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Araştırma Makalesi

Farklı Enerji Kaynaklarının Çevresel Açıdan İktisadi Büyüme İle Olan İlişkisi

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ÖZ

Yirminci yüzyılın ikinci yarısından sonra önemini hissettirmeye başlayan çevre ve çevresel duyarlılık kavramları özellikle yirmibirinci yüzyılın başından itibaren hemen her disiplin üzerinde önemli bir etki alanına sahip olmuştur. Sanayileşmenin artmasıyla beraber gerek sanayi tesisleri gerekse nihai sanayi ürünlerinin çevreye yansıyan negatif etkisi iktisat ve iktisadi kalkınma kavramlarını da bu bağlamda tartışmaya açmıştır. Fosil enerji kaynaklarından nükleer enerjiye geçilmesi ve üretimde yenilenebilir enerji kaynaklarının kullanılması, karbon emisyonu ve iktisadi büyüme birbiriyle yakından ilintili multidisipliner bir çalışma alanı haline gelmiştir. 1982-2020 yılları arasındaki döneme ait verilerin kullanıldığı bu çalışmada ele alınan ülkelerin karbon emisyonu miktarı, kişi başına düşen gayri safi yurtiçi hasılası, nükleer enerji ve yenilenebilir enerji arasındaki uzun dönemli ilişki panel eşbütünleşme testine tabi tutulmuş ve karbon emisyonu ve ekonomik büyüme arasında uzun dönemli anlamlı bir ilişki tespit edilmiştir. Öte yandan nükleer ve yenilenebilir enerji üretimi ile karbon emisyonu arasında ise anlamlı bir ilişki saptanamamıştır.

Anahtar kelimeler: CO_2 Emisyonu, yenilenebilir enerji, iktisadi büyüme

The Relationship of Different Energy Sources and Economic Growth in Environmental Perspective

ABSTRACT

The concepts of environment and environmental sensitivity, which started to make themselves felt after the second half of the twentieth century, have had a significant impact on almost every discipline, especially since the beginning of the twenty-first century. With the increase in industrialization, the negative impact of both industrial facilities and final industrial products on the environment has opened the concepts of economics and economic development to discussion in this context. The transition from fossil energy sources to nuclear energy and the use of renewable energy sources in production, carbon emissions and economic growth have become a multidisciplinary field of study, which are closely related to each other. In this study, in which data from the period between 1982 and 2020 are used, the long-term relationship between the amount of carbon emissions, per capita gross domestic product, nuclear energy and renewable energy was subjected to panel cointegration test. Test results indicates that there is a long-term significant relationship between carbon emission and economic growth. On the other hand, no significant relationship was found between nuclear and renewable energy production and carbon emissions.

