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Do energy taxes reduce the carbon footprint? Evidence from Turkey*

Enerji vergileri karbon ayak izini azaltır mı? Türkiye'den kanıtlar

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ÖZ

Bu çalışma, 1994–2017 dönemi Türkiye veri setini kullanarak enerji vergilerinin karbon ayak izi üzerindeki etkisini incelemektedir. Bu çalışmada, değişkenler arasındaki uzun dönemli bir ilişkinin varlığını analiz etmek için Johansen eş-bütünleşme testleri kullanılmaktadır. Ayrıca, uzun dönem eş bütünleşme katsayılarını belirlemek için dinamik en küçük kareler (DOLS) ve tam düzeltilmiş en küçük kareler (FMOLS) tahmin yöntemleri uygulanmaktadır. Johansen eş bütünleşme analizinden elde edilen bulgular, değişkenler arasında uzun dönemli bir eş bütünleşme ilişkisinin olduğunu doğrulamaktadır. Ayrıca, DOLS ve FMOLS sonuçları, enerji vergilerinde meydana gelen bir artışın uzun vadede karbon ayak izini azalttığını ortaya koymaktadır. Bulgular, çevresel vergilerin belirli çevre kalite standartlarına ulaşmak için etkili birer alternatif politika aracı olarak kullanılabileceğini göstermektedir. Ayrıca, bu tür vergilerin maliyetleri etkilemek suretiyle ekonomik karar birimlerinin çevreye zararlı üretim ve tüketim alışkanlıkları üzerinde etkili olabildiğine dair kanıtlar sunmaktadır.

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ABSTRACT

This study examines the effect of energy taxes on the carbon footprint in Turkey using the data set for 1994-2017. Johansen cointegration tests were used in this study to analyze the existence of a long-term relationship between the variables. Moreover, the estimation methods "dynamic ordinary least squares" (DOLS) and "fully modified ordinary least squares" (FMOLS) were applied to determine the long-term cointegration coefficients. The results of the Johansen cointegration analysis confirm that there is a long-term cointegration relationship between the variables. In addition, the results of DOLS and FMOLS show that an increase in energy taxes reduces the carbon footprint in the long term. In conclusion, the results of the study suggest that environmental taxes can be used as an effective alternative policy tool to achieve certain environmental quality standards. In addition, the results provide evidence that such taxes can influence costs and, by doing so, have an effect on the economic decision units' habits of environmentally harmful production and consumption.

1. Introduction

With the advent of industrial revolution, energy became one of the important resources for production. In recent years, the effects of globalization movements have also led to an increase in energy use. The structural change that emerged in this process has increased the competitive environment, and as a result, increasing production and income has become the main goal of economic development (Aydin, Esen and Aydin, 2019). Thus, emerging production and consumption patterns have caused an increase in the demand for energy. As the world population and urbanization increase, human needs and thus environmental damage caused by human-induced pollution also increase (Aydin

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and Esen, 2018; Aydin and Onay, 2020). In this environment, economies focused on increasing their incomes and ignored environmental problems at first. This has caused a number of environmental problems such as the destruction of natural and ecological resources, the more release of carbon emissions in the atmosphere, and the accumulation of non-recyclable waste. Human-induced pollution has reached a level that threatens human health and ecological system.

Environmental degradation has deteriorated gradually due to the increase in economic competition and growth across the world, and this has brought to the forefront the environmental problems and the fight against them (Aydin and Esen, 2017; Aydin, Darici and Kutlu, 2019). Financial tools such as environmental taxes, a large part of which are energy taxes, have become important to combat environmental pollution. Energy tax is a specific taxation and defined as the taxes collected on both transportation and fixed energy products (Gündüz, 2013). The fight against environmental pollution has been the topic of many international conferences, and it has been asserted in these conferences that the problems induced by environmental pollution are caused by carbon and greenhouse gas emissions which are the main cause of climate change. This being the case, the ecosystem has started to be seriously damaged and come under threat due to the overconsumption of resources.

