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THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND CAPACITY FOR GENERATING CO_2 EMISSIONS: TESTING THE VALIDITY OF THE ENVIRONMENTAL KUZNETS CURVE FOR TURKEY*

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ABSTRACT

This study is an attempt to measure the validity of the inverted U-shaped Environmental Kuznets Curve through empirical treatment with the help of ARDL bound test and vector error correction model. The study then aims to find whether there is a long-term relationship between economic growth and environmental pollution. In the literature, the methodology is used by different researchers for different countries. The findings, in general, endorse the presence of inverted U association between growth of the economy and carbon emissions releases. Given this framework, the need for empirical assessment becomes increasingly relevant in partial contribution to policy innovations for the purpose of pollution reduction. The findings for the study supports environmental Kuznets curve in Turkey for the period of 1960-2013.

Keywords: *Carbon Emission, Industrial Pollutants, ARDL Model.*

TÜRKİYE'DE İKTİSADİ BÜYÜME VE CO_2 EMİSYONU YARATIM KAPASİTESİ ARASINDAKİ İLİŞKİNİN GEÇERLİLİĞİNİN ÇEVRESEL KUZNETS EĞRİSİ İLE TEST EDİLMESİ

ÖZET

Bu çalışma, ARDL sınır testi ve vektör hata düzeltme modeli kullanarak, ters-U şeklindeki Çevresel Kuznets Eğrisi'nin geçerliliğini ampirik olarak test etmeyi amaçlamaktadır. Bu bağlamda, çalışmanın hedefi, iktisadi büyüme ile çevresel kirlilik arasında uzun dönemli bir ilişkinin olup olmadığının tespit edilmesine yöneliktir. Literatürde, farklı ülkeler için farklı çalışmalar tarafından kullanılan bu yöntemin genel bulguları ekonominin büyümesi ile karbon emisyonu salınımı arasında ters-U şeklinde bir ilişkinin varlığını doğrulamaktadır. Bu çerçevede, ampirik değerlendirmelerin, çevresel kirliliğin azaltılması için politika önerisine yönelik yenilikçi katkıların sağlanması için giderek artan düzeyde öneme sahip olduğuna inanılmaktadır. Türkiye'de 1960-2013 yılları arasındaki verileri kullanılarak yapılan bu çalışmanın bulguları, Çevresel Kuznets Eğrisi'ni desteklemektedir.

Anahtar Kelimeler: *Karbon Emisyonları, Endüstriyel Kirleticiler, ARDL Model.*

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1. Introduction

Inverted U-shaped Environmental Kuznets Curve (EKC) suggests that at (relatively) low per-capita income levels, pollution level will increase- perhaps at an increasing pace-after having reached at a peak, pollution will decline. The World Development Report (World Bank, 1992) reflects the evaluation on the EKC in a manner which environmental standards were to constantly improve alongside the improvement in income. That is to say, effective way of protecting environmental balance and quality is to increase income; in other words to increase GDP[1]. At the rudimentary stage of industrialization, growth and pollutants rise together in a process which can be depicted as a natural phenomenon[2]. Despite the positive inclination proven by the results of EKC in line with the substantial growth in per-capita income, some damage stemming from the early phases of industrialization can have grave permanent impact on the environment and even on economic growth[3]. In the early stages, per-capita income and degree of environmental degradation move hand in hand up until a threshold is reached, environmental quality -in terms of water, air, soil, energy and even food- becomes a scarce good and subsequently demand for it grows enormously.

Environmental economics is a relatively young sub-branch of economics, as the public interest increased on environmental problems, particularly generation of pollution, so did the interest of academics, research attempts were triggered on EKC in early 1990s (Grossman & Krueger, 1991; Shafik & Bandyopadhyay, 1992). World Bank (1992) initiated the concept of EKC in an attempt to prove a case in the field of environmental economics. Then came more comprehensive works, working with generally cross-country data to contribute to measurement of global emissions, various type of pollutants were to be used as variables and various techniques were employed to highlight broader implications and underlying challenges including issues related to climate change. Stern et al. (1996), Stern (2004), Panayotou (1993), Panayotou et. al. (1999), Dasgupta et al. (2002), Dinda (2004), Ekins (1997), Barbier (1997), de Bruyn (1997) and Galeotti et. al. (2006) are the stimulating researches in this respect.

