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The causal relationship between environmental taxes for sustainable development and greenhouse gas emissions (CO_2): a case study of Türkiye

Sürdürülebilir gelişme için çevre vergileri ile sera gazı salınımı (CO_2) arasındaki nedensellik ilişkisi: Türkiye örneği

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ABSTRACT

Fossil fuels utilized in energy production, transportation, industrial processes, and agricultural activities continuously emit harmful gases into the atmosphere. These emissions contribute to the greenhouse effect, elevating the Earth's average temperature and leading to global warming and changing climate. Reducing human-induced emissions of greenhouse gases is crucial for ensuring sustainable development. One of the policy instruments to be implemented for this purpose is taxes that aim to reduce environmental pollution directly and indirectly. Analysing the relationship between greenhouse gas emissions and such taxes is of great importance for the effectiveness of tax policies and instruments to combat climate change and for future practices that aim to directly reduce environmental pollution, such as carbon taxation. Given the context provided, this study aims to examine the causal relationship between energy taxes and transport taxes, which are regarded as measures to alleviate environmental pollution, in Türkiye. Additionally, the study seeks to assess their influence on CO_2 emissions. The results of the Hatemi-J Causality Analysis reveal a distinct causal link from CO_2 emissions to both total environmental taxes and energy and transport taxes.

Keywords: Environmental Taxes, CO_2 Emissions, Sustainable Development.

Jel Classification: H23, Q01, Q58.

ÖZ

Enerji üretimi, ulaşım ve endüstriyel süreçler için kullanılan fosil yakıtlar ve tarım faaliyetleri atmosfere salınan zararlı gazları sürekli olarak arttırmaktadır. Bu gazlar atmosferde sera benzeri bir etkiye neden olarak Dünya'nın ortalama sıcaklığını, küresel ısınmaya ve iklim değişikliğine neden olacak kadar yükseltmektedir. İnsan kaynaklı seragazı emisyonlarının azaltılması, sürdürülebilir kalkınmanın sağlanmasında büyük önem taşımaktadır. Bu amaçla uygulanacak politika araçlarından biri de çevre kirliliğini doğrudan ve dolaylı olarak azaltmayı hedefleyen vergilerdir. Sera gazı emisyonları ile bu tür vergiler arasındaki ilişkinin ölçülmesi, iklim değişikliği ile mücadelede izlenen ve gelecekte karbon vergisi gibi doğrudan çevre kirliliğinin azaltılmasına yönelik uygulanacak vergi politikalarının ve araçların başarısı için önemlidir. Bu bağlamda Türkiye için çevre kirliliğini önleyici nitelikteki vergiler olarak kabul edilen enerji vergileri ve ulaştırma vergilerinin CO_2 emisyonu ile arasındaki nedensellik ilişkisinin araştırılması bu çalışmanın amacını oluşturmaktadır. Hatemi-J Nedensellik analizi sonuçlarına göre CO_2 emisyonundan gerek toplam çevre vergileri gerekse de enerji ve ulaştırma vergileri yönlü nedensel ilişkiler bulunmuştur.

Anahtar Kelimeler: Çevre Vergileri, CO_2 Emisyonu, Sürdürülebilir Kalkınma .

Jel Sınıflaması: H23, Q01, Q58.

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1. Introduction

Although concerns regarding environmental pollution and its associated issues began to surface in the 1970s, the roots of these problems traced back to the Industrial Revolution. The Industrial Revolution and subsequent advancements have brought numerous benefits that significantly influence the socio-economic landscapes of nations, including access to global markets, enhanced competitiveness, and increased production. However, this shift in economic activities has also led to a notable drawback: a surge in human-induced pollution levels. During this progression, the escalation in production and consumption rates has resulted in environmental degradation, nature depletion, and a rise in greenhouse gas emissions, which serve as the primary drivers of challenges like climate alteration and worldwide heating. Climate variability can be delineated by the build-up of greenhouse gases, chiefly carbon dioxide (CO_2), predominantly ascribed to human endeavours, which infiltrate the atmosphere, instigate a greenhouse phenomenon, and escalate the Earth's mean temperature (Ateş & Şanlısoy, 2024). It is anticipated that the anticipated climate shifts will exert substantial impacts on the well-being of future generations and the geographical dispersion and character of economic endeavours (Chen & Woodland, 2013: 382).

The issue of climate change can also be elucidated through the analysis of environmental indicators (GFN, 2023; OWID, 2023). While various indicators of environmental pollution exist in the literature, the most commonly favoured one is CO_2 emissions (Shahbaz & Sinha, 2019:112-140). In 1750, the global CO_2 level was estimated at 9 million tons, 28 million tons in 1800, 196 million tons in 1850, 1 billion 952 million tons in 1900, 6 billion 3 million tons in 1950, and finally, 37 billion 123 million tons in 2021 (OWID, 2023). The staggering 518% increase in CO2 emissions between 1950 and 2021 underscores widespread environmental damage globally and the magnitude of the challenge facing humanity.

The United Nations (UN) holds a central position in coordinating worldwide endeavours to tackle environmental issues and mitigate the unsustainable utilization of natural assets. This initiative traces back to the onset of concerted action, which began with the Conference on the Human Environment in 1972, the UN has convened numerous symposiums, conferences, and summits to elucidate the scope and perils of global environmental issues and to devise comprehensive solutions. Throughout this process, the objective has been to enhance awareness of environmental challenges among both governmental entities and the public. These gatherings have facilitated the proposition of global remedies for environmental pollution, fostered discussions on policies, and delineated concrete action plans (UN, 2023). Additionally, the climate action plan is encompassed within the Sustainable Development Goals (SDGs) endorsed by the UN Development Programme (UNDP), which endeavour to address the primary challenges confronting people worldwide. In this context, the objective is to identify measures to mitigate climate change and its repercussions and to incorporate them into national policies, strategies, and plans. Within this framework, numerous countries, including Türkiye, have pledged various commitments to combat climate change and environmental degradation, primarily aimed at reducing CO_2 emissions. Such commitments have been formalized through international accords such as the Montreal Protocol, the UN Framework Convention on Climate Change, the Kyoto Protocol, and most recently, the Paris Climate Agreement (UNCC, 2023; UNEP, 2023a; UNEP, 2023b).