Measures against environmental pollution are also referred to as reform. Green economy is a new production model on a global scale that refers to achieving sustainable development goals while leaving a healthy environment for future generations. Humans leave footprints in the world as a result of their habits of production and consumption throughout life. These footprints are unpredictable in the short term, but may cause permanent damage to nature and therefore to human health in the long term. There are various indicators for sustainable development. One of these indicators is the “ecological footprint”, a new environmental calculation method to measure human demand on nature. Developed in the early 1990s by Rees (1992), Rees and Wackernagel (1994), ecological footprint calculations consist of six main ecological components: carbon footprint, cropland footprint, built-up land footprint, forest land footprint, fishing grounds footprint, and grazing land footprint (WWF, 2012). Carbon footprint accounts for the majority of the ecological footprint. Therefore, ecological footprint also includes greenhouse gas emissions. CO_2 and greenhouse gas emissions, two of the most striking issues of global warming, have affected air pollution and climate change. It has gained importance to reduce emissions in the fight against pollution and climate change. Carbon footprint, expressed in carbon dioxide equivalent, is the measure of the damage caused by human activities to the environment in terms of the amount of greenhouse gas produced.

Since the 1970s the ecological footprint has exceeded and continues to exceed the biocapacity worldwide (WWF, 2012). It is estimated that natural capacity will not be sufficient to meet the demands of humanity in this world order and sustainability will not be possible in such an ecosystem. According to the data of the World Wildlife Fund (WWF), the trends in the use of natural resources in Turkey are similar to the global ones (WWF, 2012). In other words, it is seen that individuals living in Turkey consume natural resources and put pressure on nature at the same rate as the world average. According to the data of WWF (2012), carbon footprint has the largest share (46-49%) in Turkey's total ecological footprint, as it does on a global scale.

The purpose of this study was to examine the effect of energy taxes on the carbon footprint in Turkey between 1994 and 2017. To this end, the existence of a long-term relationship between the variables was analyzed using Johansen cointegration tests. Moreover, the estimation methods “dynamic ordinary least squares” (DOLS) and “fully modified ordinary least squares” (FMOLS) were applied to determine the long-term cointegration coefficients.

To sum up, the rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 provides the data, the model, and the empirical results. Finally, Section 4 concludes with some discussions and policy suggestions.

2. Literature Review

In many previous studies on the effect of environmental taxes on various pollution indicators (carbon dioxide (CO_2) emissions, sulfur dioxide emissions, exhaust emissions, deforestation, etc.), it has been reported that environmental taxes are important in the development of environmental quality. For example, Manne and Richels (1990), Whalley and Wigle (1991), Alfsen et al. (1995), Nakata and Lamont (2001), Wissema and Dellink (2007), Lu et al. (2010), Miller and Vela (2013), Gemechu et al. (2014), Andersson (2015), Chen et al. (2017), Niu et al. (2018) and Wolde-Rufael and Mulat-Weldemeskel (2021) asserted that environmental taxes had a reducing effect on pollution emissions. Using Fourier Granger causality tests with smooth structural breaks, Aydin (2020) examined the effects of environmental tax revenues on the ecological footprint in 11 OECD countries between 1995 and 2016. He reported that the direction of causality ran from environmental tax revenues to ecological footprint in Germany, Sweden, and Denmark; while in France and Spain, there was a one-way causality running from ecological footprint to environmental tax revenues. Sasmaz (2016) examined a similar subject for EU-15 countries in the period 1995-2012 using panel cointegration tests and Panel FMOLS tests and reported that the increases in environmental tax revenues reduced CO_2 emissions. Similarly, Topal and Günay (2017) examined the data from 53 countries for the period 2000-2014 using static panel data analysis method and reported that environmental taxes had a positive effect on environmental quality. Using the panel smooth transition regression model for the 15 EU countries, Esen et al. (2021) point out that revenues from environmental taxes significantly reduce ecological deficits after passing a certain threshold level.