Environmental issues with regards to environmental degradation, the any kind of pollution that adds up to this process, are irreversibly global matters. Sustainable development is a relatively new but an ambitious discipline, try to establish how environmental, ecological and resource scarcity issues can be addressed given the global economic order amidst the given level of environmental degradation. There exists vast income inequality dispersion among the nations and regions across the nations and only way to bridge the gap between underdeveloped and developed world is the achievement of a fast growth in favor of the former cluster of countries. Again, creation of more income equality means increased production and energy consumption which in return potentially prone to generate additional pollution and other types of pollution-related environmental degradation in the face of global warming and climate

1 The argument goes further that better environment can be possessed and maintain when nations and individuals get wealthier by producing more, this is a call for developing economies both to get richer and contribute to the global environmental well-being is indeed intellectually appealing. For more details on this argument, see Beckerman (1992).

2 For this tendency, Dasgupta et al. (2002) have given a clear explanation that could be thought out intuitively. At the initial phase of industrialization, industrial activity is relatively primitive, yet production processes are strictly progressing under tougher conditions; due to competition, cost considerations and so on. Poverty-stricken residents are engaged in constant industrial work in order to make ends meet.

3 More on this, for example, see Taguchi (2012).

change. The pioneering article by Shafik & Bandyopadhyay (1992), finding a close relationship between per-capita income and environmental degradation, namely environmental Kuznets Curve approach, established that this relationship is illustrated by an inverted U-shaped curve. This intellectually appealing concept and empirical findings attached to it further established that intensive carbon and other major pollutant emissions tend to decline when a certain growth (per-capita GDP) level is attained. This result would further boost new concepts and perspectives in the study of development economics. The income level associated with a turnaround in the amount of pollution after reaching a peak is varying between 8000-20000 dollars depending on the type of the pollutant, country and even the investigation techniques used. Kuznets Curve approach is important in that conjuncture for it suggesting a level of average income which starts to respond to the sustainable development efforts.

There exists a vast body of research conducted in the field of EKC by focusing on global performance through employing cross-country panel data techniques. Testing and measuring pollution in global scale is important, yet technically measurement of individual performances by no means is less important-whether it be measurement of global pollutant or local one. Turkey is a middle-income developing country, constantly challenging to boost its industrial production capacity and naturally industrial output. Turkish policy makers usually concerned with boosting export production alongside the production generated for domestic use. To this end; Turkish economy can be considered as an open economy expecting considerable gain from foreign trade in the long-run. Turkey has established ties with European Community as early as in 1959 and concluded an association agreement with the EEC (European Economic Community) in 1963 which came into force in 1965. Achievement of gradual trade liberalization between Turkey and Community member countries over the time was one of the main pillars of this association agreement. Finally, Turkey have had managed to conclude a customs union agreement with the EU that came into effect in 1996 with which Turkish economy were being linked not only to the EU countries but also to a host of other countries across the globe. By gradually following the path of trade liberalization over the time; Turkey has built up capabilities to generate pollution in production of exported goods. The binding industrial regulations aimed at mitigating the effects of pollutants-including CO_2 emissions- by industrial plants have not yet reached at a satisfactory level. Testing the validity of EKC for Turkey gives clues about the GDP growth-CO_2 correlation wherewith the results help to highlight a sustainable future industrial and energy policy trajectory for Turkey.

Empirical findings of a theoretical investigation can be considered as the pinnacle of an academic work in economics, yet this process should not necessarily be insulated from the broader implications inherent in the theoretical framework. Likewise, a large body of academic work on Environmental Kuznets Curve hypothesis follows a similar pattern without much focus placed on the environmental problems in general and global warming in particular. This work is an attempt to bridge this gap by connecting environmental issues to the empirical investigation so that corresponding theoretical findings become more insightful and comprehensible. Thus, this study differs in a manner that it includes both theoretical and political perspectives on EKC in an eclectic manner in which doing so would render results more meaningful of the empirical investigation based on Turkey.

