Determinants of Environmental Quality in Turkey on the Regional Basis

Authors

Osman Altuğ ÇAKMUR[1*]

Affiliation

[1]Doctoral Program in Economics, Graduate School of Social Sciences Yeditepe University, İstanbul 34755, Turkey.

*To whom correspondence should be addressed: osmanaltug.cakmur@std.yeditepe.edu.tr

Abstract

This study explores the intricate relationship between economic growth and environmental sustainability, emphasizing the indispensable role of the environment in sustaining economic activities in Turkey.

Central to the investigation is the Environmental Kuznets Curve (EKC) hypothesis, which posits an inverse U-shaped relationship between per capita income and environmental degradation. The study extends its focus to the Turkish context, bridging theory with empirical evidence and emphasizing the unique dynamics of the nation's international trade relations.

Empirical results highlight the phenomenon of carbon leakage, indicating that developed countries transfer pollution-intensive production to Turkey, while Turkey reciprocates in trade with certain regions. The lack of environmental policies in Turkey's economic relations raises critical implications for future research, emphasizing the need to scrutinize the impact of foreign trade on environmental degradation.

In conclusion, this research contributes to the ongoing discourse on sustainable development by providing a nuanced understanding of the interplay between economic growth and environmental stewardship. The research's novelty lies in its depth of analysis on specific variables and regional focus, offering practical insights for policymakers, scholars, and concerned citizens grappling with the challenge of balancing economic development with environmental responsibility.

Keywords: Carbon leakage; environmental kuznets curve; environmental policies

INTRODUCTION

In economic activities of countries, environment is unavoidably a significant part of production processes for continuously providing the needed raw materials and other inputs. At the end of production and particularly during the consumption stage however, resulting wastes often have a massive harming impact on the environment. Indeed, some wastes that cannot be recycled lead to environmental pollution, while others can be recycled and brought back for re-usage in production. Environmental degradation, in turn, negatively affects all economic activities, since the two are irreversibly intertwined. As a matter of fact, the interdependence between environment in general and economy stems from the fact that economic activities can only be sustained by producing (and selling) commodities using raw materials offered by the environment. Thus, it is undebatable that the environment is the fundamental component of economic prosperity (Ulucak and Erdem, 2014: 80).

Starting with the Industrial Revolution, mass production has brought in an ever-growing use of resources for more production. This increase in production leads to growing income levels, further contributing to consumerism — at the cost of environmental issues. Among these issues triggered by excessive production and consumption is the depletion of the ozone layer, the global climate change, erosion, diminishing fresh water resources and the overall air pollution (Bayraktutan and Uçak, 2011: 18).

The relationship between environment and economy is often marked by the development level of a country. In that, developed countries are observed to lay more emphasis on solving environmental problems with a number of proposed solutions such as investment and technology policies with remedial actions. To cover the costs of environmental damage, public administrations in these countries can easily demand financial self-sacrifice from producers and consumers, while underdeveloped and developing countries are often observed to ignore environmental issues (Akyıldız, 2008: 35).

In this vein, developing countries are seen to apply industrial activities leading to high levels of pollution in their industrialization process, and they conventionally lack any comparative advantage in their industrial production. Nevertheless, consumers in developed countries around the world have been demanding clean environment practices and environmental legislations. Such demands, in turn, have increased the costs for "dirty industries". On the other hand, the so-called dirty industries tend to migrate from developed to developing countries today due to the relatively low environmental awareness of consumers and inadequate environmental regulations in these developing countries. Scholars explain and refer to this situation by the “Pollution Shelter Hypothesis” (Akbostancı et al., 2006: 3, Akyıldız, 2008: 156). According to the pollution shelter hypothesis, central economies transfer their industrial wastes — leading to environmental pollution and posing a risk to nature — to peripheral economies together with the units that produce by ineffective production technologies.

Based on these developments, economists have been studying the increasing effects of economic growth on the environment since the 1990s, when globalization gained momentum. This study will particularly dwell upon the Environmental Kuznets Curve in an attempt to explore the systematic relationship between per capita income and environmental pollution. Accordingly, scholars adopting this approach indicate that there is an “inverse U”-shaped relationship between environmental pollution and per capita income. In his study in 1955, Simon Kuznets explained the relationship between unfair distribution of income and per capita income. Due to the similarity between this relationship referred to in this study and the one between environmental pollution and per capita income, scholars attributed the name “Environmental Kuznets Curve” in an attempt to explain it (Saatçi and Dumrul, 2011: 67).

To elaborate, the Environmental Kuznets Curve (EKC) explains the hypothetical relationship between deterioration of environmental conditions and per capita income level. In this line, the theory assumes that quality of life first deteriorates due to environmental pollution, however, it later improves along with the increasing per capita income. In other words, while environmental pollution tends to aggravate at the initial stages of industrialization, improving economic development later triggers a decrease in this degradation according to the Environmental Kuznets Curve hypothesis (Akyıldız, 2008: 142-143).

Some suggest that the increasing trend of environmental pollution drives back after a certain threshold value with the impact of increased environmental awareness coming along with economic growth. In this context, scholars accept per capita income and economic growth rates as the basic components of the Environmental Kuznets Curve. Also, as mentioned before, the relationship between per capita income and environmental pollution is explained to be in the form of an inverse U due to three fundamental effects: the scale effect, the structural effect and the technology effect. The scale effect is associated with the increasing Environmental Kuznets Curve, while the structural and technology effects are explained by the decreasing Environmental Kuznets Curve. For a deeper understanding of these three effects, it would be more than useful to refer to an example: if a country applies policies to increase its foreign and domestic trade by means of various investments in industrialization, the resulting output will tend to increase environmental degradation. This incrementing trend is explained as the scale effect. On the other hand, if that country fails to meet its energy need to sustain industrialization and growing trade volumes through efficient mechanisms, then they will face a level of environmental pollution that no longer benefits their economic growth. In this case, the resulting economic gains will only be proportional to the level of environmental pollution. Thus, they will need environmental regulations for alleviation, which corresponds to the decreasing curve, or, in other words, the structural effect on the Environmental Kuznets Curve. Finally, the technology effect on the curve refers to further improvement in the environmental conditions by the help of foreign investments in environmentally-friendly products and services (triggered by increased environmental awareness), explaining the increasing trend on the Kuznets Curve (Saraç and Yağlıkara, 2017: 256).