On the other hand, results of the studies by Agostini et al. (1992), Bruvoll and Larsen (2004), Gerlagh and Lise (2005), Hotunluoğlu and Tekeli (2007), Lin and Li (2011), Loganathan et al. (2014) and Akkaya and Hepsag (2021) suggest that environmental taxes have a very limited effect in reducing pollutant emissions. Hotunluoğlu and Tekeli (2007) used 18 European countries' data for the period 1995-2003 to examine the effects of carbon taxes on CO2 emissions. They used the panel least squares method and reported that carbon taxes had a slight effect in reducing emission, that is, they had no significant effect. In their study examining the effects of carbon taxation on CO2 emissions using time series data for Malaysia from 1974 to 2010, Nanthakumar et al. (2014) asserted that carbon taxation policies were not effective in controlling CO2 emissions. In a similar study carried out by Akkaya and Hepsag (2021) using Turkey's data for the period 1985-2018, it was reported that taxes on fuel had no effect on CO2 emissions.

3. Model, Dataset, and Empirical Results

The effect of energy taxes on carbon footprint was empirically examined in this study. Annual time series data for Turkey from 1994 to 2017 was used to estimate the relationship. The period 1994-2017 was selected based on the availability of data. In the study, the model used to test the relationship between the total tax revenue from energy taxes and the carbon footprint (as a measure of the damage caused by human activities to the environment in terms of the amount of greenhouse gases produced) was defined as follows:

$$carbon_t = \beta_0 + \beta_1 enrtax_t + \beta_2 lngdpper_t + \beta_3 lnenruse_t + \varepsilon_t \quad (1)$$

Where carbon refers to carbon footprint (global hectare (gha) per person), enrtax to the energy taxes revenue (% of GDP in million Euros), lngdpper (natural logarithm of GDP per capita in US$), lnenruse (natural logarithm of energy use in kg of oil equivalent per capita) and ε to the error term. Table 1 provides a summary of the description and source of the variables.

Table 1. Data source and description

Indicator name	Symbol	Unit of measurement	Source
Carbon footprint	carbon	Global hectare (gha) per person	GFN (2021)
Energy taxes revenue	enrtax	% of GDP in million Euros	OECD (2021)
Gross Domestic Product per capita	gdpper	Current US$	WB (2021)
Energy use	enruse	Oil equivalent per capita (kg)	WB (2021)

The data on carbon footprint was retrieved from the database of Global Footprint Network (GFN, 2021), the data on energy taxes from the database of OECD (Organization for Economic Co-operation and Development) (OECD, 2021), and the data on per capita income from the database of World Bank (WB). Table 2 shows the descriptive statistics of the data series used in the study.

Table 2. Descriptive statistical analysis for the sample period (1994–2017)

Variables	Observations	Mean	Median	Maximum	Minimum	Std. Dev.
carbon	24	1.616389	1.618395	2.233370	1.066670	0.321150
enrtax	24	2.205625	2.280000	3.197000	0.874000	0.588851
lngdpper	24	8.774088	8.958331	9.442625	7.727684	0.570024
lnenruse	24	7.185880	7.167205	7.504790	6.883960	0.170681

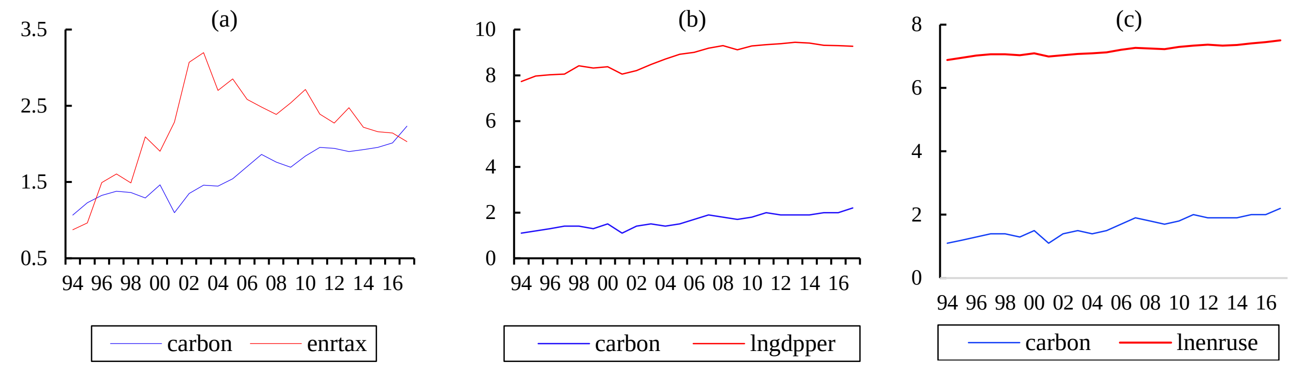
The results of the correlation matrix created to determine the correlation relationship between the variables related to Turkey for the sample period (1994–2017) are presented in Table 3.