The rest of the article is structured as follows: the following chapter deals with the Environmental Kuznets Curve in comparative and critical manner. Globalization, distinction between different source of pollutants and a brief review of some major contributing countries from Asia are the issues covered in this part. This chapter also includes literature review of EKC in a critical manner. The next chapter presents the model and empirical method for testing the validity of EKC for Turkey by focusing on CO_2 emission data and; presents and interprets the results. The final chapter concludes the results of this work.

2. Environmental Kuznets Curve Hypothesis: Theoretical and Empirical Context

What originally Kuznets Curve stands for is that it is a plain statement about a correlation between income level and income equality. Kuznets (1955) proved that as the level of per-capita income rises in a particular economy, the level of income inequality that matches each per-capita income would decline. He conceptualized the notion of inverse U-shaped curve to represent a correlation between income and income equality which inspired environmental economists through shifting the interest from income inequality to pollution and environmental degradation in various respect.

2.1. EKC Hypothesis: A Further Review

The EKC hypothesis is first emerged with Grossman & Krueger (1991)'s pioneering work that assessed the position of Mexico in a comparative study. They set out to investigate the possible challenges and effect of NAFTA with a particular focus on growth and environment. They established that through NAFTA partnership, Mexico would boost their economic growth without feeling the adversities. They further established to show that enhancing growth through free trade would not deteriorate environmental quality but would categorically improve for the better-phrasing the established relationship indicated by EKC. Uchiyama (2016: 27) emphasizes the fact that many works have been undertaken at the time on EKC focuses on worldwide data, while studies at individual country level had not been many. Khanna & Plassmann (2004: 10) relates that "most empirical studies on the EKC focus on the aggregate relationship between pollution and income. They use national level panel data and include only income (typically GDP per capita) and variables that are unlikely to be correlated with income so as to capture the direct and indirect effects of income on pollution".

There are authors that give a list to substantiate reasons for inverted U shaped EKC. Among others, Andreoni & Levinson (2001) offer their account of EKC on this, the following is the review that largely drawn upon their highlights: Those points are primarily related to the changes that occur through shifts (increase) in per-capita income. First of all, there are changes in production, production methods, technology and consumption patterns in relation with consumer preferences. There come changes in public attitude towards environment and environmental protection-demand (preference) for environment gets stronger as income rises towards the peak. In a way, the power of increasing public awareness that calls for relevant institutional changes. Those warranted structural reforms are then expected to initiate stringent regulations in return. Technically speaking, increasing returns to scale impact in relation with the pollution abatement- mass production and usage of abatement technologies are closely related.

2.2. A Highlight of Global Environmental Issues

In most developing countries, masses in industrial urban areas are struggling to earn a living so that environmental improvement is not a priority in their mind nor people's environmental awareness level has reached to a near to reasonable. Concerning the pollution reduction activities, that way of interference is generally impossible since expenditures are very high and they cannot afford to make changes in favor of environmental protection. On the other hand; state or local regulations are extremely loose to generate real impact, so that little intervention on production methods. However; when a certain income level is reached, pollution (level) starts falling after a peak is reached and when an advanced economy status is achieved with matching high per-capita income, falls enormously- with a negative response to the subsequent increases in income. Those richer communities become environmentally conscious and care for the environment they lived in. Relevant regulations are introduced and effectively applied; even the firms did abide by environmental cleanliness to a certain degree.

Those findings suggest some improvements in environment through mitigating effect of income; and must even further boost efforts in the direction of reducing pollution; cleaning environment and maintaining the quality that has already been reached. Needless to say, considerations alike must be of primary concern in the long-run rather than expecting GDP growth single-handedly to deal with the prolonged environmental problems[4]. Through the Industrialization process, the substantial growth achieved in wealth and living standards must equally be translated into direct actions aiming to tackle pollution and subsequent environmental degradation; not only through challenging domestically but also through global efforts. In the process, individual efforts must be coordinated with urgent priority in uniting forces for collaboration with developing nations. Substantial gains can only be made through stringent regulations and bulky investment; and through financial and technical contribution to developing nations[5]. Paris Agreement 2015 has created a sphere of optimism by drawing a road map in the direction of global collaboration[6]. The firm objective of raising environmental awareness in societies is key to future improvement in environmental quality for the future generations where desire for high standards will overlap throughout[7].