Key words: CO_2 Emission, renewable energy, economic growth

INTRODUCTION

The mechanization in industrial revolution and the brisk rise in mass production in the industrial sector brought with them a demand for high energy. Industrializing nations expanded their output, but in order to satisfy their rising energy demands, they also went through significant political problems. Even while these countries' economies grew as a result of their increased energy use, the environment became more polluted. Economic progress will also come to a halt due to rising environmental expenses. While using renewable energy sources is advised for environmental reasons, using fossil fuels to meet energy needs results in carbon emissions. In terms of carbon emissions, fossil fuels, which also have the traits of an exhaustible and unsustainable resource, have grown to be a significant problem for scholars working in environmental economics. In order to achieve economic development while maintaining environmental quality and welfare, it is crucial to use sustainable and renewable resources to meet energy needs. Supportive environmental laws should also be put in place to encourage this. Besides per capita income, one of the most important indicators of a developed country is the existence of policies to protect the environment and nature. As it is known, along with the development of the economy and the increase of population, production and consumption activities also increase. This pollutes the environment and destroys natural resources. The environmental costs of pollution have a negative impact on economic budgets. Especially since industrialization, excessive production and consumption activities have caused serious damage to natural structures. Simply put, air and water pollution is one of the biggest problems facing governments. Innovative environmental policies are one of the most important tools for decision makers and practitioners to reduce the negative effects of environmental pollution and improve welfare standard. While developed countries implement strict environmental policies, developing countries do not pay enough attention to this issue. Another factor causing environmental pollution, which has been increasing rapidly sinc eindustrialization, is the need for energy. Fossil fuels used to meet energy needs cause the release of carbon dioxide (CO_2) gas, the most important pollutant in the atmosphere. Energy sources that do not emit carbondioxide are recognized as an important key to combating global warming and increasing global energy security. (Elliott, 2007, Ferguson, 2007) Therefore, instead of using fossil fuel resources to reduce carbondioxide emissions and meet energy demand, renewable and sustainable natural resources such as wind energy, hydro energy, biomass energy, solar energy, geothermal energy and uncontrolled nuclear energy should be prioritized. The increase in production and consumption activities after the Industrial Revolution accelerated economic growth, but at the same time caused a great destruction process for the environment. For this reason, Simon Kuznets, in his 1955 study on the relationship between income inequality and the environment, argued that income inequality expands in the early stages of economic development and tends to narrow as economic development continues, and that the relationship between income inequality and the environment tends to bean inverted U-shape). (Kuznets, 1955) Later, as environmental problems became more serious, the relationship between income and the environment attracted more attention and led to an increase in research on this issue. Grossman and Krueger (1991) and Shafik (1992) were among the first studies to address the relationship between income and environment. Panayotou (1993) is considered to be the author of the first study to use the environmental Kuznets curve hypothesis of the relationship between environment and income. The indicators used to determine the environmental quality in the Environmental Kuznets Curve Hypothesis are emissions of gases such as methane (CH4), nitrous oxide (N2O), sulfur dioxide (SO2), especially carbon dioxide (CO_2) that constitutes the majority of air pollution, reduction rate of forest areas, waste includes elements such as water. The environmental Kuznets curve hypothesis (EKC) states that environmental pollution increases in the early stages of economic growth, but decreases in the later stages of economic growth. In countries with little industrialization and predominantly agricultural economies or in pre-industrial times, environmental degradation was negligible. In advanced industrialized countries, however, this excessive and rapid situation causes environmental degradation due to the increase in production and consumption activities with the aim of economic growth and the rapid depletion of natural resources. In proportion to environmental pollution, the quality of life is also negatively affected. On the other hand, in developed countries, an environmentally sensitive and environmentally friendly attitude has been adopted in order to prevent the deterioration of the quality of life and the emergence of environmental problems during the development period based on economic growth. Therefore, it is observed that the environmental Kuznets curve takes a downward course during the economic growth period in developed countries and environmental degradation decreases despite economic growth.

