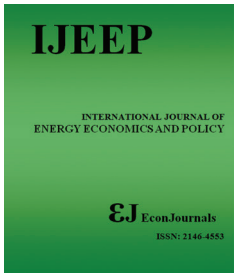

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Investigation of the Effect of Energy Consumption on Carbon Emissions in Azerbaijan in the Context of the Environmental Kuznets Curve

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ABSTRACT

There is a close and mutual relationship between environmental problems and economics. While the increase in economic activities causes environmental problems, environmental problems negatively affect sustainable economic growth. The main purpose of this study is to empirically investigate the effect of energy consumption on carbon emissions in the context of the Environmental Kuznets Curve (EKC) hypothesis in the Azerbaijan economy in the period 1997-2021. Data between energy consumption per capita, income per capita and carbon emissions were included in the analysis. The determination of this relationship was investigated by the Granger causality method. As a result of the analysis, it is clear that the Environmental Kuznets Curve Approach is not valid for Azerbaijan.

Keywords: Energy Consumption, Carbon Emission, Environmental Kuznets Curve, Granger
JEL Classifications: O13, Q40, E20

1. INTRODUCTION

There is a very close and reciprocal relationship between environmental problems, which are becoming increasingly important, and the economy. While the rapid increase in economic activities causes environmental problems, environmental problems also negatively affect economic development and economic structure. Economic development increases environmental pollution, and environmental pollution increases the economic and social costs of economic development. Because the economy and the environment are closely related, it is impossible to exclude environmental problems from the economy. In this context, effective use of environmental resources is of great importance for a sustainable economic development. The concept of environment, which is emphasized to have an active role in sustainable growth, has become a concept that draws attention and is frequently researched.

The main factors causing environmental pollution are industrialization, transportation, population density, poverty, soil erosion, traffic and traffic density, exploitation of resources by misregulation of property rights, etc. is counted. Especially recently, economic growth in Asian countries is the most important factor causing environmental pollution. The proof of this is air pollution and changes living in the ecosystem (Borhan et al., 2012). Traditional energy sources are a major contributor to environmental contamination, which in turn poses a danger to sustainable development. This, in turn, has a knock-on effect on renewable energy sources.

The environment is involved in the production process by providing the necessary raw materials and other inputs for the continuity of economic activities; however, at the end of production and especially consumption processes, wastes that harm the environment are formed. While some wastes are included

in the production process by recycling, some wastes that cannot be recycled cause environmental pollution. This situation may cause negative effects on economic activities. The interdependence between the environment and the economy arises not only from the fact that the environment provides raw materials for the production process, but also directly from the fact that it is one of the basic elements of economic welfare (Ulucak and Erdem, 2012).

There is a very close and reciprocal relationship between environmental problems, which are becoming increasingly important, and the economy. While the rapid increase in economic activities causes environmental problems, environmental problems also negatively affect economic development and economic structure. Economic development increases environmental pollution, and environmental pollution increases the economic and social costs of economic development (Keleş, 1997).

Mass production that emerged with the industrial revolution means more use of resources for more production. Increasing production increases the level of income and causes more consumption and brings with it some environmental problems. Problems such as the depletion of the ozone layer, global climate changes, erosion, reduction of clean water resources, and air pollution are given as examples of environmental problems caused by overproduction and overconsumption (Bayraktutan and Airplane, 2011).

The level of relationship between the environment and the economy differs according to the development levels of the countries. In developed countries, which focus on environmental problems in a wide range from investment policies to technology policies, necessary costs can be incurred and public administrations can easily demand the necessary financial devotion from producers and consumers, while the environmental issue is ignored in developing countries (Akyıldız, 2008).

It is seen that developing countries tend towards industrial activities that cause high pollution in the industrialization process and traditionally do not have a comparative advantage. The increase in clean environment demands of developed country consumers and environmental legal regulations around the world increase the costs of "dirty industries." In addition, due to the relatively low environmental awareness of consumers in developing countries and the insufficient environmental regulations in these countries, there is a migration of dirty industries from developed countries to developing countries, and this situation is defined as the "Pollution Shelter Hypothesis" (Akyıldız, 2008). The pollution shelters hypothesis means the transfer of industrial wastes that create environmental pollution and pose a risk to nature, and units that produce with ineffective production technologies from central economies to peripheral economies.