Türkiye is among the parties to the environmental regulations enforced by the European Union (EU). Given that the EU stands as Türkiye's primary trading ally, adherence to these policies becomes imperative. Of particular significance today is the European Green Deal, revealed by the EU on December 11, 2019, with the aim of rendering Europe the first climate-neutral continent by 2050. A pivotal stride toward achieving this objective is the Carbon Regulatory Mechanism at the

Border (CCRM), which came into effect on 17 May 2023. This mechanism holds the potential to exert significant effects on Türkiye's foreign trade with the EU. According to the 2026 Carbon Border Adjustment (CBA), sectors including iron and steel, aluminium, cement, fertilizer, electricity, and hydrogen, known for their substantial CO_2 emissions, will be subject to charges during the importation process. In other words, Türkiye will encounter a carbon tax on exports in these sectors. In Türkiye, the Green Deal Working Group was established pursuant to Presidential Circular No. 2021/15 and formulated a regulation pertaining to the Green Deal Action Plan. The Action Plan encompasses "81 initiatives are set to be implemented to achieve the outlined objectives across various categories including carbon regulations at the border, promoting a green and circular economy, advancing green financing, ensuring a clean, economically sustainable, and secure energy supply, fostering sustainable agriculture, facilitating sustainable and intelligent transportation, combating climate change, engaging in diplomatic efforts, and conducting information and awareness-raising campaigns in line with the EU's policy priorities" (Republic of Türkiye Ministry of Trade, 2023a and 2023b).

It is unlikely that the private sector, which aims to maximize profits, will consider environmental costs without legal regulations. In such circumstances, policymakers bear significant responsibility for addressing environmental issues and mitigating environmental damage. As a result, policymakers have devised various economic and financial instruments to combat environmental problems. In recent years, there has been a marked increase in research efforts evaluating the effectiveness of policy instruments implemented in response to these developments and growing environmental consciousness (Akçay et al., 2023:62). Environmental taxes, recognized as a potent instrument for mitigating greenhouse gas emissions within the arsenal of public policy strategies, have garnered attention (Kotnik et al., 2014: 169). Researchers have delved into the correlation between environmental levies, sub-tax classifications, and CO_2 emissions across varied datasets, temporal scopes, and implementation methodologies. Consequently, the objective of this research is to illuminate and scrutinize the causal connections between policies aimed at curbing environmental degradation and CO_2 emissions within the timeframe of 1995-2021 in Türkiye. The causal links between total environmental taxes, as well as energy and transport taxes – categorized as sub-components of environmental taxes in national and international datasets – and CO_2 emissions were investigated via Hatemi J Causality Analysis. Hence, the study aimed to ascertain both the environmental impacts of government-implemented fiscal policies and the efficacy of these policies. Analysing the influence of taxes aimed at curbing environmental pollution on greenhouse gas emissions (specifically CO_2) in Türkiye and discerning the direction of causality makes it possible to forecast the effectiveness of tax policies and instruments, such as carbon taxes, to be directly implemented for environmental pollution reduction in the future. Furthermore, the discoveries gleaned from this investigation hold the potential to provide invaluable contributions to the existing body of literature concerning the identification of SDGs and instruments in Türkiye.

The subsequent sections of the study are organized as follows: in the second section, environmental taxes are discussed at a conceptual level and statistical data regarding these taxes and CO_2 emissions are evaluated in the context of Türkiye. The third section entails the literature review, whereas the fourth section outlines the data, methodology, and findings of the empirical analysis. Finally, the conclusion section highlights policy recommendations aimed at mitigating CO_2 emissions derived from the results of the analysis.

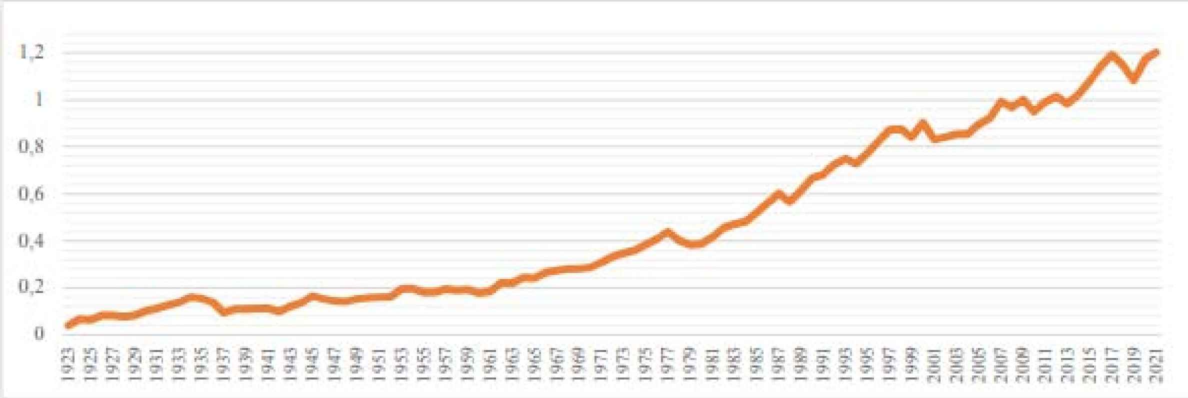
2. Environmental Taxes and Environmental Statistics of Türkiye

Policy instruments available to policymakers to address environmental market failures can be classified into several categories including taxation, regulation, information programs, innovation policies, environmental subsidies, or legal regulations (He et al., 2018; Stiglitz, 2000). Within this framework, public authorities aiming for environmental sustainability possess a diverse array of tools at their disposal. Rosiek highlights the particular significance of environmental taxes among these instruments (Rosiek, 2015: 233). Environmental taxes have emerged in response to the growing utilization of emissions trading and other economic mechanisms, as well as the recognition of limitations in traditional environmental regulations (Fullerton et al., 2008: 1). In the absence of government intervention, polluting economic activities incur minimal or no costs to the polluting entity. Consequently, environmental protection typically necessitates collective action spearheaded by the government (Rosiek, 2015: 233). Thus, environmental taxes assume a crucial role.

To mitigate the impacts of CO_2 emissions on common global resources, international measures have been undertaken and specific policies have been enacted within this framework. Among them, the carbon tax stands out as a fiscal tool employed to diminish CO_2 emissions nationally. Researchers hold diverse perspectives regarding the effects of environmental taxes. While some assert that environmental taxes yield positive environmental and economic outcomes (Pearce, 1991; Tekin & Vural, 2004; Morley and Abdullah, 2010; Dikmen & Çiçek, 2020), others contend that negative effects outweigh the positive ones (Fullerton et al., 2008: 4). Environmental taxes engender positive impacts such as safeguarding the environment and natural resources, encouraging the uptake of renewable energy sources, internalizing negative externalities, serving as an additional revenue stream for governments, fostering environmental awareness among individuals, enabling firms to innovate environmentally friendly products, and incentivizing the adoption of alternatives with lesser environmental impact. Conversely, poorly designed environmental taxes can yield negative repercussions, including diminishing their intended positive environmental outcomes and escalating economic costs (Rosiek, 2015: 233). Environmental taxes heighten production expenses and may impede economic expansion. Particularly in scenarios where domestic production competes with goods from foreign manufacturers not subject to comparable environmental taxes, the competitive impact may detrimentally affect domestic enterprises (Fullerton et al., 2008: 4). These adverse consequences underscore the necessity for crafting and implementing public policies aimed at mitigating environmental harm without compromising economic growth and production.