Merchandise trading between countries can have both positive and negative effects on carbon emissions, depending on various factors such as transportation methods, production practices, and overall supply chain management. On one hand, merchandise trading can potentially reduce carbon emissions by promoting the international trade of goods and services. This can allow countries to specialize in producing goods or services with lower carbon footprints, thus reducing emissions related to the production of those goods or services in other countries. For example, if a country with abundant renewable energy resources exports clean energy to another country that relies heavily on fossil fuels for its energy production, it could potentially reduce the overall carbon emissions of both countries. Moreover, trading can enable countries to access goods and services from other countries more efficiently, reducing the need for resource-intensive domestic production that may result in higher emissions. For instance, importing goods from a country with advanced and energy-efficient manufacturing processes may result in lower emissions compared to producing the same goods domestically in a country with less efficient production methods. On the other hand, merchandise trading can also lead to increased carbon emissions, particularly when long-distance transportation methods such as shipping or air freight are used. The transportation of goods across long distances can contribute significantly to greenhouse gas emissions, particularly if the transportation is reliant on fossil fuels. Additionally, when countries trade goods with different environmental regulations, it can lead to a phenomenon called "carbon leakage," where production shifts to countries with less strict environmental regulations, resulting in increased emissions in those countries.

Limited evidence suggests that merchandise trading can reduce carbon emissions directly. However, some studies have indicated that certain types of merchandise trading, such as e-commerce and circular economy models, could potentially reduce emissions indirectly by improving supply chain efficiency and reducing waste. For example, a report by the Ellen MacArthur Foundation suggests that circular economy principles, which prioritize the use of renewable resources and the minimization of waste, could lead to significant reductions in greenhouse gas emissions (Ellen MacArthur Foundation, 2019). Similarly, a study by the Carbon Trust found that e-commerce can be more carbon-efficient than traditional retailing, particularly in terms of last-mile delivery (Carbon Trust, 2021). However, it is important to note that the overall impact of merchandise trading on carbon emissions is complex and depends on a range of factors, including the types of goods being traded, the modes of transportation used, and the energy sources powering production and delivery. In many cases, the carbon emissions associated with merchandise trading may offset any potential benefits, particularly if transportation is a significant factor. In summary, while merchandise trading may have the potential to reduce carbon emissions indirectly through improved supply chain efficiency and circular economy models, it is unlikely to have a significant impact on emissions reduction without broader changes in production and consumption patterns.

Carbon leakage can have several negative implications for climate policy effectiveness, such as reducing the incentive for countries or regions to implement ambitious climate policies and slowing down the transition to a low-carbon economy. It can also lead to unfair competition between firms and countries or regions, where firms in countries or regions with weaker climate policies gain a competitive advantage over firms in countries or regions with stronger climate policies. Various measures have been proposed to address carbon leakage, such as border carbon adjustments, which impose a carbon price on imported goods based on the carbon intensity of their production. This can help level the playing field between domestic and foreign firms, and incentivize countries or regions to implement stronger climate policies. Other measures include promoting international cooperation and harmonization of climate policies, as well as improving the energy efficiency and competitiveness of energy-intensive, trade-exposed sectors. Carbon leakage is a well-documented phenomenon in the academic literature on climate policy. It refers to the displacement of emissions from countries or regions with stricter climate policies to countries or regions with weaker or no policies, leading to a net increase in global emissions (Böhringer & Rutherford, 2008; Fischer & Fox, 2012; Paulus & Böhringer, 2014). The phenomenon is particularly relevant for energy-intensive, trade-exposed sectors, such as steel, cement, and aluminum production, where firms face high production costs and strong international competition (Böhringer & Carbone, 2016; Jotzo & Mazouz, 2019). In these sectors, higher energy prices resulting from climate policies can lead to production shifting to countries or regions with lower energy prices and weaker climate policies, resulting in increased emissions in those countries or regions (Keller et al., 2017). Carbon leakage can have several negative implications for climate policy effectiveness, such as reducing the incentive for countries or regions to implement ambitious climate policies, and slowing down the transition to a low-carbon economy (Fischer & Fox, 2012; McGlade et al., 2018). It can also lead to unfair competition between firms and countries or regions, where firms in countries or regions with weaker climate policies gain a competitive advantage over firms in countries or regions with stronger climate policies (Jotzo & Mazouz, 2019). Various measures have been proposed to address carbon leakage, such as border carbon adjustments, which impose a carbon price on imported goods based on the carbon intensity of their production (Gersbach et al., 2017; Paulus & Böhringer, 2014). Other measures include promoting international cooperation and harmonization of climate policies, as well as improving the energy efficiency and competitiveness of energy-intensive, trade-exposed sectors (Böhringer & Carbone, 2016; Fischer & Fox, 2012).

This study aims to answer the question of whether the merchandise trading of Turkey with various regions has an impact on the country's carbon emissions by gathering empirical evidence. The phenomenon of Carbon Leakage is tried to be observed to understand if Turkey is leaking carbon to other regions and/or is being leaked from those regions. The empirical study is based on the EKC theory and the model is designed to test the relationship between carbon emissions of Turkey and merchandise trading of Turkey on the regional basis.

RESULTS

According to the Kuznets Curve relationship, it is defended that up to a certain threshold level, CO_2 emissions increase as GDP of a given country increases. However, after that threshold, CO_2 emissions start to decrease along with the GDP increases. Several lines of research explain this inverse U shape relationship by stating that after a certain GDP increase, high income countries lower down their CO_2 emissions by exporting their CO_2 to the lower-income countries with which they have been engaged in trade relations (Jebli, Youssef, & Öztürk, 2016). Based on these studies, it may be claimed that trade with lower income countries decreases CO_2 emission as CO_2 is transferred to these countries again through trade; while trade with higher income countries increase CO_2 emission as these countries transfer their CO_2 to the lower income countries. In present study, the ARDL model is chosen for the analyses of this relationship, and Eviews software applied for detailed description. Thus, this chapter starts with explaining why the ARDL model is the most suitable model in this case, and then explains the regions where Turkey has trade relations with other countries. Here, Europe and Central Asia, High Income Countries, and the Arab World are selected as higher-income countries that Turkey engages in trade relationship with, while the MENA (Middle East and North Africa) are chosen as lower-income countries that Turkey engages in trade relationship with. After that, the models that are constructed in Eviews are explained. In the final step, the findings from the models are explained with various implications.

