysian Economy? A Time Series Analysis. *Economic Modelling*, 35, 145-152.

Smarzynska, B. K. and Wei, S. J. (2001). Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth? (No. w8465). *National Bureau of Economic Research*.

Van Hoa, T. and Limskul, K. (2013). Economic Impact of CO2 Emissions on Thailand's Growth and Climate Change Mitigation Policy: A Modelling Analysis. *Economic Modelling*, 33, 651-658.

World Bank Data Base, https://data.worldbank.org/

Yavuz, N. Ç. (2014). CO2 emission, energy consumption, and economic growth for turkey: evidence from a cointegration test with a structural break. *Energy Sources, Part B: Economics, Planning, and Policy*, 9(3), 229-235.