According to the 1927 census, Türkiye's population stood at 13.6 million, whereas by 2023, it had surpassed 85 million (TurkStatb). The increase in production and consumption, parallel to population growth, has led to environmental degradation and a surge in CO_2 emissions. While Türkiye's average growth rate for the period 1923-2022 was 4.96%, this process resulted in environmental costs such as CO_2 increase (TurkStata). Figure 1 illustrates Türkiye's global share of CO_2 emissions from 1923 to 2021. Following significant advancements in Türkiye's industrialization during the 1960s and the commencement of the planned development phase, the CO_2 ratio witnessed a notable increase. While this ratio remained below 0.5 percent until the 1980s, it experienced a rapid surge thereafter, surpassing 1.2 percent. Türkiye's shifting from an import-substitution industrialization strategy to an export-oriented industrialization paradigm along with its integration with globalization, is deemed influential in this transformation. Over the period from 1923 to 2021, Türkiye's CO_2 share surged by approximately 416%, whereas the increase during the 1995-2021 period examined in this study amounts to 56%.

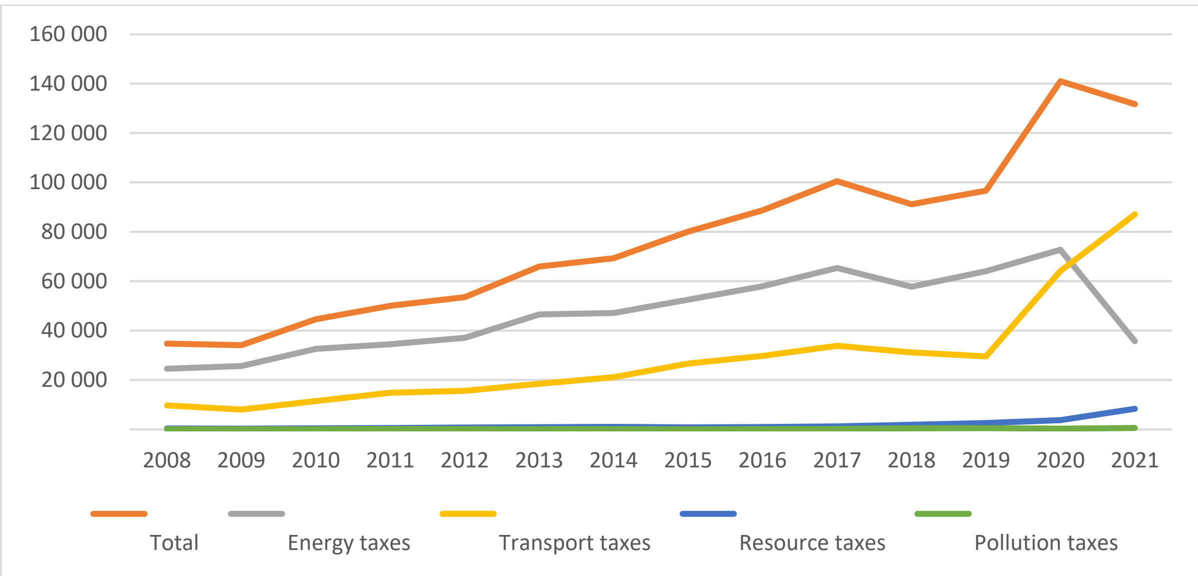
Figure 1: Türkiye's Share in Global CO_2 Amount (%)



Source: Akçay et al. 2023:62

In Türkiye, environmental taxes are defined as taxes within the System of National Accounts, where the tax base is established according to the physical unit of goods demonstrated to have a designated adverse effect on the environment. Currently, the Environmental Cleaning Tax stands as the sole tax directly implemented with consideration for environmental concerns. However, certain taxes within the system exhibit characteristics of environmental taxes in terms of the impacts they generate. Taxes such as the Special Consumption Tax (SCT) and Motor Vehicles Tax fall into this category owing to their potential environmental repercussions. As depicted in Figure 2, environmental taxes incorporated in the National Account System encompass energy, transport, resource, and pollution taxes (TurkStatb). Consequently, it is observed that the amounts of environmental taxes have been trending up over the years, with energy and transport taxes representing the largest share among environmental taxes.

Figure 2: Environmental Taxes in Türkiye (Million TL)

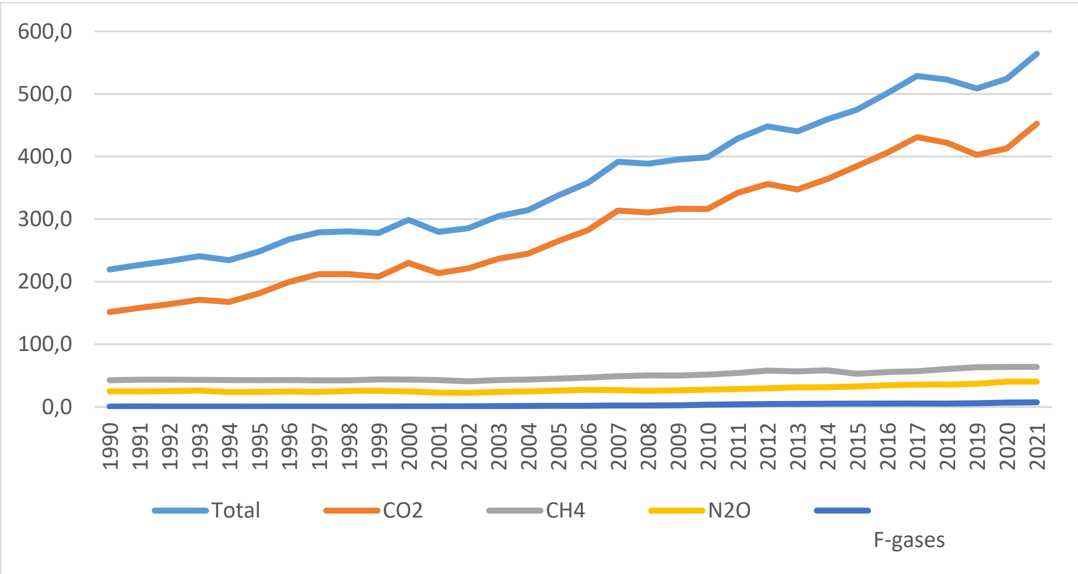


Source: TurkStata, https://data.tuik.gov.tr/Kategori/GetKategori?p=cevre-ve-enerji-103&dil=1

Greenhouse gases are compounds that cause the greenhouse effect. Greenhouse gases are classified as direct greenhouse gases and indirect greenhouse gases. CO_2 , methane (CH_4), diazo monoxide (N_2O) and fluorinated gases (F-gases) are direct greenhouse gases where nitrogen oxides (NO_x), non - methane volatile organic compounds (NMVOC), ammonia(NH_3), carbon monoxide (CO) and sulphur dioxide (SO_2) emissions are indirect greenhouse gases (TurkStatb). As greenhouse gas compounds trap heat in the atmosphere, they contribute to an increase in atmospheric temperature, leading to global warming (Kılınç & Altıparmak, 2020: 217).