Turkey's Merchandise Trade Data are gathered from the database of the World Bank. The inputs refer to annual records from 1960 to 2020. Both Turkey's total trade openness data and regional trade data are used in the analyses. The regions with trade relations are chosen as the "Arab World", "Europe and Central Asia", "High-Income Countries", and the "Middle East and North Africa". The data analyzed include Carbon emission, GDP, the square of GDP, energy consumption, renewable energy supply, trade openness, and regional merchandise exports and imports.

The countries, which belongs to the regions, are listed below:

"Arab World"

"Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, West Bank and Gaza, Yemen."

"Europe and Central Asia"

"Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Channel Islands, Croatia, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Georgia, Germany, Gibraltar, Greece, Greenland, Hungary, Iceland, Ireland, Isle of Man, Italy, Kazakhstan, Kosovo, Kyrgyz Republic, Latvia, Liechtenstein, Lithuania, Luxembourg, Moldova, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkmenistan, Ukraine, United Kingdom, Uzbekistan."

"High-Income Countries"

"Andorra, Antigua and Barbuda, Aruba, Australia, Austria, Bahamas, Bahrain, Barbados, Belgium, Bermuda, British Virgin Islands, Brunei Darussalam, Canada, Cayman Islands, Channel Islands, Chile, Croatia, Curacao, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, French Polynesia, Germany, Gibraltar, Greece, Greenland, Guam, Hong Kong, Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Korea, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, China, Malta, Monaco, Nauru, Netherlands, New Caledonia, New Zealand, Northern Mariana Islands, Norway, Oman, Panama, Poland, Portugal, Puerto Rico, Qatar, Romania, San Marino, Saudi Arabia, Seychelles, Singapore, Sint Maarten (Dutch Part), Slovakia, Slovenia, Spain, St. Kitts and Nevis, St. Martin (French

Part), Sweden, Switzerland, Trinidad and Tobago, Turks and Caicos Islands, United Arab Emirates, United Kingdom, United States, Uruguay, Virgin Islands (U.S.)."

"Middle East and North Africa"

"Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, West Bank and Gaza, Yemen."

The base equation of the model is as follows:

$$ln\mathrm{CO}_{2t} = \beta_0 + \beta_1 ln\mathrm{GDP}_t + \beta_2 ln\mathrm{GDP}^2{}_t + \beta_3 ln\mathrm{TRADE}_t + \beta_4 ln\mathrm{ENCON}_t + \beta_5 ln\mathrm{RE}_t + \varepsilon_t$$

Here, CO_2 refers to the carbon dioxide emission, *GDP* refers to the gross domestic product, *TRADE* refers to the total trade amount, *ENCON* refers to the energy consumption, and *RE* refers to the renewable energy supply. CO_2 is the dependent variable, while all the other variables are predictors that are expected to have an effect on the dependent variable. There are two different approaches used while running the regional models. The regional models that are used separately for each region, under Approach 1, are as follows:

$$ln\mathrm{CO}_{2t} = \beta_0 + \beta_1 ln\mathrm{GDP}_t + \beta_2 ln\mathrm{GDP}^2{}_t + \beta_3 ln\mathrm{ENCON}_t + \beta_4 ln\mathrm{RE}_t + \beta_5 ln\mathrm{MEXPREGION}_t + \beta_6 ln\mathrm{MIMPREGION}_t + \varepsilon_t \quad (6.3.2)$$

In this equation, *MEXPREGION* refers to the merchandise export of a specific region, while *MIMPREGION* refers to the merchandise import of that specific region. On the other hand, under Approach 2, merchandise export and import appear as two different variables in regression. Other than merchandise export and merchandise import of the region, the variable *TRADEREGION* is also added to the model, which is the total export and import of Turkey for the remaining regions other than that specific region. This *TRADEREGION* variable is added to the model to be able to check the trade that takes place outside the region. The regional models under Approach 2 are as follows:

$ln\text{CO}_{2t} = \beta_0 + \beta_1 ln\text{GDP}_t + \beta_2 ln\text{GDP}^2{}_t + \beta_3 ln\text{ENCON}_t + \beta_4 ln\text{RE}_t + \beta_5 ln\text{TRADEREGION}_t + \beta_6 ln\text{MEXPREGION}_t + \beta_7 ln\text{MIMPREGION}_t + \varepsilon_t$ (6.3.3)

In Approach 2, besides merchandize exports and imports of a specific region, the total amount of trade of that region (exports + imports) is also added to the model, named as variable *TRADEREGION*. Hence, all the models are run twice for each region, one without the variable *TRADEREGION* and one with the variable *TRADEREGION*.

The descriptive statistics are presented for each of the variables in Table 1.

Table 1

Descriptive statistics

	Mean	Median	Max	Min	Std. Dev.	Obs.
CO2	164915,7	145859	414898	16821	117947,7	61
ENCON	58,57557	50,58	128,7	10,69	37,56055	61
EXPORT	62267,61	20138,04	247186,4	287,7106	80160,89	61
GDP	281592,3	130690	950579	8022	319153,5	61
GDP2	1,81E+11	1,71E+10	9,04E+11	64356049	2,89E+11	61
TRADE	0,323444	0,33984	0,564	0,05727	0,166243	61
RE	9441,721	9636	15130	5966	2378,732	61
IMPORT	71085,54	24956,95	266904,3	513,769	90842,76	61
LOGGDP	11,67608	11,78058	13,76483	8,989943	1,479938	61
LOGGDP2	138,5211	138,7821	189,4704	80,81908	34,28753	61
MEXPARAB	8,29E+09	2,22E+09	3,67E+10	24692185	1,24E+10	61
MEXPEUCA	5,32E+09	1,07E+08	2,43E+10	2101654	7,83E+09	61
MEXPHI	2,82E+10	9,36E+09	1,17E+11	2,48E+08	3,67E+10	61
MEXPMENA	6,68E+09	1,96E+09	3,29E+10	24812808	9,97E+09	61
MIMPARAB	4,26E+09	2,47E+09	2,17E+10	14014967	4,75E+09	61
MIMPEUCA	1,01E+10	4,14E+08	4,82E+10	3103314	1,49E+10	61
MIMPHI	3,83E+10	1,55E+10	1,36E+11	4,14E+08	4,63E+10	61
MIMPMENA	4,54E+09	2,51E+09	1,66E+10	600641	5,17E+09	61