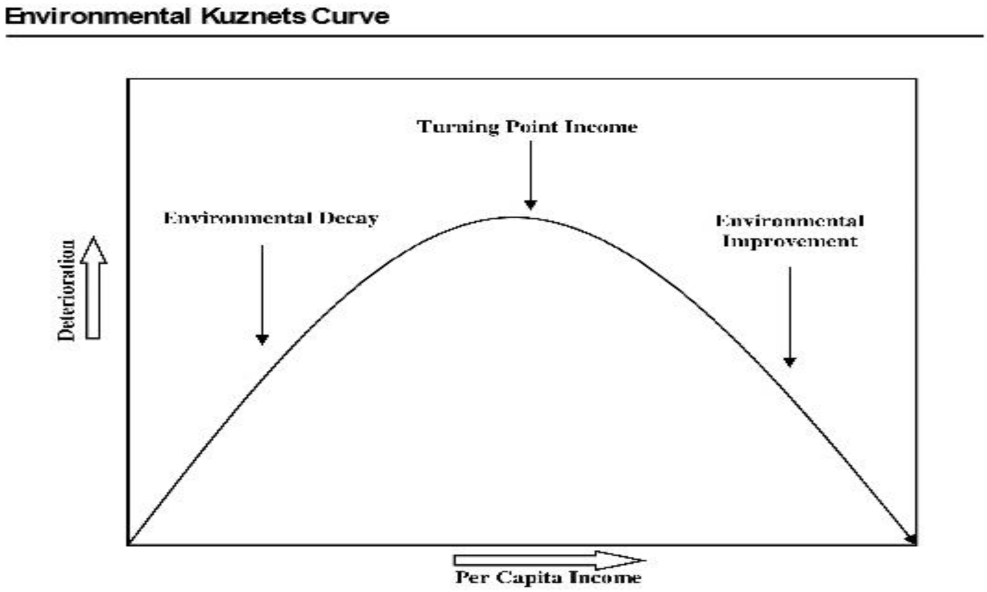

Figure 1. Enviromental Kuznets Curve
Source: Yandle, Bhattarai, Vijayaraghavan, 2004

Lıterature

A review of the literature on environmental Kuznets curves, carbon emissions, energy sources and their economic impacts reveals a number of studies.

Shafik and Bandyopadhyay (1992) analyzed the rates of decline in forest area, CO_2 per capita, GDP per capita and water pollution variables in a panel data analysis for the years 1961-1986 and observed a monotonic increase in CO_2 emissions.

Panayotou (1993) analyzed the existence of the environmental Kuznets curve for the period 1982-1994 using data from 30 countries and concluded that this curve is inverted U-shaped.

In a study covering 18 OECD countries from 1980 to1997, Cole (2004) observed that the environmental Kuznets curve is inverted U-shaped.

Menyah and Wolde (2010) examined the causal relationship between nuclear and renewable energy consumption and carbon dioxide emissions in the US between 1960 and 2007. However, they did not find a causal relationship between renewable resource consumption and carbon dioxide emissions, but they found a unidirectional causal relationship from carbon dioxide emissions to renewable resource consumption.

Narayan and Narayan (2010) used a panel cointegration methodology for CO_2 and real GDP variables from1980 to 2004 for 43 developing countries. The analysis concludes that the environmental Kuznets curves for South Africa and the Middle East countries are inverted U-shaped.

Menagaki (2011) analyzed 27 European countries for the period 1997-2007. A panel error correction model was used for this analysis. The analysis showed that there are no short or long-run causal relationships between the variables. This means that, according to the authors' study, renewable energy consumption has little impact on economic growth in Europe.

Mor and Jindal (2012), in their study investigating the Environmental Kuznet Curve for the 1997-2008 Kyoto Countries, concluded that the curve is in an inverted U shape.

Pao and Fu (2013) examined the relationship between real economic growth and four types of energy in Brazil between the 1980s and 2010s. Cointegration test was used in the study. The results concluded that the variables used have long-run equilibrium and a two-way causal relationship. In addition, it is concluded that there is a positive interaction between the variables.

Dong, Sun, Jiangand Zeng (2019) developed an environmental Kuznets curve for China for the period 1993-2016 using CO_2, GDP, fossil fuel consumption per capita, nuclear energy consumption per capita and renewable energy consumption per capita. They verified the results. As a result of the study, they found that nuclear and renewable energy play an important role in reducing carbon dioxide emissions.

Yao, Zhang and Zhang (2019) analyzed renewable Kuznets curves (RKCs) for 17 developed and developing countries for the period 1990-2014. The study concludes that the use of renewable energy sources affects carbon emissions and the Kuznets curve reaches the tipping point earlier.

In our study for eight developed and developing countries—the United States, China, Indonesia, France, South Korea, India, Turkiye, and Greece—the long-term relationship between per capita GDP (Gross Domestic Product), carbon emissions (CO_2), nuclear and renewable energy was examined. The Environmental Kuznet Curve approach's validity was also examined in this study.