Figure 3 shows the total and sub-component values of direct greenhouse gas emissions in Türkiye for the period 1990-2021. The figure illustrates that CO_2 emission stemming from the use of primary energy resources represent the largest share of greenhouse gas emissions. CH_4 and N_2O are in the second and third place, respectively.

Figure 3: Greenhouse Gas Emissions by Gases (Million Tonnes CO_2 Equiv.)



Source: TurkStata, Greenhouse Gas Emission Statistics, 1990- 2021.

3. Literature Review

If the market mechanism fails to address negative externalities, the necessity of public intervention arises. The leading instrument of this intervention is fiscal policy. Hence, elucidating the correlation between taxes, a pivotal instrument of fiscal policy in the fight against pollution of the environment, and CO_2, which is the major pollution indicator, is essential for both policymakers and economic entities contributing to pollution in terms of implementing measures against environmental pollution (Akçay et al. 2023: 63). Environmental taxes have emerged as an important fiscal instrument due to the "polluter pays" principle. Indeed, numerous studies in recent literature have delved into the intersection of fiscal policy and environmental concerns. There has been extensive study on the use of environmental taxes to combat environmental pollution. In the literature, many variables such as carbon emission, greenhouse gas emission, ecological footprint, environmental performance index, ecological balance are accepted as environmental indicators. In addition, the factors causing environmental pollution have been analysed in different periods, with different variables and with variously applied methods.

The studies present in the literature can be categorized into several groups based on the effects under consideration. One significant grouping of studies has examined the correlation between economic growth and environmental pollution indicators, often utilizing the Environmental Kuznets Curve (EKC) hypothesis proposed by Grossman and Krueger (1991). Grossman and Krueger introduced the EKC to the literature by adapting Kuznets' (1955) Kuznets Curve, which shows that the relationship between income and economic growth distribution is inverted-U shaped, to environmental problems. The EKC is a curve based on the hypothesis that economic growth first increases CO_2 emissions and then decreases them. The reason for such a relationship between growth and CO_2 is that after reaching a certain level of income, countries take certain measures due to their increased sensitivity to environmental pollution, as well as the increase in environmental awareness at the social level, thus environmental indicators change positively over time. In this field with a vast literature, studies such as Roberts & Grimes (1997), Magnani (2000), Dijkgraaf & Vollebergh (2005), Atıcı & Kurt (2007) and Shahbaz et al. (2016) have found that the rate of increase in CO_2 emissions decreases after countries reach a certain income level through technological developments and environmental regulations. However, there are also studies with contrary findings, such as those by He&Richard(2010), Fodha&Zaghdoud(2010) and Koçak (2014). On the other hand, Torras&Boyce (1998) and Cole (2003) have identified that the processes experienced in developed and developing countries differ, emphasizing the influence of country-specific factors in the emergence of the EKC. The relationship between economic growth and environmental pollution indicators such as CO_2 or ecological footprint has also been analysed independently from the EKC (Zhang & Cheng,2009; Fotros & Maabooudi,2011; Bekmez & Nakıpoğlu,2012; Öztürk & Acaravcı,2013; Miller & Vela,2013; Ploeg & Withagen,2014; Loganathan et al.,2014; Artan et al.,2015; Alper & Alper,2017; Özkaya, 2022; Dedemen Özkan, 2023; Fatty & Ağan, 2024). In the literature reviewed, alongside a substantial body of research indicating a negative correlation between growth and pollution indicators, a smaller set of studies have identified a positive relationship between these variables. The other group of studies focused on carbon emissions in different sectors (Kiuila & Rutherford, 2013; Güldoğan, 2013; Çebişli & Yelman, 2023). In these sectoral studies, it was determined that the energy sector has higher values in terms of greenhouse gas emissions compared to other sectors, followed by agriculture, industrial processes and cement enterprises.

Indeed, studies exploring the association between CO_2 emissions and tax revenues are prevalent in the literature. These investigations seek to discern the impact and correlation of environmental taxes on emissions. Morley (2012), Polat & Eş Polat (2018), Atay Polat & Ergün (2021) and Meireles et al.(2021) for EU countries, Oral & Sayın (2015), Önder (2017), Akyol & Gül (2021) and Fatima et al.(2023) for OECD countries, Safi et al.(2021) for G7 countries, Saqib et al.(2023) for G10 countries, Doğan et al.(2022) for the 25 countries with the highest environmental performance index value, Meng et al.(2013) for Australia, Kiuila et al.(2019) for the Czech Republic and Doğan et al.(2023) for Türkiye, environmental taxes demonstrate a negative and statistically significant impact on pollution. Çakmak (2018), while reaching a similar result for Türkiye, investigated how environmental taxes affect different sectors and found that environmental taxes positively affect fishing and hunting, forestry, housing construction sectors, and negatively affect energy, machinery and equipment sectors. Hajek et al.(2019) also investigated the effects of the carbon tax in the energy sectors of Sweden, Finland, Denmark, Ireland and Slovenia. Their findings indicate that the carbon tax is environmentally efficacious, leading to a reduction in emissions stemming from fossil fuel consumption. Yılmazcan & Çakmak (2018) included another policy instrument aimed at preventing climate change, carbon emission trading, in their study. Thus, they investigated which of the carbon emission trading or carbon emission tax instruments would be effective. The findings suggest that the individual efficacy of each instrument is inadequate, highlighting the imperative of their combined utilization. Uyduranoglu & Ozturk (2020) determined that public acceptance is important for the success of carbon tax implementation in Türkiye. Akbelen (2019) reached a similar conclusion in his study and found that the carbon tax and emission trading implemented by EU countries and the United States can also be implemented in Türkiye. According to Akkaya & Hepsag (2021), the transformation of SCT on fuel into a carbon tax in Türkiye will have a significant impact on emission reduction. Özbek (2023) examined the correlation between environmental taxes, patents related to environmental technologies, energy consumption, growth, and CO_2 emissions within the Turkish economy. The outcomes unveiled environmental taxes and patents for environmental technologies mitigate CO_2 emissions, whereas energy consumption and economic growth contribute to an increase in CO_2 emissions. Akçay et al. (2023) have presented a distinct observation pertaining to Türkiye. According to the findings of the study, taxation between 1923 and 2021 has exerted an amplifying impact on environmental pollution within the country.