Table 1 shows the average, minimum, maximum and standard deviations of each variable. It can also be found on this table that there are 61 observations. Here, ARAB refers to Arab World, EUCA refers to Europe and Central Asia, HI refers to High-Income Countries, and MENA refers to the Middle East and North Africa.

To investigate the order of integration of the variables, four alternative unit root tests are performed, which are the PP, the KPSS, ADF, and the DF-GLS. The outcomes of the unit root analysis are shown in Table 2. The null hypothesis of PP, ADF, and DF-GLS unit root tests claims that the unit root is present and series are non-stationary. Whereas, the null hypothesis of the KPSS test claims that the variables are stationary. Here, all the variables except RE (renewable energy supply) have unit roots. On the other hand, the variable RE is generated by stationary processes.

Table 2

Unit root analysis.

	ADF	DF-GLS	PP	KPSS
CO_2	2,197	3,741*	8,341	0,876*
ENCON	2,181	3,701*	6,903	0,871*
GDP	2,43	2,724*	2,834	0,806*
GDP^2	1,279	-0,745	3,51	0,636*
TRADE	-1,051	-0,063	-0,868	0,859*
RE	-3,494*	-3,529*	-3,467*	0,484*
TRADEARAB	-1,051	-0,063	-0,868	0,859*
MEXPARAB	3,024	-1,125	2,722	0,655*
MIMPARAB	1,223	1,646	0,395	0,860*
MEXPEUCA	1,15	-0,105	2,012	0,696*
MIMPEUCA	7,546	0,478	0,354	0,675*
TRADEEUCA	-1,259	-0,236	-1,182	0,837*
MEXPHI	5,919	-0,23	2,814	0,705*
MIMPHI	3,784	1,398	1,908	0,815*
TRADEHI	-0,724	0,263	-0,235	0,871*
MEXPMENA	-1,012	-1,447	2,382	0,631*
MIMPMENA	0,421	0,694	0,003	0,736*
TRADEMENA	-0,931	0,008	-0,774	0,844*

Before the long-run and short-run ARDL tests, bounds tests are applied as the first step of analysis, indicating the long-term correlation among the variables. In the bounds test, if F statistics is over the upper bounds this means that there is a long-run relationship. If F statistics is lower than the lower bounds, then there is no long-run relationship. If the F statistic is between the lower and upper bound, then the test is inconclusive.

Additionally, the cointegration F test for the base equation can be found below. Here, the F statistics are over the upper bound, thus there exists a long-run relationship between the variables.

After this step, short-run and long-run analyses are conducted for Approach 1 and Approach 2 of each model. Here, it is worth consideration that when no short-run relationship is found between the variables of the model, then this means that the obtained significant results might not be due to a short-run shock or a short-term recursive deviation of the variable, but a real long-term relationship might exist. After this step, long-run tests are applied to see whether there really exists a long-run relationship.

In the short-run analysis of the base equation, it might be seen that CointEq(-1) is significant. Thus, there is no short-term Kuznets curve relationship.

Table 3

Base equation short-run analysis.

Regressors	Coefficient	Prob.
DLOGGDP	-1.103373	0.0002
DLOGGDP2	0.002380	0.0001
DLOGTRADE	-0.069694	0.0843
DLOGENCON	0.451344	0
DLOGRE	0.01119	0.0056
CointEq(-1)	**0.070061**	**0**

In the long-run analysis, it can be observed that the long-run Kuznets relationship is significant. All the regressors have a significant relationship with CO_2 emissions.

Table 4

Base equation long-run analysis.

Regressors	Coefficient	Prob.
DLOGGDP	**4.629354**	**0.0042**
DLOGGDP2	**-0.188944**	**0.0011**
DLOGTRADE	**-0.060811**	**0.0143**
DLOGENCON	**2.138977**	**0**
DLOGRE	**-0.012534**	**0.0055**

$lnCO_{2t} = \beta_0 + \beta_1 ln\mathrm{GDP}_t + \beta_2 ln\mathrm{GDP}^2_t + \beta_3 ln\mathrm{ENCON}_t + \beta_4 ln\mathrm{RE}_t + \beta_5 ln\mathrm{MEXPARAB}_t + \beta_6 ln\mathrm{MIMPARAB}_t + \varepsilon_t$ (6.3.4)

Here, besides the effect of GDP, there is an investigation of the square of GDP, environmental consumption, and renewable energy supply, the effects of merchandise exports and imports from and to the Arab World, on CO_2 emissions. In the short-run analysis of the trade with the Arab World under Approach 1, it can be seen that CointEq(-1) is significant, implying that there is no short-term Kuznets curve relationship.

Table 5

Short-run analysis of trade with the Arab World under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	0.773645	0.0026
DLOGGDP2	0.034211	0.0019
DLOGENCON	0.788810	0.0000
DLOGRE	0.006165	0.0088
DLOGMEXPARAB	-0.027728	0.2250
DLOGMIMPARAB	-0.013280	0.2150
CointEq(-1)	**-0.007429**	**0.0000**

Under Approach 1, there is a long-run Kuznets curve relationship. Here, all of the regressors have marginal significant relationship with CO_2 emissions.