Table 3. Result of the correlation matrix test

Variables	carbon	enrtax	lngdpper	lnenruse
carbon	1			
enrtax	0.356261	1		
lngdpper	0.936518	0.500189	1	
lnenruse	0.986301	0.336349	0.926783	1

The correlation coefficients reported in Table 3 indicate the existence of positive and very high correlations between the variables. Besides, the correlation between energy taxes and carbon footprint seems to be quite weak. Figure 1 is important in terms of depicting the high correlation relationships among the variables.

Figure 1. Trends on the relationship between carbon footprint and the variables in Turkey



While graph (b) in Figure 1 shows the parallelism between carbon footprint and per capita income, a similar structure can be clearly seen in graph (c), which reflects the relationship between carbon footprint and per capita energy use. However, in the graph (a), which shows the energy taxes-carbon footprint nexus, it is seen that the relationship between the series changes periodically.

To examine the time series properties of each variable, it must first be determined whether the series are stationary, and if so, at what level they are stationary (Esen, 2012). In time series analysis, in order to obtain empirically significant relationships between the variables, the series should not contain unit roots, that is, it should be stationary. In general, aggregated time series contain non-stationary behavior (stochastic trend) (Kwiatkowskiat et al., 1992). Spurious regression problem or invalid statistical inferences may be encountered when studying on non-stationary time series. If this is the case, the results obtained from regression analysis may not reflect the real relationship (Gujarati, 1995; Lin and Brannigan, 2003; Shrestha and Bhatta, 2018). Therefore, in this study, the stationarity of the series was tested using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. Table 4 shows the results.

Table 4. Unit root test results

Variables	ADF Unit Root Test				PP Unit Root Test			
	Level		First Difference		Level		First Difference	
	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & Trend
carbon	-0.8069	-3.3026	-6.0127*	-5.8498*	-0.4970	-3.3026	-7.3620*	-7.7942*
enrtax	-2.5048	-1.6503	-4.5159*	-5.3889*	-2.5215	-1.4066	-4.5113*	-6.4444*
lngdpper	-1.7812	-1.3817	-4.5688*	-4.6768*	-1.7832	-1.4708	-4.5688*	-4.6768*
lnenruse	-0.4549	-2.4003	-4.7441*	-4.6455*	-0.4153	-2.5249	-4.8960*	-5.0376*

* and ** indicate significance at the 1% and 5% level, respectively.

Based on the results of both ADF and PP unit root tests in Table 4, it was concluded that at $p < 0.05$ significance level, all of the carbon, enrtax, lngdpper and lnenruse variables contained a unit root at level and were stationary when the first differences were considered. Table 5 shows the Dickey-Fuller min-t breakpoint unit root test results.

Table5. Dickey-Fuller min-t breakpoint unit root test results

	Level					
	Intercept		Trend & Intercept		Trend	
	min-t stat.	Breakpoint	min-t stat.	Breakpoint	min-t stat.	Breakpoint
carbon	-4.162	2005	-4.559	2005	-4.031	2002
enrtax	-4.661	2001	-6.663*	2001	-4.301	2003
lngdpper	-3.230	2015	-3.884	2010	-4.053	2013
lnenruse	-4.342	2001	-5.126	2005	-4.159	2002
	First Difference					
carbon	-6.558*	2001	-6.058*	2001	-6.043*	2017
enrtax	-6.940*	2002	-6.821*	2002	-5.315*	1999
lngdpper	-6.981*	2001	-17.578*	2008	-6.994*	2008
lnenruse	-6.567*	2005	-5.569**	2005	-5.152*	1999

The p-values based on Vogelsang (1993) asymptotic one-sided p-values. The lag lengths are determined on the basis of the SIC (Schwarz information criterion). * and ** indicate significance at the 1% and 5% level, respectively.