In contrast to these findings, Loganathan et al. (2014), in their examination of Malaysia, discovered that the carbon tax did not effectively curtail CO_2 levels. Furthermore, they identified a bidirectional causal relationship between the carbon tax and CO_2 emissions. Bayar & Şaşmaz (2016) for Finland, Denmark, the Netherlands, Norway and Sweden, Özkaya (2022) for EU countries, Yavuz & Ergen (2022) for G20 countries, Özkan (2023) found no significant relationship between environmental tax and CO_2 emissions in a study of Türkiye, Germany, France and Italy. Silajdzic & Mehic (2018) concluded that energy and transport taxes are not an effective tool for pollution reduction in a study of 10 EU countries. Damirova & Yayla (2020), in their study for 10 countries including Türkiye, found that environmental taxes have no effect on environmental pollution as a result of FMOLS analysis and contradictory results that environmental taxes increase environmental pollution with DOLS analysis.

In summary, it can be stated that there is no consensus among the findings obtained. Indeed, the literature presents a mixed picture regarding the long-term relationship between environmental taxes and CO_2 emissions, with some studies showing evidence of such a relationship while others yield conflicting results. Moreover, in endeavours to ascertain causal relationships, diverse causal links have been identified. This underscores the necessity of evaluating the association between environmental taxes and environmental pollution in a nuanced manner, considering the specific contexts of countries and the methodologies utilized in the studies.

4. Data Set and Econometric Method

4.1 Data Set

The study delves into the causality relationship between total environmental taxes, energy taxes, transport taxes, and CO_2 emissions over the period 1995-2021 in Türkiye, employing the Hatemi-J Asymmetric Causality Test. Detailed information regarding the variables utilized in the analysis is outlined in Table 1.

Table 1: Information on the Variables Used in the Study

Variables	Abbreviation	Value	Period	Source
Total CO_2 Emissions (Million Tonnes)	LCO	Logarithmic	1995-2021	TURKSTAT
Environmental Taxes / GDP (%)	LCV	Logarithmic	1995-2021	OECD Stat.
Energy Taxes / GDP (%)	LEV	Logarithmic	1995-2021	OECD Stat.
Transport Taxes GDP (%)	LUV	Logarithmic	1995-2021	OECD Stat.

In Türkiye, environmental taxes consist of energy, transport, resource and pollution taxes. Among these taxes, energy and transport taxes have the highest rates. Hence, alongside scrutinizing the causality relationship between CO_2 emissions and total environmental taxes, the study also examined the causality relationship between energy taxes, transport taxes, and CO_2 emissions. CO_2 emissions were chosen as the indicator of environmental pollution due to their predominant share among greenhouse gas emissions. The main limitation of the study is that the data set range includes the period 1995-2021 in the institutions where the data are obtained.

Table 2 provides the descriptive statistics of the variables utilized in the analysis.

Table 2. Descriptive Statistics Related to Variables

	LCO	LCV	LEV	LUV
Average	5.932635	1.010054	0.677445	-0.407178
Median	5.970496	1.131402	0.797507	-0.210721
Maximum	6.335763	1.386294	1.163151	0.231112
Minimum	5.514235	0.165514	-0.843970	-1.514128
Standard Deviation	0.256579	0.306103	0.416199	0.514983
Skewness	-0.042554	-1.061327	-1.973682	-0.662284
Kurtosis	1.591723	3.399112	7.735748	2.134838
Jarque-Bera	2.239300	5.248067	42.76011	2.815856
Probability Value	0.326394	0.072510	0.000000	0.244650

Table 2 indicates that the skewness values of the variables are negative, suggesting that their distributions are skewed to the left. Negative skewness values in the series imply the occurrence of extreme events. According to the kurtosis values, it is seen that LCV and LEV variables have thick tail feature as the kurtosis value is greater than the '3' critical value for normal distribution, while LCO and LUV variables do not have thick tail feature as the kurtosis value is less than the '3' critical value. According to the Jarque-Bera test statistic, it can be stated that variables other than LEV do not have a normal distribution.

4.2. Econometric Method

In the study, the causality relationship between the variables is examined using the Hacker-Hatemi-J causality test, which is an asymmetric causality test. As mentioned earlier, the non-normal distribution of variables, except for LEV, impacts the asymptotic distribution of the Wald test. The Wald test follows a chi-squared distribution with degrees of freedom equal to the number of constraints. In order to eliminate this problem, critical values should be obtained by using bootstrap simulations. Another important point is related to the possible changes in the asymmetric Granger causality relationship between the series over time. Indeed, the causality relationship between variables can evolve over time due to the influence of various economic or political events occurring at the national or global level. Therefore, it is necessary to test this stability of the causality relationship by choosing causality analysis that takes this situation into account. For this reason, the study utilizes the time-varying form of the asymmetric causality test developed by Hatemi-J (2012). This method is briefly explained below (Hacker & Hatemi-J, 2006; Ağan & Aydın, 2018:808; Demir, 2021).

The Granger & Yoon (2002) approach can be taken as a starting point for the causality test by Hatemi-J(2012). Hatemi-J(2012) assumes that there are two integrated series as in equations (1) and (2) for the causality test:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{i} \varepsilon_{1i} \quad (1)$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{i} \varepsilon_{2i} \quad (2)$$

If positive and negative shocks are represented as in equation (3):

$$\varepsilon_{1i}^{+} = maks\ (\varepsilon_{1i}, 0),\ \ \varepsilon_{1i}^{-} = min\ (\varepsilon_{1i}, 0), \varepsilon_{2i}^{+} = maks\ (\varepsilon_{2i}, 0),\ \ \ \varepsilon_{2i}^{-} = min\ (\varepsilon_{2i,} 0) \tag{3}$$

$\varepsilon_{1i} = \varepsilon_{1i}^{+} + \varepsilon_{1i}^{-}$ ve $\varepsilon_{2i} = \varepsilon_{2i}^{+} + \varepsilon_{2i}^{-}$ can be expressed as. Thus, when equations (1) and (2) are rearranged:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{i} \varepsilon_{1i}^{+} + \sum_{i=1}^{i} \varepsilon_{1i}^{-}$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{i} \varepsilon_{2i}^{+} + \sum_{i=1}^{i} \varepsilon_{2i}^{-} \tag{4}$$

Equation (5) displays the cumulative representation of both positive and negative shocks in every variable:

$$y_{1i}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+},\ \ y_{1i}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-}, y_{2i}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+}\ ,\ y_{2i}^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{5}$$

In the Hatemi-J(2012) causality test, assuming that the variable y_t^{+} is equal to (y_{1t}^{+}, y_{2t}^{+}), the causality relationship between these components is tested using a p-lag vector autoregressive model (VAR) as in equation (6):

$$y_t^{+} = \alpha + A_1 y_{t-1}^{+} + \cdots + A_p y_{p-1}^{+} + u_t^{+} \tag{6}$$

The Hatemi-J test allows for an analysis that reveals the interaction among variables regarding both negative and positive shocks. Essentially, the Hatemi-J(2012) asymmetric causality test was crafted by differentiating between the negative and positive shocks of the Hacker&Hatemi-J(2006) bootstrap Granger causality test. Therefore, the application of this test to non-normally distributed series is of great importance for obtaining effective results. The results derived from employing the Hatemi-J asymmetric causality test are outlined in the subsequent section.