Table 6

Long-run analysis of trade with the Arab World under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	**10.968426**	**0.0388**
DLOGGDP2	**-0.390755**	**0.0414**
DLOGENCON	0.059147	0.0545
DLOGRE	-0.112014	0.0939
DLOGMEXPARAB	-0.084214	0.0639
DLOGMIMPARAB	-0.454201	0.0538

$lnCO_{2t} = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGDP^2_t + \beta_3 lnENCON_t + \beta_4 lnRE_t + \beta_5 lnTRADEARAB_t + \beta_6 lnMEXPARAB_t + \beta_7 lnMIMPARAB_t + \varepsilon_t$ (6.3.5)

As can be seen on the table, total trade in Turkey besides the Arab World is also included to the model as a control variable. In the short-run analysis for the trade with the Arab World under Approach 2, it can be seen that CointEq(-1) is significant and that there is no short-term Kuznets curve relationship.

Table 7

Short-run analysis of trade with the Arab World under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	-0.218033	0.0388
DLOGGDP2	0.008476	0.0232
DLOGENCON	1.044598	0.0000
DLOGRE	0.001848	0.6099
DLOGTRADEARAB	0.040969	0.2574
DLOGMEXPARAB	-0.005585	0.0004
DLOGMIMPARAB	-0.012924	0.0011
CointEq(-1)	**-0.436411**	**0.0000**

For the long-run analysis under Approach 2, considering the trade with the Arab World, there exists a significant Kuznets curve relationship. GDP, GDP^2 and ENCON have a significant relationship with CO_2 emissions. Here, it is worth to consider the merchandise imports and exports of the Arab World, and that trade outside the Arab World have marginal significant relationship with CO_2 emissions.

Table 8

Long-run analysis of trade with the Arab World under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	**1.005311**	**0.0002**
DLOGGDP2	**-0.050531**	**0.0003**
DLOGENCON	**1.521470**	**0.0000**
DLOGRE	**-0.049348**	**0.0071**
DLOGTRADEARAB	**-0.066979**	**0.0326**
DLOGMEXPARAB	**-0.055546**	**0.0426**
DLOGMIMPARAB	**0.042993**	**0.0396**

$ln\mathrm{CO}_{2t} = \beta_0 + \beta_1 ln\mathrm{GDP}_t + \beta_2 ln\mathrm{GDP}^2_t + \beta_3 ln\mathrm{ENCON}_t + \beta_4 ln\mathrm{RE}_t + \beta_5 ln\mathrm{MEXPEUCA}_t + \beta_6 ln\mathrm{MIMPEUCA}_t + \varepsilon_t$ (6.3.6)

In the short-run analysis of trade with Europe and Central Asia under Approach 1, it can be seen that CointEq(-1) is significant and that there is no short-term Kuznets curve relationship.

Table 9

Short-run analysis of trade with Europe and Central Asia under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	-0.470293	0.0012
DLOGGDP2	0.021376	0.0000
DLOGENCON	1.113164	0.0000
DLOGRE	0.009054	0.0014
DLOGMEXPEUCA	-0.006463	0.5867
DLOGMIMPEUCA	-0.046017	0.0008
CointEq(-1)	**-0.000040**	**0.0000**

In the long-run, there exists no long-run Kuznets curve relationship for trade with Europe and Central Asia under Approach 1. GDP, GDP^2, ENCON, merchandise exports and merchandise imports have a significant relationship with CO_2 emissions. Here, also merchandise exports to EUCA have marginal significant relationship with CO_2 emissions.

Table 10

Long-run analysis of trade with Europe and Central Asia under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	**-0.818635**	**0.0000**
DLOGGDP2	**1.424658**	**0.0001**
DLOGENCON	**1.140017**	**0.0000**
DLOGRE	**-0.020030**	**0.0064**
DLOGMEXPEUCA	-0.011901	0.3239
DLOGMIMPEUCA	**-0.030140**	**0.0474**

$lnCO_{2t} = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGDP^2_t + \beta_3 lnENCON_t + \beta_4 lnRE_t + \beta_5 lnTRADEEUCA_t + \beta_6 lnMEXPEUCA_t + \beta_7 lnMIMPEUCA_t + \varepsilon_t$ (6.3.7)

In the short-run analysis of trade with Europe and Central Asia under Approach 2, it can be observed that CointEq(-1) is significant. Hence, there is no short-term Kuznets curve relationship.

Table 11

Short-run analysis of trade with Europe and Central Asia under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	-0.334596	0.0000
DLOGGDP2	0.016062	0.0000
DLOGENCON	1.088929	0.0000
DLOGRE	0.007246	0.2971
DLOGTRADEEUCA	0.020097	0.0690
DLOGMEXPEUCA	-0.003536	0.0860
DLOGMIMPEUCA	-0.033709	0.0238
CointEq(-1)	**0.000578**	**0.0000**

For the long-run relationship in trade with Europe and Central Asia under Approach 2, there exists a significant Kuznets curve relationship. Here, GDP, GDP^2, total trade and merchandise exports have a significant relationship with CO_2 emissions. This time, merchandise exports to EUCA have a significant relationship with CO_2 emissions, while merchandise imports form EUCA have marginal significant relationship with CO_2 emissions.

Table 12

Long-run analysis of trade with Europe and Central Asia under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	**0.519896**	**0.0000**
DLOGGDP2	**-0.143590**	**0.0000**
DLOGENCON	**0.893957**	**0.0001**
DLOGRE	**-1.012290**	**0.0034**
DLOGTRADEEUCA	**-0.002386**	**0.0214**
DLOGMEXPEUCA	**-0.015248**	**0.0110**
DLOGMIMPEUCA	**-0.108142**	**0.0496**

$lnCO_{2t} = \beta_0 + \beta_1 ln GDP_t + \beta_2 ln GDP^2{}_t + \beta_3 ln ENCON_t + \beta_4 ln RE_t + \beta_5 ln MEXPHI_t + \beta_6 ln MIMPHI_t + \varepsilon_t$ (6.3.8)

In the short-run analysis of trade with High-Income Countries under Approach 1, it can be seen that CointEq(-1) is significant. So, there is no short-term Kuznets curve relationship.