MATERIAL AND METHOD

Dataset and Method

The study looked at 8 developed and developing countries. The data covered the period 1982 and 2020. The countries examined are Turkiye, France, Greece, China, India, Indonesia, South Korea and the United States. Data for each country obtained from the World Bank, OECD (Organisation for Economic Co-Operation and Development) and International Energy Information Administration.

Environmental Kuznets Curve Model
Model-1:
$Y_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 X_{2it} + \beta_3 X_{3it} + u_{it} Y_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 X_{it}^3 + u_{it}$ (1)
$\beta_1 = \beta_2 = \beta_3 = 0$ In case of this equality, there is no relationship between environmental pollution and income.

$\beta_1 < 0$, $\beta_2 = \beta_3 = 0$ There is a negative relationship between environmental pollution and income only when the first coefficient is less than 0. In the opposite case, there is a positive relationship.

$\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 = 0$ In this case we accept the presence of Enviromental Kuznets Curve . There is an inverted U relationship between environmental pollution and income.

Let's take the opposite situation. $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 = 0$ In this case, there is a U-shaped curve between environmental pollution and income

If we consider the cubic value, $\beta_1 < 0$, $\beta_2 > 0$ ve $\beta_3 > 0$ There is an N-shaped relationship between environmental damage and income.

The second model created is as follows:
Model-2:
$LnCO_{2it} = \beta_{0i} + \beta_1 LnGDP_{it} + \beta_2 LnGDP_{2it} + \beta_3 LnEN_{it} + u_{it} LnCO_{2it} = \beta_{0i} + \beta_1 LnGDP_{it} + \beta_2 Ln\ GDP_{it}^2 + \beta_3 LnEN_{it} + u_{it}$ (2)

Definitions
i : country group
t : time series
CO_2 : carbon emissions per capita income
GDP : per capita income gross domestic product (2015 USD)
GDP^2 : squared gross domestic product per capita
EN : nuclear and renewable energy generation
The logarithms of all variables are taken. Eviews12 and Stata16 programs were used for econometric analysis.

Table 1. Descriptive statistics

Variable	Observation	Average	Standard Error	Minimum	Maximum
CO_2	312	1.312891	1.040984	-0.967584	3.010128
GDP	312	8.881374	1.452706	5.960079	10.99912
GDP_2	312	17.76276	2.905411	11.92016	21.99824
EN	312	-0.1848610	1.883937	-4.004429	2.996817

FINDINGS AND DISCUSSION

Cross-Section Dependency and Coefficient Homogeneity Test

Before Panel Data Analysis, first of all, the cross-sectional dependence of the data and the homogeneity of the coefficients are tested. Since the T>N condition is met in the study, that is, the time series is larger than the cross-section, the Breusch-Pagan LM Test (1980), Peseran (2004) and Peseran Ullah Yamagato (2008) tests were used to determine the cross-sectional dependence. The hypotheses of all three tests are shown below.

H_0= T here is no horizontal section dependency

H_1= There is horizontal section dependency

Table 2. Cross-Section Dependency Tests

Test	Statistics	Possibility
Breusch-Pagan LM Test (1980)	225,1	0,000
Peseran Ullah Yamagato (2008)	83,01	0,000
Peseran (2004) CD Test	10,24	0,000

As can be seen from the results in Table 2, the probability value for all three tests is 0.000, i.e. less than 0.05 at the 5% significance level and the null hypothesis H0 is rejected. Therefore, it can be concluded that the horizontal range is dependent. The unit root test and cointegration test to be conducted in the remainder of this study should be chosen according to the horizontal cross-section dependence. Another test that plays a decisive role in the tests applied in the rest of the study is the coefficient homogeneity test: Pesaran Yamagata (2008) delta test is applied to determine whether the slope coefficients are homogeneous or heterogeneous across the countries analyzed.

Table 3. Homogeneity Test

	Delta	Possibility
adj	24,550	0,000
	26,293	0,000

According to the findings, the probability values are less than 0.05 and the probability values are 0.000. Accordingly, it has been concluded that the slope coefficients are different for all countries in the horizontal section and therefore heterogeneous.