5. Empirical Findings

Despite the fact that classical regression analysis assumes time series variables to be stationary, meaning that their variance and mean are constant over time (Gujarati, 2006: 713), it is a known fact that many economic time series do not exhibit stationarity. In econometric analyses employing non-stationary time series, the outcomes often suffer from spuriousness, indicating that the association between the dependent and independent variables results in the "spurious regression" issue. In the presence of such a problem, both standard t-statistics and other standard statistics are higher than they should be. This leads to erroneous results. Hence, it is crucial to ascertain the stationarity status of variables to mitigate the risk of spurious regression. In this study, the stationarity levels of the series were assessed using the ADF (Augmented Dickey-Fuller) and Phillips-Perron Tests, with the results showcased in Table 3. Based on the findings, it can be affirmed that the variables exhibit stationarity in first differences [I(1)].

Table 3. ADF and PP Unit Root Test Results

		Variables	ADF	PP
Level	Constant	LCO	-0.517064 (0)	-0.465105 (4)
		LCV	-2.723232 (0)	-2.723232 (0)
		LEV	1.040433 (3)	-0.170852 (1)
		LUV	-2.128222 (0)	-2.128222 (12)
	Constant and Trend	LCO	-2.516185 (0)	-2.516185 (0)
		LCV	-1.760542 (0)	-1.429654 (7)
		LEV	0.098885 (0)	1.022473 (6)
		LUV	-3.097930 (0)	-2.910938 (4)
1st Difference	Constant	LCO	-5.105507 (0)*	-5.263930 (4)*
		LCV	-5.232064 (0)*	-5.232867 (1)*
		LEV	0.302528 (2)	-2.528886 (0)
		LUV	-5.338563 (0)*	-7.138508 (15)*
	Constant and Trend	LCO	-4.942701 (0)*	-5.057668 (4)*
		LCV	-6.835619 (0)*	-9.322433 (7)*
		LEV	-4.181566 (0)**	-3.795592 (2)**
		LUV	-4.958388 (3)*	-12.08735 (24)*

Notes: * and ** the values denote stationarity of the series at 1% and 5% significance levels, respectively. The figures in parentheses represent the optimal lag length based on the Schwarz information criterion for ADF and the Bartlett Kernel Newey-West Bandwidth criterion for PP. For ADF and PP tests: Mac Kinnon (1996) critical values are -3.711457 and -2.981018 for constant at 1% and 5%, respectively, and -4.344307 and -3.603202 for constant + trend at 1% and 5%, respectively.

Granger (1969), Toda-Yamamoto (1995), and Hacker & Hatemi-J (2006) causality tests are symmetric causality tests, assuming parity in the effects of positive and negative shocks. However, Hatemi-J (2012) introduced the asymmetric causality test to address potential misleading results from symmetric tests, especially in scenarios of asymmetric information or heterogeneity among economic units. This test, based on decomposing positive and negative shocks from the Hacker & Hatemi-J (2006) causality test, allows for a nuanced analysis of how economic units react differently to such shocks. In this study, the Hatemi-J (2012) asymmetric causality test is favoured and employed, with the findings detailed in Table 4.

Table 4: Hatemi-J Asymmetric Causality Test Results

Null Hypothesis	MWALD	Null Hypothesis	MWALD
CO_2^{+}- Environmental Taxes $^{+}$	3.586* (0.000)	Environmental Taxes^{+}- CO_2^{+}	1.364 (0.126)
CO_2^{+}- Environmental Taxes^{-}	1.269 (0.253)	Environmental Taxes^{+}- CO_2^{-}	4.425* (0.000)
CO_2^{-}- Environmental Taxes $^{+}$	2.564 (0.152)	Environmental Taxes^{-} - CO_2^{+}	2.563** (0.026)
CO_2^{-}- Environmental Taxes^{-}	2.568* (0.000)	Environmental Taxes^{-} - CO_2^{-}	0.621 (0.184)
CO_2^{+}- Energy Taxes $^{+}$	1.532*** (0.062)	Energy Taxes^{+}- CO_2^{+}	2.586 (0.153)
CO_2^{+}- Energy Taxes $^{-}$	3.452 (0.168)	Energy Taxes^{+}- CO_2^{-}	3.428 (0.231)
CO_2^{-}- Energy Taxes $^{+}$	0.156** (0.045)	Energy Taxes^{-} - CO_2^{+}	5.412* (0.000)
CO_2^{-}- Energy Taxes $^{-}$	2.564* (0.000)	Energy Taxes^{-} - CO_2^{-}	0.537 (0.197)
CO_2^{+}- Transport Taxes $^{+}$	3.459* (0.000)	Transport Taxes^{+}- CO_2^{+}	3.125 (0.862)
CO_2^{+}- Transport Taxes $^{-}$	0.965 (0.523)	Transport Taxes^{+}- CO_2^{-}	4.358** (0.032)
CO_2^{-}- Transport Taxes $^{+}$	1.538** (0.012)	Transport Taxes^{-} - CO_2^{+}	5.230* (0.000)
CO_2^{-}- Transport Taxes^{-}	1.632* (0.000)	Transport Taxes^{-} - CO_2^{-}	1.239 (0.251)

Note: Bootstrap number is 10000. The values in parentheses represent probability values for the test statistic. *, ** denote statistical significance at the 1% and 5% levels, respectively.

The results of the causality analysis indicate a causal relationship between carbon emissions to both total environmental taxes and energy and transport taxes. It can be stated that when carbon emissions increase, environmental taxes, energy and transport taxes also increase. This suggests that the government implements specific policies on environmental taxes in response to increase in carbon emissions. Conversely, based on the magnitudes of the coefficients, it can be inferred that a reduction in carbon emissions leads to decreases in environmental taxes, energy taxes, and transport taxes, although the causality effect in this scenario appears to be less pronounced than in the former case. In addition, an asymmetric causality relationship was also found such that energy and transport taxes increase when carbon emissions decrease. However, the casualty relationship is of low intensity in this context. Furthermore, causality relations from taxes to carbon emissions can also be examined. When environmental taxes are reduced, carbon emissions increase; when environmental taxes increase, carbon emissions decrease. Conversely, when examining the matter in terms of specific types of environmental taxes, it is noted that carbon emissions tend to rise when energy and transport taxes are reduced, whereas carbon emissions decrease when transport taxes are increased. The findings of the study are in line with Oral & Sayın (2015), Çakmak (2018), Yılmazcan & Çakmak (2018), Akbelen (2019), Uyduranoğlu & Öztürk (2020), Şimşek & Kesbiç (2020), Atay Polat & Ergün (2021), Akkaya & Hepsag (2021), Meireles et al.(2021), Akyol & Gül (2021), Doğan et al.(2022), Doğan et al.(2023), Özbek (2023), Fatima et al.(2023), Saqib et al.(2023).