As in Table 5, when the stationarity status of carbon, enrtax, lngdpper and lnenruse series is analyzed by considering structural breaks, it is concluded that all of the series have unit roots at the level, except for the enrtax variable for all

Models. It is seen that only the enrtax series among these variables is stationary in Model 2- trending data with intercept and trend break.

As a result of the unit root tests, it was found that the integration levels of the variables were the same, that is, they were stationary at the same level. Then, it was examined whether there was a long-term relationship between the variables using cointegration tests. Existence of a cointegration between the variables means that there is a long-term relationship. At this stage of the research, Johansen's (1988, 1995) approach was used to examine whether there was a long-term relationship between the variables. The optimal lag length should be determined before performing the Johansen cointegration test. Therefore, the vector autoregressive (VAR) model was estimated to determine the optimal lag length between variables. As a result, the optimal lag length for the Johansen cointegration test was determined as 1 based on the SIC. After determining the optimal lag length, the Johansen cointegration test was used to determine the presence and number of cointegration relationships. Table 6 shows the results of the Johansen cointegration test, which is based on Trace and Maximum Eigen-value statistics, for the lag length of 1.

Based on the results in Table 6, it can be asserted that the hypothesis H_0 (there is no cointegration between the variables at the significance level of 5% in both the maximum eigenvalue (λmax) and the trace (λtrace) test statistics) is rejected. So, there are two cointegration relationships between the variables at the 0.05 level in both tests. As can be seen in Table 6, the trace statistic was found to be 69.347, which is above the critical value of 54.079 at the significance level of 5%. Therefore, the null hypothesis (r = 0) was rejected at the significance level of 5%. Similarly, also for the maximum eigenvalue test, the null hypothesis of no cointegration was rejected at the significance level of 5% (λ max = 29.456> 28.588). These results confirm that there is a cointegration relationship between the variables. In other words, there is a long-term relationship between the energy taxes and the carbon footprint in Turkey.

Table 6. The results of the cointegration tests and diagnostic tests

Johansen cointegration tests					System diagnostics		
H_o	λtrace	%5 c.v.	λmax	%5 c.v	Serial correlation	Heteroskedasticity	Normality
r = 0	69.3475*	54.0790	29.4565*	28.5880	24.71013	177.5726	5.925263
r ≤ 1	39.8909*	35.1927	24.2103*	22.2996	(0.095)	(0.162)	(0.656)
r ≤ 2	15.6806	20.2618	9.06671	15.8921			
r ≤ 3	6.61389	9.16454	6.61389	9.16454			

* denotes statistically rejection of the H_o in favor of H_1at the 5% level. The critical values (c.v.) based on MacKinnon-Haug-Michelis (1999). The lag lengths are determined on the basis of the SIC. "r" denotes the number of cointegrating relation. Numbers in () represent p-values.

As for the general model fit, when the reliability of the models was tested using a series of diagnostic tests such as autocorrelation, heteroscedasticity, and normality tests; it was found that the probability values were above 5%. So, there was no autocorrelation or heteroscedasticity problem in the model, and the residuals were normally distributed. As can be seen in Table 6, there is no evidence of serious violations of all diagnostic tests.

After confirming the existence of a long-term relationship between the variables, cointegration parameters should be estimated. The Ordinary Least Squares (OLS) estimator is simple to use for model estimation, but it can cause some problems. For example, in the OLS method, the dynamic effect on the variables that make up the model is not taken into consideration. Moreover, the OLS method may yield biased results in estimating a model with a small sample size. Therefore, in this study, the coefficients of the cointegration vector were analyzed using the DOLS and FMOLS estimation methods. The DOLS and FMOLS estimation results are given in Table 7.