Table 13

Short-run analysis of trade with High-Income Countries under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	-0.866760	0.0002
DLOGGDP2	0.036626	0.0002
DLOGENCON	1.211071	0.0000
DLOGRE	0.018090	0.0000
DLOGMEXPHI	-0.046381	0.0348
DLOGMIMPHI	-0.028733	0.2028
CointEq(-1)	**-0.229687**	**0.0000**

In the long-run, while doing trade with High-Income Countries, as GDP is significant but GDP^2 is non-significant, CO_2 emissions increase linearly due to economic growth and no Kuznets curve relationship exists. GDR, ENCON, RE, merchandise exports and merchandise imports have a significant relationship with CO_2 emissions. Here, it is worth consideration that merchandise exports to High-Income Countries and merchandise imports from High-Income countries have a significant relationship with CO_2 emissions, as well**.**

Table 14

Long-run analysis of trade with High-Income Countries under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	**-0.795185**	**0.0183**
DLOGGDP2	0.015811	0.6131
DLOGENCON	**1.380292**	**0.0000**
DLOGRE	**0.082227**	**0.0188**
DLOGMEXPHI	**0.068042**	**0.0455**
DLOGMIMPHI	**0.103829**	**0.0345**

$ln\text{CO}_{2t} = \beta_0 + \beta_1 ln\text{GDP}_t + \beta_2 ln\text{GDP}^2_t + \beta_3 ln\text{ENCON}_t + \beta_4 ln\text{RE}_t + \beta_5 ln\text{TRADEHI}_t + \beta_6 ln\text{MEXPHI}_t + \beta_7 ln\text{MIMPHI}_t + \varepsilon_t$ (6.3.9)

In the short-run analysis of trade with High-Income Countries under Approach 2, it can be found that CointEq(-1) is significant and that there is no short-term Kuznets curve relationship.

Table 15

Short-run analysis of trade with High-Income Countries under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	-0.010989	0.0000
DLOGGDP2	0.002457	0.0000
DLOGENCON	1.088830	0.0000
DLOGRE	0.008935	0.2140
DLOGTRADEHI	0.020228	0.0367
DLOGMEXPHI	0.009730	0.8358
DLOGMIMPHI	-0.023298	0.2234
CointEq(-1)	**- 0.001418**	**0.0000**

In the long-run analysis of trade with High-Income Countries under Approach 2, it can be seen that both GDP and GDP^2 are non-significant and there is no Kuznets curve relationship. ENCON, merchandise exports and merchandise imports have a significant relationship with CO_2 emission. It should be noted that merchandise exports to High-Income Countries and merchandise imports from High-Income countries again have a significant relationship with CO_2 emissions.

Table 16

Long-run analysis of trade with High-Income Countries under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	-0.541856	0.2163
DLOGGDP2	0.027128	0.8314
DLOGENCON	**0.029525**	**0.0254**
DLOGRE	-0.262629	0.2602
DLOGTRADEHI	0.024828	0.4857
DLOGMEXPHI	**-0.086472**	**0.0328**
DLOGMIMPHI	**0.098779**	**0.0083**

$ln\text{CO}_{2t} = \beta_0 + \beta_1 ln\text{GDP}_t + \beta_2 ln\text{GDP}^2_t + \beta_3 ln\text{ENCON}_t + \beta_4 ln\text{RE}_t + \beta_5 ln\text{MEXPMENA}_t + \beta_6 ln\text{MIMPMENA}_t + \varepsilon_t$ (6.3.10)

In the short-run analysis of trade with the Middle East and North Africa under Approach 1, it can be seen that CointEq(-1) is significant. Thus, there is no short-term Kuznets curve relationship.

Table 17

Short-run analysis of trade with the Middle East and North Africa under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	-0.583861	0.0060
DLOGGDP2	0.027202	0.0028
DLOGENCON	0.817990	0.0000
DLOGRE	-0.002821	0.4529
DLOGMEXPMENA	-0.035701	0.0040
DLOGMIMPMENA	0.000885	0.6524
CointEq(-1)	**0.115809**	**0.0000**

In the long-run analysis of trade with the Middle East and North Africa under Approach 1, both GDP and GDP^2 are significant and there exists a Kuznets curve relationship. Therefore, there is a reverse-U shaped relationship between economic growth and CO_2 emissions. There is also a significant relationship between ENCON, RE, and merchandise exports and CO_2 emissions. The variable of merchandise exports to MENA is significant, while merchandise imports from MENA is non-significant.

Table 18

Long-run analysis of trade with the Middle East and North Africa under Approach 1.

Regressors	Coefficient	Prob.
DLOGGDP	**4.354020**	**0.0000**
DLOGGDP2	**-0.162435**	**0.0000**
DLOGENCON	**1.604423**	**0.0000**
DLOGRE	**-0.022546**	**0.0385**
DLOGMEXPMENA	**-0.302009**	**0.0196**
DLOGMIMPMENA	- 0.020135	0.6482

$lnCO_{2t} = \beta_0 + \beta_1 ln GDP_t + \beta_2 ln GDP^2_t + \beta_3 ln ENCON_t + \beta_4 ln RE_t + \beta_5 ln TRADEMENA_t + \beta_6 ln MEXPMENA_t + \beta_7 ln MIMPMENA_t + \varepsilon_t$ (6.3.11)

In the short-run analysis of trade with Middle East and North Africa Countries under Approach 2, it can be seen that CointEq(-1) is significant. So, there is no short-term Kuznets curve relationship.

Table 19

Short-run analysis of trade with the Middle East and North Africa under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	-0.292540	0.0001
DLOGGDP2	0.011502	0.0004
DLOGENCON	1.172420	0.0000
DLOGRE	-0.003853	0.2818
DLOGTRADEMENA	-0.015520	0.6324
DLOGMEXPMENA	-0.056125	0.0002
DLOGMIMPMENA	-0.026032	0.0040
CointEq(-1)	**-0.699952**	**0.0000**

In the long-run analysis of trade with the Middle East and North Africa under Approach 2, both GDP and GDP^2 are again significant and there exists a Kuznets curve relationship. So, there is a reverse U-shaped relationship between economic growth and CO_2 emissions.

Table 20

Long-run analysis of trade with the Middle East and North Africa under Approach 2.