Unit Root Test

In order for the estimation results in the study to give correct results, the stationarity of the series should be tested. For this, Peserane CIPS (2007) Unit Root Test was used

Tablo 4. Peseran CIPS Birim Kök Testi

		Critical Values		
Variables	CIPS Value	%10	%5	%1
CO_2	-1.477	-2.21	-2.33	-2.55
GDP	-1.348	-2.21	-2.33	-2.55
GDP2	-1.348	-2.21	-2.33	-2.55
EN	-2.536	-2.21	-2.33	-2.55

The table value for N,T=(8.39) is shown as 2.33.

According to the findings shown in Table 4, it is seen that the CO_2, GDP and GDP2 variables are not stationary at the 5% significance level, and the EN variable at the 1% significance level. As a result, all series are stationary at first order difference and are not I(0) at level.

Panel Cointegration Test

The next step followed in the study is the Panel Cointegration Test, and in this study, Westerlund Edgerton (2007) and its companion Westerlund Durbin-H (2008) Test were used. Westerlund Edgerton (2007)

Cointegration Test is a cointegration test used in case of cross-sectional dependence, in which the dependent variable is stationary at I(1) but the independent variables can be stationary at I(0) and I(1) levels. Since the cross-section in the study is dependent, Robust Probability Values are taken into account as a result of the cointegration test. Two hypotheses of Westerlund Edgerton (2007) Cointegration Test:

H0= No cointegration relationship

H1= There is cointegration relationship

As a result of the findings, the H0 hypothesis was rejected and the existence of a cointegration relationship was determined. Bootstrap value is taken as 300, lag 1, premise 1.

Table 5.Westerlund Cointegration Test

Westerlund Bootstrap Panel Cointegration Test		
Test	**Value**	**Robust Possibility Value**
Gt	-2.032	0,777
Ga	-5.491	0.970
Pt	-3.512	0.933
Pa	-3.953	0.947
Durbin-Haussman Panel Cointegration Test		
Test		**Possibility Value**
Durbin-haussman Grup		0,089
Durbin-haussman Panel		0,052

Cointegration Coefficient Test

After determining the cointegration relationship, the cointegration coefficients between the series are estimated. Due to the horizontal cross-sectional dependence and heterogeneity between the series, this study uses the Augmented Mean Group Estimator (AMG) estimation method, which takes these two conditions into account in estimation. AMG estimationis an econometric estimation method developed in 2009 and introduced by Eberhardt and Bond. The AMG estimation, introduced by the authors, allows estimating the overal coefficients for the panel, while providing information on the entire horizontal cross-section, i.e. country-specific coefficients.

Table 6. Co-integration Coefficients (The dependent variable CO_2)

Country	GDP	GDP2	EN
Türkiye	0.9087*** (0.000)	0.4543*** (0.000)	0.0819** (0.037)
France	-0.8251*** (0.000)	-0.4125*** (0.000)	-0.0916 (0.259)
Greece	0.5137*** (0.000)	0.2568*** (0.000)	-0.3530*** (0.000)
China	0.5892*** (0.000)	0.2946*** (0.000)	0.4815*** (0.000)
India	0.8832*** (0.000)	0.4416*** (0.000)	0.5101*** (0.000)
Indonesia	1.2036*** (0.000)	0.6018*** (0.000)	-0.0196 (0.608)
South Korea	0.6549*** (0.000)	0.3274*** (0.000)	0.0572** (0.052)
USA	-0.3981*** (0.000)	-0.1990*** (0.000)	-0.7889*** (0.000)
	0.4412* (0.072)	0.2206* (0.072)	-0.0152 (0.919)