Table 7. The results of long-run coefficient estimates based on FMOLS and DOLS for carbon

Variables	DOLS	FMOLS
	Coefficient	*Coefficient*
enrtax	-0.032212** (0.012511)	-0.024633** (0.011297)
lngdpper	0.241061* (0.036232)	0.080149* (0.026923)
lnenruse	1.038595* (0.115400)	1.622848* (0.083936)
R-squared adj.	0.99	0.97

Standard errors in parentheses. Statistical significance levels: * $p < 0.01$, and ** $p < 0.05$

Table 7 shows the estimation of the long-term relationship between the total tax revenue from energy taxes and the carbon footprint induced by human activities. Based on the DOLS and FMOLS estimation results, it can be asserted that there is a long-term, negative relationship between the energy taxes and the carbon footprint. In the long term, a one-unit increase in energy taxes decreases the carbon footprint by 0.03 according to the DOLS estimator and by 0.02 according to the FMOLS estimator. The results of both estimators show that energy taxes are an important factor on the carbon footprint and can contribute to Turkey's environmental development. Moreover, when the DOLS and FMOLS results were examined, it was found that the coefficients of the per capita income and per capita energy use variables were statistically significant at the 0.01 level and positive as expected. Bases on this result, it can be asserted that as the economic activities per capita increase, the carbon footprint induced by these activities also increases in Turkey.

4. Conclusion and Evaluation

Pollution liability, that is, pollution pricing approach is one of the market-based economic approaches that can be actively used to prevent environmental pollution. Pollution liability includes a series of environmental taxes levied to regulate the behavior of producers and consumers. Taxes on energy production and energy products are used as an alternative environmental policy tool in the fight against environmental pollution. The effect of the Turkish energy taxes on carbon footprint was empirically examined in this study. To this end, the relationship was analyzed using the annual data for the period 1994–2017. In the study, cointegration analysis was used to test the existence of a long-term relationship between the variables. In the model, Johansen cointegration tests were applied to test the cointegration relationship, and the DOLS and FMOLS estimators to estimate the long-term coefficients. The empirical results showed that there was a long-term, negative, and statistically significant relationship between the energy taxes and the carbon footprint. It was found that a one-unit increase in the revenues from energy taxes decreased the carbon footprint by 0.03 according to the DOLS estimator and by 0.02 according to the FMOLS estimator. These results show that taxation of energy use provides a price signal because the costs of environmental pollution can be levied on polluters, and this can affect the production and consumption decisions in the context of environmental concerns. In other words, taxes on energy can be used as a policy tool to reduce environmental pollution and/or protect the environment. In conclusion, it can be asserted that such taxes are an appropriate environmental policy tool that can provide incentives for reducing pollutant emissions and thus carbon footprint.

References

Agostini, P., Botteon, M., & Carraro, C. (1992). A carbon tax to reduce CO2 emissions in Europe. *Energy Economics*, 14(4), 279-290. https://doi.org/10.1016/0140-9883(92)90034-B

Akkaya, Ş., & Hepsag, A. (2021). Does fuel tax decrease carbon dioxide emissions in Turkey? Evidence from an asymmetric nonlinear cointegration test and error correction model. *Environmental Science and Pollution Research*, 1-8. https://doi.org/10.1007/s11356-021-12907-9

Alfsen, K. H., Birkelund, H., & Aaserud, M. (1995). Impacts of an EC carbon/energy tax and deregulating thermal power supply on CO_2, SO_2 and NO_x emissions. *Environmental and Resource Economics*, 5(2), 165-189. https://doi.org/10.1007/BF00693022

Andersson, J. (2015). *Cars, carbon taxes and CO2 emissions*. Centre for Climate Change Economics and Policy Working Paper WP No. 238. London: Grantham Research Institute on Climate Change and the Environment. (Accessed on 14.05.2021), http://re.indiaenvironmentportal.org.in/files/file/Cars%2C%20carbon%20taxes%20and%20CO2%20emissions.pdf

Aydin, C., & Esen, O. (2017). The validity of the environmental Kuznets curve hypothesis for CO2 emissions in Turkey: new evidence from smooth transition regression approach. *Mustafa Kemal University Journal of Social Sciences Institute*, *14*(39), 101-116.