2.3. Globalization and EKC

It is a widely known fact that globalized world trade has bolstered specialization in production and trade not only in advanced high-income developed countries but also in developing countries with low or medium income outlay. Therefore; developing countries are actively playing out their role in global trade in pursuit of benefiting from specialization of the international trade. More and more the volume of consumption is rising and durable goods produced in developing world are being traded in massive scales with the rest of the developed World as result of creation of an environment which is conducive to trade, investment and financial deals. China stands out as a text-book example for the specialization through which traded goods are highly diversified. It is believed that an additional burden of pollution is

4 These remarks are in line with the views reflected by Arrow et al. (1995).
5 The principles in this respect can be phrased as "Global alleviation" and "Burden sharing".
6 For the detailed account on the nature of global coordination, collaboration and liabilities, see, Droge (2016) on the details of Paris Agreement 2015.
7 In a way, such conscious and systematic efforts can be recognized as public good.

being generated through the process of global trade. Within this context; there exists a growing relevant argument that accuses developing countries of inflicting excessive amount of pollution on developing countries through trade[8].

Apart from metal processing, mining, and manufacturing industry, now old-fashioned coal-burning electric power generation plants have been notoriously contributing to environmental degradation through emitting most harmful atmospheric pollutant, CO_2 with mostly inefficient technologies. Regarding this, China stands out as a victim as well as a culprit as a consequence. CO_2 and other industrial gases make the life unbearable for the inhabitants of major urban areas with the underlying industrial hubs. CO_2 emissions become more and more conspicuous and fatal hazard for the city dwellers. Regarding coal-based energy production; China is reported to have been gradually closing down the old plants. China has made a pledge through Paris agreement towards substantial reductions in CO_2 emissions by stepping up their efforts for the period between 2020 and 2030. Renewable energy investment is expected to become a major priority and EU authorities pledged financial support for China[9].

Regarding CO_2 emissions that India generates annually is not much optimistic at the present; people of densely populated cities in this poverty-stricken country running through gradually increasing direct health hazards stemming from industrial pollution -in addition to the hostile conditions they are exposed to in the surrounding shanty towns of the urban areas. Yet, private investment in renewable green energy production today has become more popular than ever- this sector drawing on more and more private investors into this sector for the electricity generation particularly investing in solar energy systems. Indian government has pledged to provide incentives for the future investment on renewable energy with a goal of increasing much needed total electricity production. Nevertheless; environmental damage has been created through various means is far from being eliminated outright in the decades to come.

South Korea and Japan are still major contributor of CO_2 emissions in the South-Asia region despite the high level of per-capita income they hold and despite the state of art technologies being used in industrial production. The new era commencing by 2020 highlights the strict administrative processes in dealing with industrial pollution and both countries are expected to do their utmost to comply with the required reductions in CO_2 emissions. Environmentally conscious public in both countries are expected to encourage and even further assist their policy makers in their commitment to implement vital environmental policies. The new era highlighted as Paris COP-21 process can help mitigate environmental degradation to an enormous extent in a time span of three decades providing that all parties from international community played their part in full commitment continuously. However; the announced action plan or like of it by no means expected to heal environmental scars entirely in the foreseeable future. Yet; this fact makes swift mobilization of efforts an utmost priority and more meaningful then have ever been. Last but not least; academics from various disciplines are expected to carry on their contribution through conducting their research more intensively in this regard.

8 Through outsourcing, developed countries give up producing a wide range of goods domestically by passing on the production of wide range of goods onto developing countries through trade and by doing so shifting potential pollution from national economy to overseas; one might suggest that they are outsourcing pollution to generate environmental degradation elsewhere.

9 EU as a political entity; and other major advanced economies have a responsibility to provide financial backing for developing countries within an action plan as required by Paris agreement and preceding protocols. It is expected that some developed nations and international institutions likely to provide assistance on the basis of voluntariness.