6. Conclusion and Discussion

The increasing greenhouse gas emissions lead to natural phenomena such as climate change and global warming. During this process, international institutions and organizations strive to implement climate action plans, which are key objectives for achieving sustainable development, and to increase awareness of environmental issues worldwide. Meanwhile, governments have started to use various tools that prioritize environmental awareness. Among these instruments, environmental taxes are the most significant.

This study endeavours to ascertain the causal connections between total environmental taxes, energy taxes, transport taxes, and CO_2 emissions in Türkiye from 1995 to 2021. The relationships among these variables were scrutinized utilizing the Hatemi-J causality test. Upon analysing the results of the causality analysis, it becomes evident that there exists a causal relationship from CO_2 emissions to both total environmental taxes and energy and transport taxes. As CO_2 emissions rise, environmental taxes, as well as energy and transport taxes also increase.

When investigating the presence of a reverse casualty relationship, it is observed that carbon emissions rise when environmental taxes, such as energy and transportation taxes, are decreased and carbon emissions decline when total environmental taxes and transportation taxes increase. This shows that implemented fiscal policies are effective. On the other hand, carbon emissions are not affected when energy taxes are increased. Considering the different effects of the tax type on CO_2, it is understood that transport taxes are more effective on carbon emissions in our country.

They not only contribute to public revenue but also serve as a significant instrument in mitigating environmental pollution. This highlights the effectiveness of environmental taxation policies in aligning economic incentives with environmental conservation goals. In order for this tool to be used effectively, policymakers need to implement well-designed policies. As Rosiek (2015) suggests, the following functions should be taken into consideration when designing environmental taxes;

-Environmental tax bases should apply to polluters and polluting behaviour, with some exceptions.

- The scope of environmental taxes should be equal to the scope of environmental damage.

-Tax rates should be proportionate, reliable, clear, predictable and coordinated with the environmental damage.

- Fiscal consolidation should be supported by revenues from environmental taxation or support the reduction of other taxes.

- Competitiveness concerns should be carefully assessed.

- Public acceptance of environmental taxes and open communication are crucial.

- In some cases environmental taxes can be combined with other policy instruments.

All of these efforts, particularly in collaboration with international institutions and organizations, need to be undertaken, and all countries should exhibit this behavior. In addition to these, incentives can be provided for production technologies that incorporate environmentally friendly practices in order to minimize the production-related damages. Certainly, awareness-raising campaigns and programs are crucial for highlighting the significance of environmental sustainability and reducing harm to the environment. These initiatives should be designed to reach all segments of society, ensuring broad awareness and engagement across various sectors. By promoting a shared understanding of environmental issues and encouraging sustainable practices, such campaigns can help bring about positive behavioral changes and nurture a culture of environmental responsibility.

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References

Ağan, B., & Aydın, Ü. (2018). Kripto para birimlerinin küresel etkileri: Asimetrik nedensellik analizi In T. Korkmaz, M. İ. Yağcı, İ. Ege, & T. T. Turaboğlu (Ed.), *Uluslararası Katılımlı 22. Finans Sempozyumu Bildiriler Kitabı,* Ekin Yayınevi, *797-816*, Mersin.

Akbelen, M. M. (2019). *Karbon vergileri ve emisyon ticareti sistemleri, Avrupa Birliği ve Amerika Birleşik Devletleri örneklerinden hareketle Türkiye`de uygulanabilirliği* (Unpublished master's thesis). Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü, Isparta.

Akçay, F., Yavuz, E., & Kılıç, E. (2023). Karbon emisyonu ile vergileme arasındaki ilişkinin cumhuriyetten günümüze analizi: Kantil eşbütünleşme yaklaşımından kanıtlar. *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 23(Özel Sayı), 59-78.

Akkaya, S., & 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*, *28,* 35094–35101. doi: 10.1007/s11356-021-12907-9

Akyol, H., & Gül, K. (2021). Çevresel vergi politikalari sürdürülebilir kalkınmayı desteklemede ne kadar etkilidir: OECD ülkeleri örneği. *Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 24(46), 977-997. doi: 10.31795/baunsobed.896534

Alper, F. Ö., & Alper, A. E. (2017). Karbondioksit emisyonu, ekonomik büyüme, enerji tüketimi ilişkisi: Türkiye için bir ARDL sınır testi yaklaşımı. *Sosyoekonomi,* 25(33), 145-156.

Artan, S., Hayaloğlu, P., & Seyhan, B. (2015). Türkiye'de çevre kirliliği, dışa açıklık ve ekonomik büyüme ilişkisi. *Yönetim ve Ekonomi Araştırmaları Dergisi,* 13(1), 308-326.

Atay Polat, M., & Ergün, S. (2021). Kirlilik emisyonlarının azaltılmasında çevre vergilerinin rolü: AB ülkeleri örneği. *İzmir İktisat Dergisi*, 36(2), 379-397. doi: 10.24988/ije.202136209

Ateş, E., & Şanlısoy, S. (2024). The impact of global value chains on climate change. *Journal of Social and Economic Development*. doi: 10.1007/s40847-023-00320-6

Atıcı, C., & Kurt, F. (2007). Türkiye'nin dış ticareti ve çevre kirliliği: Çevresel kuznets eğrisi yaklaşımı. *Tarım Ekonomisi Dergisi*, 13(2), 61-69.

Bayar, Y., & Şaşmaz, M. (2016). Karbon vergisi, ekonomik büyüme ve CO_2 emisyonu arasındaki nedensellik ilişkisi: Danimarka, Finlandiya, Hollanda, İsveç ve Norveç örneği. *International Journal of Applied Economic and Finance Studies*, 1(1), 32-41.

Bekmez, S., & Nakıpoğlu, F. (2012). Çevre vergisi-ekonomik büyüme ikilemi. *Gaziantep Üniversitesi Sosyal Bilimler Dergisi*, 11(3), 641-658.

Chen, X., & Woodland, A. (2013). International trade and climate change. *International Tax Public Finance,* 20(3), 381–413. doi: 10.1007/s10797-012-9244-x..