Aydin, C., & Esen, Ö. (2018). Reducing CO2 emissions in the EU member states: Do environmental taxes work?. *Journal of Environmental Planning and Management*, *61*(13), 2396-2420. https://doi.org/10.1080/09640568.2017.1395731

Aydin, C., & Onay, R. D. (2020). Does Energy Intensity Affect the Relationship Between Financial Development and Environmental Pollution?. *Broad Research in Artificial Intelligence and Neuroscience*, *11*(1), 144-156. http://dx.doi.org/10.18662/brain/11.1/20

Aydin, C., Darici, B., & Kutlu, Ş. Ş. (2019). Does Economic Growth Reduce Environmental Pollution?. *Anemon Journal of Social Sciences of Mus Alparslan University*, *7*(2), 191-196. https://doi.org/10.18506/anemon.459157

Aydin, C., Esen, Ö., & Aydin, R. (2019). Is the ecological footprint related to the Kuznets curve a real process or rationalizing the ecological consequences of the affluence? Evidence from PSTR approach. *Ecological indicators*, *98*, 543-555. https://doi.org/10.1016/j.ecolind.2018.11.034

Aydin, M. (2020). Seçilmiş OECD ülkelerinde çevre vergilerinin çevre kirliliği üzerindeki etkileri: yapısal kırılmalı nedensellik testinden kanıtlar. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, (28), 137-154. https://doi.org/10.18092/ulikidince.704936

Bruvoll, A., & Larsen, B. M. (2004). Greenhouse gas emissions in Norway: do carbon taxes work?. *Energy policy*, 32(4), 493-505. https://doi.org/10.1016/S0301-4215(03)00151-4

Chen, W., Zhou, J. F., Li, S. Y., & Li, Y. C. (2017). Effects of an energy tax (carbon tax) on energy saving and emission reduction in Guangdong province-based on a CGE model. *Sustainability*, 9(5), 681.https://doi.org/10.3390/su9050681

Esen, O. (2012). The effect of exchange rate uncertainty on exports in Turkey. *Finans Politik ve Ekonomik Yorumlar*, (568), 89-89.

Esen, Ö., Yıldırım, D. Ç., & Yıldırım, S. (2021). Pollute less or tax more? Asymmetries in the EU environmental taxes–Ecological balance nexus. *Environmental Impact Assessment Review*, *91*, 106662. https://doi.org/10.1016/j.eiar.2021.106662

Gemechu, E. D., Butnar, I., Llop, M., & Castells, F. (2014). Economic and environmental effects of CO2 taxation: an input-output analysis for Spain. *Journal of Environmental Planning and Management*, 57(5), 751-768. https://doi.org/10.1080/09640568.2013.767782

Gerlagh, R., & Lise, W. (2005). Carbon taxes: a drop in the ocean, or a drop that erodes the stone? The effect of carbon taxes on technological change. *Ecological Economics*, 54(2-3), 241-260. https://doi.org/10.1016/j.ecolecon.2004.12.037

GFN (2021). *Ecological Footprint database.* (Accessed on 01.05.2021), https://data.footprintnetwork.org/

Gujarati, D. N. (1995). Basic Econometrics. New York: McGraw Hill.

Gündüz, İ. O. (2013). Bir Çevre Vergisi Türü Olarak Enerji Vergisi: Fosil Yakıtların Vergilendirilmesi-I. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *22*(2), 111-125.

Hotunluoğlu, H., & Tekeli, R. (2007). Karbon vergisinin ekonomik analizi ve etkileri: karbon vergisinin emisyon azaltıcı etkisi var mı?. *Sosyoekonomi*, *6*(6), 107-125.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, *12*(2-3), 231-254. https://doi.org/10.1016/0165-1889(88)90041-3

Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*. New York: Oxford University Press.

Lin, B., & Li, X. (2011). The effect of carbon tax on per capita CO2 emissions. *Energy policy*, 39(9), 5137-5146. https://doi.org/10.1016/j.enpol.2011.05.050

Lin, B., & Li, X. (2011). The effect of carbon tax on per capita CO2 emissions. *Energy policy*, *39*(9), 5137-5146. https://doi.org/10.1016/j.enpol.2011.05.050

Lin, Z., & Brannigan, A. (2003). Advances in the analysis of non-stationary time series: An illustration of cointegration and error correction methods in research on crime and immigration. *Quality and Quantity*, *37*(2), 151-168. https://doi.org/10.1023/A:1023367205756