2.4. Distinction between Local and Stock Pollutants

Environmental degradation is not solely composed of flow type pollutants but it also encompasses any stock type of pollution which is accumulated over the time. Therefore, environmental degradation that stock type of pollutants carried out on the planet up to now is at alarmingly high level with catastrophic implications. Therefore, concrete efforts in search of achieving real results to prevent further catastrophic progress leading up to climate change cannot be achieved without the initiatives of strong domestic and global institutions. Lopez (1994) and Jones & Manuelli (1994) highlight the importance of the institutions being the central force in effectively dealing with environmental issues. As for international efforts and coordination, Paris agreement of 2015 has paved the way for future action that was initially triggered by Kyoto Protocol. Yet international efforts must become more institutionalized and strengthened both in terms of financial and political robustness and wider recognition of transparency.

As Arrow et al. (1995) highlight, improvement in the quality of environment can be observed through GDP growth, yet this correlation cannot be viewed as a taken for granted solution for every environmental issue which are in many cases are represented as "stocks" that are accumulated over the long period of time. Despite the vast amount of findings that provide support for declining segment of EKC for advanced economies, there are number of works that draw attention to the otherwise[10]. Khanna & Plassmann (2004) noted that in the past, degrees of environmental pollution have risen as economies grown to be developed and income levels increased; therefore there is much more empirical support for the upward sloping segment of the correlation suggested by the EKC. Uchiyama (2016: 18) underlines lack of regulation in the case of CO_2: "The EKC with regards to air quality is observed when the pollution area is local, the pollutant is of a flow type and decomposes in a relatively short time, and some regulations have already been introduced. When, as is the case with CO_2, the pollutant is of a stock-type and few regulations have been introduced, the existence of the EKC remains controversial". As a result, he further suggests the presence of two cases for the EKC, with respect to CO_2 emissions: "one with an inverted –U curve or another that is monotonically increasing".

2.5. Literature Review: Empirical Research

Empirical researches use different indicators for environmental degradation such as air quality, water quality and other environmental quality indicators to estimate the EKC hypothesis. However, the relationship between these indicators and economic growth has mixed results, meaning that each type of pollutant and economic growth relation would not necessarily follow a uniform trajectory. Thus, the results produced are differentiated for each particular pollutant item[11]. Agras & Chapman (1999) in attempt to test two EKCs respectively, use per-capita energy consumed and per-capita CO_2 emissions for 34 countries for the period of 1971-1989. According to the results of their research, they found no concrete support for the presence of EKC. Some of the research findings are in conflict with the proposed results of EKC; i.e. findings of Stern et al. (1996), Ekins (1997), Selden & Song (1994), Khanna & Plassmann (2004) imply that substantially increasing world production and income about to deteriorate

10 There are findings supporting that developed countries like those of South Korea and Japan had been observing increases in CO_2 emissions until very recently.

11 For a detailed literature review, see Shahbaz & Sinha (2019).

present global pollution. These findings can be related to the sustainable development argument into which the EKC itself provided valuable insight. That is to say; constantly increasing world production in the absence of policies designed to coordinate production capacities and without burden sharing type of collaborative arrangements; the resources of our planet will continue to be depleted at an increasing pace while creating additional burden of massive pollution.

The works by Grossman & Krueger (1995) and Selden & Song (1994) bring in substantial evidence in support of EKC by using some particular pollutants in their empirical testing. Selden & Song (1994) particularly highlight that EKC's applicability is more tenable for the local pollutants rather than global ones. Taguchi (2012) tested the validity of EKC by employing the panel data for 19 countries for the period 1950-2009. He finds that sulphur emissions demonstrate the inverted U-pattern, while on the other hand Carbon emissions incline to rise as does per-capita income, given the observed data range[12]. When environmental protection happens to be a focus of substantial investment, income growth rate declines respectively (Chimeli & Braden, 2002: 4)[13].

2.6. Theoretical Issues and Criticism

Perman & Stern (2003) and Stern (2004), concerning the argument about EKC hypothesis, conclude that EKC hypothesis is not robust. On the other hand, Uchiyama (2016) finds the model formulation rather problematic by claiming that there had been a few research works in line with the theoretical model. Further on, he stresses a point by claiming that "there is a gap between theoretical and empirical results." Uchiyama (2016) on the other hand highlights the fact by reminding that plenty of empirical works undertaken were "based on worldwide panel data", and the fact that there had not been a lot of research conducted at single country level.