Due to the strict environmental policies implemented in developed countries, the production costs of companies operating in these countries are increasing. In developing countries, the priority of economic decision-making units is to increase income and ensure growth. In these countries, it is aimed to maintain economic growth despite the damage to the environment. Manufacturers in dirty industries in developed countries shift their activities to developing countries where environmental standards are relatively low in order to avoid the costs of high environmental standards. Low environmental standards in developing countries; This is due to the fact that they need all kinds of industrial activities because their income levels are low, environmental awareness and sensitivity are not developed and property rights are not well defined (Akyıldız, 2008).

2. LITERATURE REVIEW

Jaunky (2011) examined the compatibility of the GDP and CO_2 emissions of 36 high-income countries with the EKC hypothesis for the period 1980-2005 by panel data unit root and cointegration tests. As a result of the empirical analysis, the EKC hypothesis is supported in the example of Greece, Malta, Oman, Portugal and England. The 1% increase in GDP observed for the entire panel increases CO_2 emissions by 0.68% in the short term and by 0.22% in the long term.

Magnani (2001) emphasizes that economic development increases environmental quality over time and supports the EKC hypothesis. Hamilton and Turton (2002) examined the relationship between economic growth, energy intensity and greenhouse gas for OECD countries using the data for the period of 1982-1997. They found that the energy density increased.

Ahmed and Long (2012), with annual data for Pakistan for the period 1971-2008; Using the variables of carbon dioxide emission, economic growth, energy consumption, trade liberalization and population density, they investigated the suitability of the EKC hypothesis. The cointegration relationship between the variables was analyzed using the Auto Regressive Distributed Lag (ARDL) approach. The short- and long-term relationship between carbon dioxide emissions and growth supports the EKC. That is, Pakistan's energy consumption and economic growth cause environmental pollution.

Ari and Zeren (2011) tested the EKC hypothesis by examining the relationship between CO_2 and per capita income in their study for Turkey and Mediterranean countries. In their analysis with the panel data method, they determined a N-shaped relationship between CO_2 and per capita income. It has also been emphasized that population density and energy consumption have a positive effect on environmental pollution. Başar and Temurlenk (2007), using the 1950-2000 period data, concluded that the EKC Hypothesis is not valid for Turkey. However, they found an inverse N-shaped relationship between income level and carbon dioxide emissions per capita. Omay (2013) tested the EKC hypothesis by examining the relationship between economic growth and carbon dioxide emissions using the 1980-2009 period data for Turkey. As a result of the empirical analysis, he found an inverse N-shaped relationship between economic growth and carbon dioxide emissions. This result does not support the EKC hypothesis in the literature.

Say and Yücel (2006) examined the Turkish energy sector in general for the period 1970-2002. The relationship between total energy consumption and total carbon emissions was analyzed

in the study. As a result of the regression analysis, a strong relationship was determined between these two variables.

Halicioglu (2009) tested the causality relationship between carbon emissions, energy consumption, income and foreign trade using time series data for the period 1960-2005. According to the empirical results, the most important explainers of carbon emissions in Turkey are energy consumption and foreign trade, respectively. Zhang and Cheng (2009) used time series to prove the existence of causality between economic growth, energy consumption and carbon emissions in China for the period 1960-2007. According to the results of the analysis, one-way Granger causality was determined between Gross domestic product and economic growth, energy consumption and carbon emissions.

Apergis et al. (2010) tested the causality relationship between carbon emissions, nuclear energy consumption, renewable energy consumption and economic growth using the panel error correction model for the 1984-2007 period in 19 developed and developing countries. According to the long-term estimations, there is a statistically significant negative relationship between nuclear energy consumption and emissions, while there is a statistically significant positive relationship between renewable energy consumption and emissions. It has been concluded that nuclear energy consumption plays an important role in reducing carbon emissions in the short term, whereas renewable energy consumption does not contribute to reducing emissions.

Ozturk and Acaravcı (2010) investigated the long-run causality relationship between economic growth, carbon emissions, energy consumption and employment rates for the 1968-2005 period in Turkey using the autoregressive distributed lag (ARDL) approach. According to the Granger causality test results, carbon emissions per capita and energy consumption per capita are not the cause of real GNP per capita, but employment rates are the cause of real GNP per capita in the short run. According to the results, policies to prevent energy from harming the environment, such as limiting energy consumption and controlling carbon emissions, do not have an adverse effect on real growth.

Menyah and Wolde-Rufael (2010) investigated the long-run relationship between economic growth, pollutant emissions and energy consumption in South Africa for the period 1965-2006 using additional variables such as labor and capital. Using the boundary test approach for cointegration, both short- and long-term positive relationships between variables and a statistically significant relationship between pollutant emissions and economic growth were found.