Loganathan, N., Shahbaz, M., & Taha, R. (2014). The link between green taxation and economic growth on CO2 emissions: fresh evidence from Malaysia. *Renewable and Sustainable Energy Reviews*, 38, 1083-1091. https://doi.org/10.1016/j.rser.2014.07.057

Lu, C., Tong, Q., & Liu, X. (2010). The impacts of carbon tax and complementary policies on Chinese economy. *Energy Policy*, 38(11), 7278-7285. https://doi.org/10.1016/j.enpol.2010.07.055

Manne, A. S., & Richels, R. G. (1990). CO2 emission limits: an economic cost analysis for the USA. *The Energy Journal*, 11(2), 51–74. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol11-No2-3

Miller, S., & Vela, M. (2013). *Are environmentally related taxes effective?*. IDB Working Papers, WP. No. IDB-WP-467. https://dx.doi.org/10.2139/ssrn.2367708

Nakata, T., & Lamont, A. (2001). Analysis of the impacts of carbon taxes on energy systems in Japan. *Energy Policy*, 29(2), 159-166. https://doi.org/10.1016/S0301-4215(00)00104-X

Nanthakumar, L., Shahbaz, M., & Taha, R. (2014). The effect of Green Taxation and Economic Growth on Environment Hazards: The Case of Malaysia. MPRA Paper 1–16. Munich, Germany: University Library of Munich. (Accessed on 14.05.2021), http://mpra.ub.uni-muenchen.de/56843/.

Niu, T., Yao, X., Shao, S., Li, D., & Wang, W. (2018). Environmental tax shocks and carbon emissions: An estimated DSGE model. *Structural Change and Economic Dynamics*, *47*, 9-17. https://doi.org/10.1016/j.strueco.2018.06.005

OECD (2021). *Environment Statistics (database).* (Accessed on 01.05.2021), https://data.oecd.org/envpolicy/environmental-tax.htm

Rees, W. E. (1992). Ecological footprints and appropriated carrying capacity: what urban economics leaves out. *Environment and Urbanization*, 4(2), 121-130.

Rees, W. E., & Wackernagel, M. (1994). Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy. In: A. Jansson, M. Hammer, C. Folke, R. Costanza (Eds.), *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, (pp. 362-390). Washington, DC: Island Press.

Sasmaz, M. U. (2016). Validity of double dividend hypothesis in EU-15 countries. *New Trends and Issues Proceedings on Humanities and Social Sciences*, 2(2), 30-36. https://doi.org/10.18844/gjhss.v2i2.412

Shrestha, M. B., & Bhatta, G. R. (2018). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science*, *4*(2), 71-89. https://doi.org/10.1016/j.jfds.2017.11.001

Topal, M. H., & Günay, H. F. (2017). Çevre vergilerinin çevre kalitesi üzerindeki etkisi: Gelişmekte olan ve gelişmiş ekonomilerden ampirik bir kanıt. *Maliye Araştırmaları Dergisi*, *3*(1), 63-83.

WB (2021). World Development Indicators. (Accessed on 14.05.2021), https://databank.worldbank.org/source/world-development-indicators

Whalley, J., & Wigle, R. (1991). Cutting CO2 emissions: the effects of alternative policy approaches. *The Energy Journal*, 12(1), 109–124. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol12-No1-7

Wissema, W., & Dellink, R. (2007). AGE analysis of the impact of a carbon energy tax on the Irish economy. *Ecological economics*, 61(4), 671-683. https://doi.org/10.1016/j.ecolecon.2006.07.034

Wolde-Rufael, Y., & Mulat-Weldemeskel, E. (2021). Do environmental taxes and environmental stringency policies reduce CO_2 emissions? Evidence from 7 emerging economies. *Environmental Science and Pollution Research*, 28, 22392–22408. https://doi.org/10.1007/s11356-020-11475-8

WWF (2012). Türkiye'nin Ekolojik Ayak İzi Raporu. İstanbul: Ofset Yapımevi. (Accessed on 10.05.2021), http://awsassets.wwftr.panda.org/downloads/turkiyenin_ekolojik_ayak_izi_raporu.pdf