With respect to results and treatment of EKC, Figuerora & Pasten (2009) concluded in comparative manner, including some controversial points, the following are some of their findings: a) overall, the EKC hypothesis is robust for developed countries; b) country specific EKC can be encountered in most of the OECD and developed countries; c) in a few OECD and developed countries the EKC is not supported by the data; d) some evidence exist that an EKC is most likely to be found in countries with regulatory processes that resemble market mechanisms. Further on; Figueroa & Pasten (2009) criticize the most cross country research undertaken, following is their quotation: "…one crucial drawback of most cross-country studies empirically testing the presence of an EKC is their assumption that the coefficients of the inverted U relationship are the same for every country, implying that the expected shape of the EKC is the same for every country and the predicted turning point in income is also the same for every country", and further claiming that, "…the assumption that the EKC coefficients are constant across countries would be misleading most of the time." (Figuerora & Pasten, 2009).

12 His findings support the view which defends that EKCs are validated for local pollutants, but not likely to be applicable for global pollutants. In addition to the works highlighted above, works carried out by the following authors are also in line with the findings of Taguchi: Dinda (2004); Cole, Rayner & Bates (1997); Horvath (1997); Holtz-Eakin & Selden (1995); Khanna & Plassmann (2004).

13 Chimeli & Braden (2002: 22) sets out linkage between global warming and fossil fuels dependent energy technologies; and emphasize that their replacement costs or other factors render such technological transformation highly difficult.

3. An Empirical Treatment of Environmental Kuznets Curve for Turkey

This part of the study aims to find an empirical relationship between economic growth and carbon emissions with EKC for Turkey. In recent years, the empirical literature for Turkey is in demand. The pioneering studies (Halicioglu, 2009; Ozturk & Acaravci, 2013) support the inverted-U shaped EKC hypothesis. The study includes the data of Turkey for the period of 1960-2013[14]. The variables are obtained from World Bank database and because the natural logs are very convenient for describing relations between economic variables, we used the logarithmic forms of all variables. In the study, we have CO_2 emissions (measured by CO_2 emissions per capita) as a dependent variable and three independent variables that they are economic growth (measured by GDP per capita), economic growth squared (as EKC variable) and energy consumption (measured by energy use per capita). All data are achieved from World Bank and the analyses are made by using STATA 14.0 software. We use Pesaran & Shin (1999) and Pesaran, Shin & Smith (2001)'s approach for the ARDL analysis that it is superior and more effective to previous approaches on determining the relationship of (long-term and short-term) co-integration between variables[15]. The ARDL form of variables in our model is shown below:

$$InCo2E_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1,i} InCo2E_{t-i} + \sum_{i=0}^{q} \alpha_{2,i} InGDPpC_{t-i} + \sum_{i=0}^{v} \alpha_{3,i}\, InGDPpC\hat{}2_{t-i} + \sum_{i=0}^{w} \alpha_{4,i} InEnUSE_{t-i} + \varepsilon_t$$

Before applying ARDL approach, we obtained the unit root test results to check whether the variables are stationary or not. We used three different unit root tests (named Augmented Dickey-Fuller, Phillips-Perron and Elliott, Rothenberg & Stock (1996)'s Dickey-Fuller GLS) and found that the variables are stationary at 1st difference, in general. The table below shows the results for unit root tests:

Table 1: ADF, PP and DF-GLS Unit Root Test Results

(with Trend & Intercept)		Level			1st Difference		
	Variables	**ADF**	**PP**	**DF-GLS**	**ADF**	**PP**	**DF-GLS**
Test statistic	$lnCo_2E$	-2,461 (0.348)	-2,451 (0.353)	-0,898	-7,952* (0.000)	-7,941* (0.000)	-4,918*
	lnGDP	-2,442 (0.358)	-2,694 (0.239)	-2,488	-7,033* (0.000)	-7,031* (0.000)	-4,464*
	lnGDP2	-2,193 (0.493)	-2,476 (0.340)	-2,335	-6,996* (0.000)	-6,993* (0.000)	-4,476*
	lnEnUSE	-2,407 (0.376)	-2,418 (0.370)	-2,082	-7,053* (0.000)	-7,060* (0.000)	-4,798*
Test critical values	%1 level	-4,143		-3,755	-4,146		-3,759
	%5 level	-3,497		-3,177	-3,498		-3,180
	%10 level	-3,178		-2,878	-3,179		-2,881

Note: *shows %.01 significance level. Also, prob-values are in parentheses.