Regressors	Coefficient	Prob.
DLOGGDP	**1.256793**	**0.0000**
DLOGGDP2	**-0.003112**	**0.0000**
DLOGENCON	**1.522776**	**0.0000**
DLOGRE	**-0.033469**	**0.0084**
DLOGTRADEMENA	**-0.107633**	**0.0186**
DLOGMEXPMENA	**-0.022680**	**0.0394**
DLOGMIMPMENA	**-0.036055**	**0.0082**

DISCUSSION

In light of the dynamic nature of international trade, the economy, and the environment, this study recognized the importance of conducting an empirical analysis specific to the Turkish context. This approach ensures that the theories and models, it is explored resonate with the unique conditions of Turkey, offering a more accurate and region-specific perspective on the relationship between economic growth and environmental sustainability.

This research journey, however, did not stop at the national level. We extended our focus to a global context by examining the application of the Kuznets Curve model beyond Turkey. Notably, we delved into regions such as Europe, the Middle East, and North Africa, uncovering results that resonated with long- and short-run analyses. These findings underscored a compelling correlation between Gross Domestic Product (GDP) and CO_2 emissions, serving as evidence of a Kuznets Curve Relationship within the Middle East and North Africa, as well as Europe and Central Asia.

Contrastingly, our analysis via the Autoregressive Distributed Lag (ARDL) Model cast a different light on the relationship within High-Income Countries. Here, it was clear that the Environmental Kuznets Curve Relationship did not manifest. Furthermore, our investigation into Turkey's trade interactions with the Middle East and North Africa region suggested that trade with these regions led to a reduction in Turkey's CO_2 emissions. In contrast, trade with High-Income Countries appeared to increase Turkey's CO_2 emissions. In conclusion, our research confidently lends empirical support to the concept of carbon leakage, where carbon emissions are transposed through merchandise trading. This finding holds significant implications for future research, advocating for a closer examination of the impact of foreign trade and economic growth on environmental degradation in countries beyond Turkey.

According to Republic of Turkey, Ministry of Trade; the main exports and imports of Turkey are raw materials, approximately the prior has more than 50% of the share while the latter has around 70% share. This indicates the possibility to transfer the carbon emissions from one country to another one. In this study, the empirical result showed that High-Income-Level countries transfer their pollution-creating production to Turkey; however, Turkey also does the same for Europe and Central Asia, Arab World, and Middle East and North Africa region. Nevertheless, Turkey has no policy transferring the carbon emissions. Economic relations of Turkey are not planned considering the environmental issues.

CONCLUSION

Economic activity, as has been explored in the previous chapters, is intrinsically linked to the continuous supply of raw materials, making the environment an indispensable resource for countries striving to sustain their economic growth. However, as nations tread the path of industrialization and economic expansion over prolonged periods, they unwittingly inflict significant harm upon the environment. This environmental degradation, in turn, acts as a double-edged sword, eventually undermining economic growth due to the depletion of vital raw materials and the adverse impacts of a deteriorating environment. This intrinsic relationship between environmental challenges and economic prosperity cannot be overstated, forming the core subject of this study.

Recognizing these underlying dynamics, economists have long been immersed in the study of the repercussions of economic growth on the environment. Among these endeavors, our study specifically sought to dissect the EKC (Environmental Kuznets Curve) hypothesis, which elucidates the intricate relationship between environmental pollution and per capita income. Based on this model, environmental quality initially deteriorates as a consequence of increased industrialization and economic activity, but as per capita income continues to rise, there is a subsequent improvement in environmental conditions. In simpler terms, this theory posits an inverse-U shaped correlation between environmental degradation and economic growth.

To illustrate this hypothesis, one can draw a historical parallel by observing that industrial pollution was virtually non-existent in pre-industrial societies, largely due to their low per capita income and limited industrial activities, which were predominantly confined to agriculture. However, the course of industrialization over time gave rise to severe environmental degradation. In response to this challenge, countries began to realign their economic structures in the wake of economic development. Clean technologies emerged, and economies started transitioning to service-oriented sectors, which, in turn, contributed to a more balanced relationship between environmental sustainability and economic growth.

Delving into the core tenets of the Environmental Kuznets Curve, it is imperative to recognize its function as a tool designed to delineate the relationship between economic growth, chiefly in terms of per capita income, and environmental degradation. Scholars operating within this framework posit that as per capita income rises, so too does environmental pollution. Nevertheless, they postulate that over time, this trend undergoes a reversal. The seminal work of Simon Kuznets in 1955 laid the foundational groundwork for this concept by initially exploring the relationship between income distribution and economic growth. Subsequently, this concept was adapted to the realm of environmental issues by Grossman and Krueger, who contended that, in the course of economic growth, environmental pollution initially surges, but then begins to decline, resulting in an inverse U-shaped relationship between per capita income and pollution levels.

This theoretical framework gave rise to a plethora of studies attempting to apply the EKC model to a range of variables. Such studies encompassed diverse facets, including the relationship between air pollution and economic growth, as measured by values like SO_2, PM, nitrous oxide (NOX), and carbon monoxide (CO), as well as investigations into greenhouse gases and water quality in relation to economic growth through causality analysis.

The culmination of these theoretical analyses sets the stage for a more comprehensive understanding of EKC approach, which elucidates the hypothetical relationship between per capita income and environmental pollution. This model proposes that the quality of life initially deteriorates as a consequence of environmental pollution, but subsequently experiences an improvement as per capita income increases. Building upon these theoretical foundations, our study provided an in-depth exploration of the Turkish context, serving to create a bridge for the gap, which is between theory and empirical evidence.

The comprehensive exploration of international trade, renewable energy trends, and the EKC model and its theoretical underpinnings serves as a valuable precursor to our study's in-depth analysis of the Turkish context. By elucidating the historical landscape and contemporary factors influencing Turkey's economic and environmental dynamics, we have laid the foundation for a more thorough understanding of the intricate interplay between environmental sustainability and economic growth within the nation.

The culmination of this research stands as a testament to the dynamic interplay between economic growth and environmental sustainability. In the quest to comprehend this intricate relationship, it is navigated the intricate pathways of history, theory, and empirical analysis. This thesis extends beyond the theoretical realm, offering a bridge between academic discourse and real-world implications as well as it invites policymakers, scholars, and concerned citizens to draw upon our findings, for they resonate with the global challenge of balancing economic development with environmental stewardship.