In a paper that Huseynli (2023a) authored, he investigated the link between the service sector and the energy consumption that affects this sector as well as the export of products and services in Italy during the period 1997-2021. This study was conducted in Italy. According to the findings of the study, a rise of just 1% in Italy's overall energy consumption may adequately account for the roughly 27% point increase in that nation's exports of commercial services.

Pao and Tsai (2011) tested the dynamic relationship between pollutant emissions, energy consumption and output for the period 1980-2007 in Brazil. According to the causality results, there is a strong bidirectional causality relationship between income, energy consumption and emissions. In the study, it has been suggested that Brazil adopt a dual strategy to increase its energy infrastructure investments to reduce emissions and prevent its negative impact on economic growth, and to accelerate energy saving policies to reduce energy waste and increase energy efficiency. Hossain (2011) tested the dynamic causal relationship between carbon emissions, energy consumption, economic growth, trade openness and urbanization using time series data for the period 1971-2007 in newly industrialized countries. According to the Granger causality test results, there is no long-term causality relationship between the variables, but there is a short-term unidirectional causality relationship from economic growth to trade openness and carbon emissions, from economic growth to energy consumption, from trade openness to economic growth, from urbanization to economic growth, from trade openness to urbanization.

Akadiri et al. (2019) investigated the causal relationship between carbon emissions, energy consumption, and economic development in Iraq from 1972 to 2013. The link between energy consumption, carbon emissions, and economic growth was examined in the cases of Indonesia and Malaysia in the study by Farabi et al. (2019).

The study by Alanazi et al. (2020) examined the short- and long-term balancing relationship between energy consumption (ECI) and carbon dioxide emissions (CO_2 EI) in Indonesia from 1980 to 2014. Yuping et al. (2021) examined the dynamic effects of globalization, non-renewable energy consumption, renewable energy consumption, and economic growth on carbon dioxide emission levels in Argentina from 1970 to 2018.

An increase in economic activity also makes environmental issues more apparent. While economic growth is often associated with environmental pollution, environmental contamination can also eventually lead to slower economic growth. Environmental issues have an impact on the tourism sector. Tourists are not drawn to locations with environmental issues in large numbers. Accommodations, food, transportation, and entertainment are all sources of employment in the tourism industry (Huseynli, 2022). In order to unlock local potential in Azerbaijan's non-oil industries, Ahmadov et al. (2021) research examined regional development policies in the country's tourism industry.

3. RESEARCH METHODOLOGY AND DATA SET

In this study, the relations between per capita energy consumption, carbon emissions and per capita income in Azerbaijan were analyzed, taking into account the 1997-2021 period. The data used in the analyzes were obtained from the World Bank database. In the study, time series were used considering the period of 1997-2021. The variables used in the analysis were included in the analysis by taking into account the auarithmic values. ADF (Augmented Dickey-Fuller) unit root test was used to test the stationarity of the

series. In addition, the causality test, which was included in the literature by Granger (1981), was used to determine the causality relationship between the variables.

$$Y_t = \alpha + \beta X_t + \varepsilon_t \quad (1)$$

Granger argues that in order to establish a meaningful relationship between the explanatory and explained variables in the above equation, both sides of the equation must be consistent. For example, if yt is a seasonal variable, xt must be a seasonal variable, and εt is in the case of white noise.

In the methods used in time series analysis, it is checked that the variables are stationary. A time series is stationary if its mean and variance do not change over time, and its covariance is only dependent on the distance between the two periods, not the period in which this covariance is calculated (Gujarati, 1999). Because of the spurious regression problem in models estimated with non-stationary time series (Granger and Newbold, 1974), the results obtained do not reflect the true relationship. In such a case, t and F statistics lose their validity. Therefore, regression analyzes with non-stationary time series can be meaningful and reflect real relationships only if there is a cointegration relationship between these time series (Gujarati, 1999).

In empirical studies in the literature, the long-term relationship between carbon emissions, per capita income and per capita energy consumption is defined as a standard logarithmic linear function. If we arrange this model for Azerbaijan is:

$$CO_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 EC_t + \varepsilon_t \quad (2)$$

Here, *CO* represents carbon dioxide emissions (kg per capita), *Y* per capita real income (USD), *EC* energy consumption (kg oil equivalent per capita) and ε_t error term. The α parameters (i = 1, 2, 3, 4) in the equation give the elasticity estimates of carbon emissions, real income per capita and energy consumption per capita.