14 The selected time period denotes the latest data available when the study was first prepared and presented.

15 We used Kripfganz's ardl command in Stata 14.0 to estimate ARDL model. Kripfganz & Schneider (2018) present a detailed information on the steps of the analysis.

Then, we estimated a bound test for ARDL model to see whether there is a long-term relationship between the variables. Bounds testing procedure is available to be used whether the variables are integrated of order zero or one, I(0) or I(1), respectively (Peasaran et al., 2001). By using Akaike information criteria, we found that the optimal lag selection for the model is (2, 0, 0, 2)[16]. The bound test results are shown at table 2. It presents that F-stat value is bigger in all levels which means CO_2 emissions, energy consumption and economic growth are co-integrated in the long-term:

Table 2: ARDL (2, 0, 0, 2) Bound Test Results

F-stat (Prob.)	%10 level	%5 level	%1 level
15,895 (0.000)	2,832-3,963	3,420-4,678	4,775-6,298

Note: The critical values are belong Kripfganz & Schneider (2018).

Also, we have estimated the ARDL model, the coefficients and the error correction form. According to the results which are shown in table above, all coefficients are statistically significant at %1 level. The long-run estimation results are shown at table below and they represent the equilibrium effects of independent variables on dependent variable. The signs of the coefficients are consistent with the expectations that the variable of economic growth and the variable of energy consumption have positive signs, but the EKC variable has a negative sign which supports EKC theory.

Table 3: ARDL (2, 0, 0, 2) Model Estimation Results and Error Correction Form

	Coefficient	t-stat	Prob.
Long-run coefficients			
lnGDPpC	6,7117 (1.846)	3,64*	0.001
lnGDPpC^2	-0,3634 (0.096)	-3,78*	0.000
lnEnUSE	0,8854 (0.197)	4,50*	0.000
Short-run coefficients			
lnGDPpC	3,1412 (1.460)	2,15**	0.037
lnGDPpC^2	-0,1701 (0.078)	-2,17**	0.035
lnEnUSE	0,4144 (0.148)	2,81*	0.007
ΔlnCo2E(-1)	-0,3408 (0.119)	-2,87*	0.006
ΔlnEnUSE	0.6745 (0.149)	4,54*	0.000
ΔlnEnUSE(-1)	0,3192 (0.145)	2,20**	0.033
C	-16,865 (7.105)	-2,37**	0.022

16 In fact, due to the results, the smallest (most negative) value of Akaike Information Criteria (AIC) is -240.730 and it belongs to ARDL (1, 0, 0, 1) model. But at post-estimation, we found that, this model which has the smallest value of AIC includes a serial correlation problem due to LM test and we chose the second smallest value of AIC with -240.311 which is ARDL (2, 0, 0, 2) model.