***%1, **%5 and *%10 significance

When the results obtained are analyzed, it can be seen that the coefficients of GDP and GDP2 are significantat 1% confidence interval for all countries for the AMG estimator with CO_2 as the dependent variable. When interpreted according to the overall panel, GDP and GDP2 for CO_2 are significant at 10% confidence interval with probability values of 0.072 and 0.072, respectively. It can be concluded that there is a positive and statistically significant relationship between income and carbon emissions. In general, a unit increase in GDP (gross domestic product) increases carbon emissions (CO_2) by 0.44 and a unit GDP squared increases carbon emissions (CO_2) by 0.22. There is a negative but statistically insignificant relationship between energy and carbon emissions. When the coefficients obtained as a result of estimation are analyzed on a country basis, it is seen that a 1% increase in Turkey's economic growth rate increases carbon emissions by 0.98%, while doubling the growth rate reduces the effect on carbon emissions to 0.45%. Therefore, it can be concluded that environmental pollution decreases as income level increases in Turkey. Similarly, in Indonesia, a one-unit increase in income increased carbon emissions by 1.20%, but this rate decreased to 0.60% when income was squared. The same is true for China, India and South Korea. When the coefficients for Greece are examined, it is seen that carbon emissions are affected by 0.51 at the normal income level, but decreased to 0.25 per square of income. At the same time, it has been determined that there is a statistically significant relationship between renewable energy production and carbon emissions for Greece, with a 1% confidence interval. For this reason, it is concluded that nuclear and renewable energy production reduces carbon emissions by 0.35 percent. Considering the coefficients of income and income squared, France follows a different course compared to other countries in the group. While a 1% increase in the normal level of income reduced carbon emissions by 0.82, this ratio was 0.41 in the square of income. As income increased, its impact on carbon emissions decreased. It may be possible that this situation can be associated with the N-shaped Circumferential Kuznets Curve. When the energy variable is interpreted for the USA, a statistically significant relationship was observed between energy and carbon emissions in the negative direction and at the 1% confidence interval. Accordingly, a 1% increase in nuclear and renewable energy production reduces carbon emissions by 0.78 percent. In the analysis, the USA has the biggest negative effect on carbon emissions.

RESULT AND CONCLUSION

The environment and the relationship between environmental factors and the economy is an important topic for many researchers today. The direct relationship between economic growth and productive capacity leads to a number of parameters caused by increased production. While the increase in the number of workers creates administrative effects such as the establishment of trade unions, the modification of legislation and financial laws according to the conditions of the day, the disposal of gaseous and liquid wastes, acoustic pollution and the search for new raw materials for natüre by manufacturing companies also manifest themselves as environmental effects of increased production. The use of energy converted from fossil fuels also increases carbon emissions. In this context, increasing the use of renewable energy sources instead of fossil-based energy sources used in production will also reduce carbon emissions. This study analyzes the long-term relationship between GDP per capita, carbon emissions, and nuclear and renewable energy using data from 1982 to 2020 for the US, China, Indonesia, France, South Korea, India, Turkiye and Greece. The panel data analysis concludes that the variables are interrelated. According to the findings, as economic growth increases, the impact of growth on environmental pollution decreases more than before. This suggests that there is a negative relationship between economic growth and environmental degradation: When the 'environmental Kuznets curve', which was proposed by Simon Kuznets in 1955 and became popular in the literature with the increase in pollution rates after the industrial revolution, is analyzed, it is seen that developed countries realize their economic growth targets and implement full-fledged environmental policies to prevent environmental damage. Therefore, pollution, which increases during the economic development period, declines in an inverted U-shape during the last development period, supporting the environmental Kuznets curve hypothesis.

A negative relationship between nuclear and renewable energy and environmental degradation was also found in Greece and the US, the two main countries in the study. Therefore, increasing nuclear and renewable energy production will reduce the environmental damage caused by carbon emissions. Turning to nuclear and renewable energy, reducing the use of destructive energy sources such as fossil fuels and reinforcing this with supportive environmental policies is an important policy to control environmental degradation and prevent environmental pollution.