In essence, this research serves as a reminder of the profound impact of economic decisions on our environment and, reciprocally, the influence of environmental conditions on the prosperity of nations. One can offer this thesis as a contribution to the ongoing dialogue surrounding the quest for sustainable development, and we are eager to witness how this discourse shapes the future of our world. A notable characteristic of our research is its specific focus on Turkey. While the EKC model has been widely applied in various contexts, this study extends its application to this particular geographic and economic setting. By doing so, this study fills a critical gap in the literature, providing a more region-specific understanding of the relationship between environmental degradation and economic growth. This regional specificity adds depth and richness to the global understanding of the EKC hypothesis.

Previous studies have underlined the EKC hypothesis holds in Turkey. Carbon emissions data showed a behavior of decline in the long run in the study of Bölük and Mert (2014), which proves that although other econometric methods such as panel cannot indicated the EKC relationship in Turkey; ARDL method enables the possibility for a U-shaped EKC in the long run. It is well known that renewable energy sources such as solar and wind are key factors for a green economy. In case of economic development, if a country applies required policies for an efficient endowment of renewable energy production, this country is likely to reach a U-shaped EKC eventually. “However, this study aims to show the effects of trading pollution intensive produce trade. This trade also holds the required conditions of reaching the EKC. Ben Jebli, Ben Youssef, Ozturk (2016) indicate the importance of trade as a tool to combat against the global warming.” Their study consists of 25 OECD countries in the years between 1980 and 2010 and their findings are parallel to this thesis. Lu, Venevsky, et all (2021) applied the same method for the eight economic zones in China. The main difference between the China case and the Turkey case is that the Chinese government applied required policies to fight against pollution, which is mainly created by the economic activities. As it is mentioned before, Turkey does not have policies that are introduced to reduce the carbon emission with respect to international trade. Another study for this aspect belongs to Shang, et al. (2023), underlining the importance of high technology exports on carbon emissions in China. Their study explains that high technology product exports have tendency the reduce the carbon footprint.

Another aspect that sets our research apart is the depth of analysis on specific variables, such as any specific variables, like income, trade, or environmental indicators. Our comprehensive examination of these variables within the context of Turkey uncovers insights that are distinct from general findings in the literature.

In summary, the novelty of our thesis is twofold: the regional focus and the in-depth analysis of specific variables. These elements not only contribute to a more comprehensive understanding of the complex relationship between economic growth and environmental degradation but also offer practical insights that can be applied to real-world challenges.

REFERENCES AND NOTES

Akbostancı, E., Türüt-Aşık, S., Tunç, G.İ. (2009). The Relationship Between Income and Environment in Turkey: Is There An Environmental Kuznets Curve? Energy Policy, 37(3), 861-867.

Akyıldız, .P. (2008). Tartışılan Boyutlarıyla "Homo Economicus". Süleyman Demirel Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Dergisi, 13(2), 29-40.

Bayraktutan, Y., Yılgör, M., & Uçak, S. (2011). Renewable electricity generation and economic growth: Panel-data analysis for OECD members. International Research Journal of Finance and Economics.

Ben Jebli, M., Ben Youssef, S., Ozturk, I. (2016). *Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries,* Ecological Indicators, 60, 824-831.

Böhringer, C., & Carbone, J. C. (2016). Effective climate policies under carbon leakage and international trade. Journal of Environmental Economics and Management, 78, 7-24.

Böhringer, C., & Rutherford, T. F. (2008). Combining bottom-up and top-down. Energy Economics, 30(2), 574-596.

Bölük, G. Mert, M. (2014), "*The renewable energy,growth and environmental Kuznets curve in Turkey :An ARDL approach"* Renewable and Sustainable Energy Reviews, 52, 587-585

Carbon Trust. (2021). Carbon impact of e-commerce vs traditional retailing. https://www.carbontrust.com/news-and-events/news/carbon-impact-of-e-commerce-vs-traditional-retailing/

Ellen MacArthur Foundation. (2019). Completing the Picture: How the Circular Economy Tackles Climate Change. https://www.ellenmacarthurfoundation.org/publications/completing-the-picture-how-the-circular-economy-tackles-climate-change

Fischer, C., & Fox, A. K. (2012). Comparing policies to combat emissions leakage: Border carbon adjustments versus rebates. American Economic Journal: Economic Policy, 4(2), 1-27.

Keller, V., Osorio, S., & Spadaro, J. V. (2017). The impacts of carbon pricing and the effects of the social cost of carbon: A literature review. Journal of Economic Surveys, 31(2), 360-395.

Lu, C., Venevsky, S., Shi,X., Wang, L., Wright, J., Wu, C. (2021) *Econometrics of the environmental Kuznets curve: Testing advancement to carbon intensity-oriented sustainability for eight economic zones in China*, Journal of Cleaner Production, 283.

Saatçi, M., & Dumrul, Y. (2015). Çevre Kirliliği Ve Ekonomik Büyüme İlişkisi: Çevresel Kuznets Eğrisinin Türk Ekonomisi İçin Yapisal Kirilmali Eş-Bütünleşme Yöntemiyle Tahmini. Erciyes Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Dergisi(37), 65-86.

Saraç Ş. & Yağlıkara A. (2017). Environmental Kuznets Curve: The Evidence from BSEC Countries. Ege Academic Review, 255-264.

Ulucak, R., & Erdem, E. (2014). Çevre - İktisat İlişkisi Ve Türkiye'de Çevre Politikalarinin Etkinliği. Akademik Araştırmalar Ve Çalışmalar Dergisi (AKAD), 4(6), 78-98.

Shang, M., Yao-Ping Peng, M., Khalid Anser, M., Imran, M., Nassani, A. A., Binsaeed, R. H., & Zaman, K. (2023). Evaluating the U-shaped environmental kuznets curve in China: The impact of high technology exports and renewable energy consumption on carbon emissions. Gondwana Research, 127, 272-287.

World Bank Data, URL: http://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS, Erişimtarihi: 06.12.2013.