4. ANALYSES AND RESULTS

In order to explain a Granger causality relationship between energy-based carbon emission, per capita energy consumption and per capita national income variables, it is primarily necessary to determine whether the variables are stationary or not, and if they are not, to what degree they become stationary. Within the framework of our analysis, the results of the ADF unit root test performed to determine the stationarity of the series are arranged with the help of Table 1.

As can be seen from Table 1, it is seen that the variables are not stationary in the level values. The stable version of the data set and the information about the data are given in Table 2.

After the data set was stabilized, the appropriate lag length for the variables was determined. As can be seen from the Table 3, the appropriate lag length is six.

After providing the necessary conditions for the analysis, the causality relationship between the variables was measured. For this, the Granger method was preferred. The analysis results regarding causality are given in Table 4.

When the Granger results are examined, it is seen that there is no causality between the variables. In other words, within the framework of this country, either the increase in energy consumption or the increase in personal income does not have any effect on the increase in carbon emissions. Likewise, there is no effect from carbon emission values to other variables. These results show that the Environmental Kuznets Curve Approach is not valid in this country from the framework of Azerbaijan.

5. DISCUSSION AND CONCLUSION

The interdependence between the environment and the economy arises not only from the fact that the environment provides raw materials for the production process, but also directly from the fact that economic welfare is one of the basic elements. With globalization, mass production has increased, and it has become necessary to use more resources for increased production. In this process, as the level of income increases, consumption also increases and some environmental problems arise.

The environmental Kuznets Curve approach explains the hypothetical relationship between environmental pollution and per capita income. In the relationship between environmental pollution and per capita income, the quality of life deteriorates initially and then improves due to environmental pollution.

In this study, per capita energy consumption and its impact on personal income and carbon emission amounts in Azerbaijan were analyzed for the period 1997-2021. According to the results of the analysis, there is no relationship between energy consumption, personal income and carbon emissions in this country. In other words, as a result of the empirical analysis, it was found that the relationship between dependent variables and carbon dioxide emissions did not support the EKC hypothesis, and this relationship was in the form of an inverted N.

Table 1: Level values of series

ADF test resault	Energy use		Carbon emission		Income	
	t-statistics	Possibility	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	−2.629155	0.1012	−1.306420	0.6095	−1.607701	0.4628
Test critical values						
1%	−3.737853		−3.737853		−3.752946	
5%	−2.991878		−2.991878		−2.998064	
10%	−2.635542		−2.635542		−2.638752	

Table 2: Stationarity level of first order series

ADF test resault	Energy use		Carbon emission		Income	
	t-statistics	Possibility	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	−5.366934	0.0002	−5.633955	0.0001	−2.662572	0.0399
Test critical values						
1%	−3.752946		−3.752946		−2.069359	
5%	−2.998064		−2.998064		−1.956406	
10%	−2.638752		−2.638752		−1.608495	

Table 3: Appropriate delay length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	89.10985	NA	2.32e−08	−9.064195	−8.915073	−9.038958
1	131.0726	66.25702	7.37e−10	−12.53396	−11.93747	−12.43301
2	137.9387	8.672939	1.01e−09	−12.30934	−11.26548	−12.13268
3	148.8672	10.35331	1.05e−09	−12.51234	−11.02112	−12.25996
4	170.6313	13.74574	4.82e−10	−13.85593	−11.91734	−13.52784
5	230.8356	19.01189*	8.93e−12*	−19.24585	−16.85990	−18.84206
6	1304.511	0.000000	NA	−131.3169*	−128.4836*	−130.8374*

*Indicates the appropriate lag length for the relevant test

Table 4: Granger causality test

Hypotheses	F-value	Probability value (P)	Decision at 1% significance level
Energy consumption is the cause of carbon emissions	0.431520	0.8059	Rejected
Increased incomes are the cause of carbon emissions	0.206553	0.9019	Rejected
Carbon emissions are the reason for increased energy consumption	0.405016	0.8167	Rejected
Carbon emissions are the cause of increased personal incomes	0.400205	0.8186	Rejected

Azerbaijan is a country with high potential in terms of renewable energy resources. It has been decided that the primary objective for Azerbaijan would be to raise the proportion of investments in renewable energy sources contributing to the country's total energy balance to 30% by the year 2030 (Huseynli, 2023b). It has significant potential especially in the fields of hydraulic energy, wind energy and solar energy. Renewable energy sources should be used efficiently in order to reduce the damage caused by energy use to the environment. Various organizations around the world state that the amount of greenhouse gases and carbon in the air should be reduced by carrying out various activities to draw attention to climate change. The fact that the EKC hypothesis is not valid for Azerbaijan, which meets most of its energy needs from renewable energy sources, also indicates a possible normal result.

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