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REFERENCES

Breusch, T. S., & Pagan, A. R. 1980. The Lagrange multiplier test and its applications to model specification in econometrics. *The review of economic studies*, *47*(1), 239-253.

Cole, Matthew A. 2004. Trade, The Pollution Ha()ven Hypothesis And The Environmental Kuznets Curve: Examining The Linkages, Ecological Economics, *48*(1), pp. 71– 81.

Diao, X. D., Zeng, S. X., Tam, C. M., & Tam, V. W. 2009. EKC analysis for studying economic growth and environmental quality: a case study in China. *Journal of Cleaner Production*, *17*(5), 541-548.

Dong, K., Sun, R., Jiang, H., & Zeng, X. 2018. CO_2 emissions, economic growth, and the environmental Kuznets curve in China: what roles can nuclear energy and renewable energy play?. *Journal of cleaner production*, *196*, 51-63.

World Bank (https://www.worldbank.org/ Acces Date: May 20, 2022

Eberhardt M., & Bond, S.R. 2009. Cross-sectional dependence in non-stationary panel models: a novel estimator, Nordic Econometric Meetings. Sweden

Elliot, D., 2007. Nuclear or Not? Does nuclear power have a place in sustainable energy future? Palgrave Macmillan, Houndmills, Basingstoke.

Ferguson, C.D., 2007. Nuclear Energy: Balancing benefits and risks. Council of Foreign Relations, CRS No. 28.

Grossman, G. M., & Krueger, A. B. 1991. Environmental impacts of a North American free trade agreement.

Kuznets, S. (1955). Economic growth and income inequality, American Economic Review, *45*(1), 1-28

Menyah, K. And Wolde-Rufael, Y. 2010. CO_2emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy, *38*, 2911-2915.

Mor, S., & Jindal, S. 2012. Estimation of environmental kuznets curve and kyoto parties: A panel data analysis. *IJCEM International Journal of Computational Engineering & Management*, *15*(1), 5-9.

Narayan, P. K., & Narayan, S. 2010. Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. *Energy policy*, *38*(1), 661-666.

Menagaki, A.N. 2011. Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. Energy Economics, *33*, 257-263.

Panayotou, T. 1997. Demystifying The Environmental Kuznets Curve: Turning A Black Box Into A Policy Tool", Environment And Development Economics, *2*(4) , pp. 465- 484.

Pao, H.T. and Fu, H.C. 2013. Renewable energy, non-renewable energy and economic growth in Brazil. Renewable and Sustainable Energy Reviews, *25*, 381-392.

Panayotou, T. 2000. Economic Growth And The Environment, CID Working Papers 56A, , pp. 1-49.

Pesaran, M. H., & Yamagata, T. 2008. Testing slope homogeneity in large panels. *Journal of econometrics*, *142*(1), 50-93.

Pesaran, M. H., Ullah, A., & Yamagata, T. 2008. A bias-adjusted LM test of error cross-section independence. *The Econometrics Journal*, *11*(1), 105-127.

Shafik, N., & Bandyopadhyay, S. 1992. *Economic growth and environmental quality: time-series and cross-country evidence, 904*. World Bank Publications.

International Energy Agency (https://www.iea.org/ Acces Date: June 1, 2022

Westerlund, J. 2008. Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics*, *23*(2), 193-233. 0.

Westerlund, J., & Edgerton, D. L. 2007. A panel bootstrap cointegration test. *Economics letters*, *97*(3), 185-19

Wolde-Rufael, Y., & Menyah, K. 2010. Nuclear energy consumption and economic growth in nine developed countries. *Energy economics*, *32*(3), 550-556.

Yandle, B., Bhattarai, M., & Vijayaraghavan, M. 2004. Environmental Kuznets curves: a review of findings, methods, and policy implications.

Yao, S., Zhang, S., & Zhang, X. 2019. Renewable energy, carbon emission and economic growth: A revised environmental Kuznets Curve perspective. *Journal of Cleaner Production*, *235*, 1338-1352.