Table 3 continued

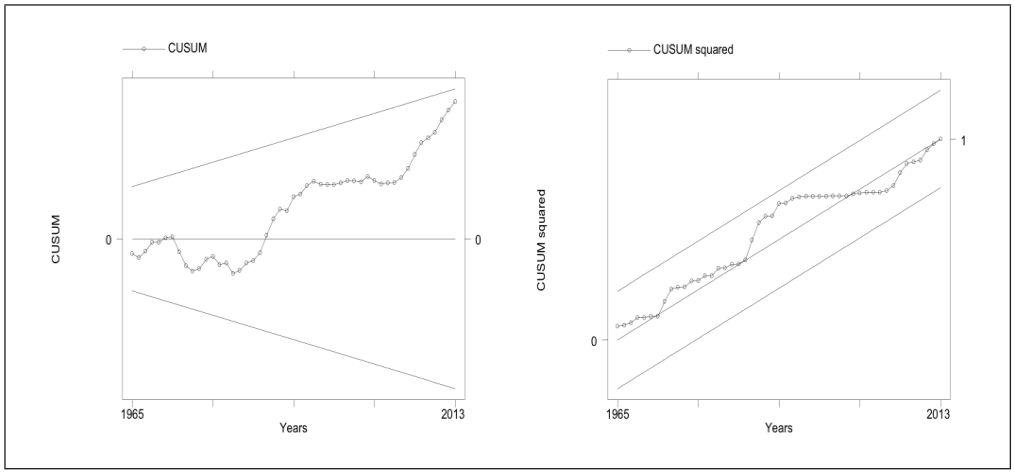
R^2	0.877	F-stat (prob)	45,12 (0.000)
ECMt(-1)	-0.4680 (0.125)	-3,75*	0.001
Diagnostic Tests			
Normality: Skewness/Kurtosis test, chi^2=1.19 (prob:0.5504)			
Serial correlation: Breusch-Godfrey LM test, chi^2=0.672(prob:0.4125)			
Heteroskedacity: Breusch-Pagan / Cook-Weisberg test, chi^2=0.17 (prob: 0.6818)			
Functional form: Ramsey RESET test, F (3, 41)=0.59 (prob: 0.6242)			

Note: * and ** show %.01 and %.05 significance levels, respectively. The values in parentheses on coefficient column are standard errors.

The model shows that CO_2 emissions affect energy use and economic growth positively and affect economic growth squared (EKC variable) negatively. It means that, for the period of 1960-2013 in Turkey, the results support environmental Kuznets curve in the long run. Finally, the coefficient of ECM term is estimated as -0.468 which is negative as expected and it is statistically significant. It means that a deviation from short term CO_2 emissions will be overcome around % 46,8 at the next period to reach long-term equilibrium.

The final analysis of the study is to test structural change over time with Brown et al. (1975)'s CUSUM and CUSUM-SQ tests. The CUSUM test is based on the cumulative sum of recursive residuals and shows the stability of coefficients if the cumulative sum stays inside the area between the critical lines The CUSUM-SQ test, which is based on the squared recursive residuals, has similar procedures (Akinlo, 2006). The figures below show that the values stay within the critical %5 bounds and confirm the stability of coefficients.

Figure 1: CUSUM and CUSUM-SQ Tests Results



4. Conclusion

As far as the EKC literature is concerned, while a great deal of research findings verifies the validity of the EKC for local pollutants, many other findings fail to provide robust evidence for verifying the presence of EKC for global pollutants. Yet; many of those works are framed in cross-country investigation through which EKC is tested for the observed range of countries as if they were a single entity. However; there increasingly a rising trend of focusing only on an individual country in testing the validity of EKC. Likewise; this work attempts to test the validity of EKC only for Turkey regarding carbon emissions. The findings brings forward enough evidence in support of EKC for Turkey for the observed sample period meaning that carbon emissions have declined after reaching a peak. Turkey is a middle income economy with a reasonable income growth. The findings support that carbon emissions in Turkey respond negatively to the increase in per-capita income representing an improvement in environmental quality. To this end, the main results of the study show that there is a long-term co-integration with relevant variables and the results also support EKC hypothesis for Turkey. Because the environmental pollution is highly co-integrated with economic growth, the authors aim to stimulate more researches which include (particularly) the stable growth policies to minimize the environmental pollution.

Despite the falling trend indicated by the findings of this study for Turkey; there remains considerable work to do in tackling emissions-for both local and global pollutants-public and policy makers should work in collective harmony to determine a feasible framework which is sustainable and responsive in the long- run. Tax incentives could be offered for pollutant firms to encourage them use abatement technologies and adopt to relatively recent innovations which would potentially bring down the level of emissions. Improvement in environmental quality in other areas must be encouraged. Green energy investment is growing slowly despite the presence of enormous potential opportunities. Investment in solar electricity generation is the field needs to be given enough attention. If necessary, technical assistance from abroad must be requested as part of a long-run action plan. Last but not least; public should constantly be informed about environmental and related issues in a manner to raise awareness and improve expectations for the future. Additionally, it is hoped that this work will humbly contribute to the efforts of raising more awareness towards global and domestic environmental protection; and help the wider communities to resonate with the caption that "a good quality environment is a public good".

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