Cole, M. A. (2003). Development, trade and environment: How robust is the environmental kuznets curve?. *Environment and Development Economics*, 8(4), 557-580.

Çakmak, H. (2018). *Çevresel vergilerin ekonomik etkileri: Karbon vergisi* (Unpublished doctoral dissertation). Maltepe Üniversitesi Sosyal Bilimler Enstitüsü, İstanbul.

Çebişli, N., & Yelman, İ. (2023). Enerji ve endüstri sektörlerinin sera gazi emisyonları, çevre vergileri ve finansal harcamalar arasındaki ilişkinin incelenmesi: Türkiye örneği. *FESA Dergisi*, 8(3), 612-621. doi: 10.29106/fesa.1244670

Damirova, S., & Yayla, N. (2020). Çevre kirliliği ile makroekonomik belirleyicileri arasındaki ilişki: Seçilmiş ülkeler için bir panel veri analizi. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, *30,* 107-126. doi: 10.18092/ulikidince.804787

Dedemen Özkan, H. (2023). *Çevre vergileri ekonomik büyüme ve $C0_2$ emisyonu arasındaki nedensellik ilişkisi: Ampirik bir uygulama* (Unpublished master's thesis). Bilecik Şeyh Edebali Üniversitesi Lisansüstü Eğitim Enstitüsü, Bilecik.

Demir, M. A. (2021). Petrol fiyatları ile Türkiye'nin dış ticaret açığı arasında zamana göre değişen nedensellik analizi. *İzmir İktisat Dergisi*, 36(2), 247-258. doi: 10.24988/ije.202136201.

Dijkgraaf, E. & Vollebergh, H. R. (2005). A test for parameter homogeneity in CO_2 panel EKC estimations. *Environmental and Resource Economics*, 32(2), 229-239.

Dikmen, S., & Çiçek, H. G. (2020). Avrupa Birliği'nde çevre vergisi gelirlerinin karşılaştırmalı analizi. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 57, 57–88. https://dergipark.org.tr/tr/download/article-file/949657

Doğan, B., Tekgüç, H., & Yeldan, A. E. (2023). Toward a green income support policy: Investigating social and fiscal alternatives for Turkey. *New Perspectives on Turkey*, *68*, 7–29. doi: 10.1017/npt.2023.2

Doğan, E., Hodžić, S., & Šikić, T.F. (2022). A way forward in reducing carbon emissions in environmentally friendly countries: The role of green growth and environmental taxes. *Economic Research-Ekonomska Istraživanja*, 35(1), 5879-5894. doi: 10.1080/1331677X.2022.2039261

Fatima, N., Yanting, Z., & Guohua, N. (2023). Role of environmentally related technologies and revenue taxes in environmental degradation in OECD countries. *Environmental Science and Pollution Research*, 30(29), 73283–73298. doi: 10.1007/s11356-023-27011-3

Fatty, M., & Ağan, B. (2024). Unraveling the link between environment and economic growth in Türkiye. *İzmir İktisat Dergisi*, 39 (1), 275-293. doi: 10.24988/ije.1356044

Fodha, M., & Zaghdoud, O. (2010). Economic growth and pollutant emissions in Tunisia: An empirical analysis of the environmental kuznets curve. *Energy Policy*, 38(2), 1150-1156.

Fotros, M., & Maaboudi, R. (2011). The impact of trade openness on CO_2 emissions in Iran, 1971-2008. *International Journal of Business and Development Studies*, 3(1), 73-84.

Fullerton, D., Leicester, A., & Smith,S. (2008). E*nvironmental taxes* (Working Paper No. 14197). NBER.

Global Footprint Network (GFN). (2023). Ekolojik ayak izi, https://www.footprintnetwork.org/

Granger, C.W., & Yoon, G. (2002), H*idden cointegration* (Working Paper). Department of Economics, University of California.

Grossman, G.M., & Krueger, A.B. (1991). E*nvironmental impacts of a North American free trade agreement* (Working Paper No. 3914). NBER.

Gujarati, D.N. (2006) *Essentials of econometrics* (3th ed.). NY: McGraw-Hill.

Güldoğan, E. (2013, Haziran). AB *ETS kriterleri açısından Türkiye çimento sektörünün karbon kaçağı riski.* III. Türkiye İklim Değişikliği Kongresi, İstanbul.

Hacker, R. S., & Hatemi-J, A. (2006). Tests for causality between integrated variables using asymptotic and bootstrap distributions: theory and application. *Applied Economics*, 38(13), 1489-1500.

Hajek, M., Zimmermannova, J., Helman, K., & Rozenski, L. (2019). Analysis of carbon tax efficiency in energy industries of selected EU countries. *Energy Policy*, 134, 1-11.

Hatemi-J, A. (2012) Asymmetric causality tests with an application. *Empirical Economics*, 43, 447-456. doi: 10.1007/s00181-011-0484-x

He, J., & Richard, P. (2010). Environmental kuznets curve for CO_2 in Canada. *Ecological Economics*, 69(5), 1083-1093.

He, L., Wu, M., Wang, D., & Zhong, Z. (2018). A study of the influence of regional environmental expenditure on air quality in China: the effectiveness of environmental policy. *Environmental Science and Pollution Research*, *25,* 7454-7468. doi: 10.1007/s11356-017-1033-8

Kılınç, E. C., & Altıparmak, H. (2020). Çevre vergilerinin CO_2 emisyonu üzerindeki etkisi üzerine bir uygulama. *Ordu Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi*, 10(1), 217-227.

Kiuila, O., Markandya, A., & Scasny, M. (2019). Taxing air pollutants and carbon individually or jointly: Results from a CGE model enriched by an emission abatement sector. *Economic Systems Research*, 31(1), 21-43.

Kiuila, O., & Rutherford, T. F. (2013). The cost of reducing CO_2 emissions: Integrating abatement technologies into economic modeling. *Ecological Economics*, 87, 62-71.

Koçak, E. (2014). T*ürkiye'de çevresel kuznets eğrisi hipotezinin geçerliliği: ARDL sınır testi yaklaşımı, İşletme ve İktisat Çalışmaları Dergisi*, 2(3), 62-73.

Kotnik, Z., Klun, M., & Škulj, D. (2014). The effect of taxation on greenhouse gas emissions. *Transylvanian Review of Administrative Sciences*, 43, 168-185.

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

Loganathan, N., Shahbaz, M., & Taha, R. (2014). The link between green taxation and economic growth on CO_2 emissions: Fresh evidence from Malaysia. *Renewable and Sustainable Energy Reviews*, *38*, 1083– 1091. doi: 10.1016/j.rser.2014.07.057.

Magnani, E. (2000). The environmental kuznets curve, environmental protection policy and income distribution. *Ecological Economics*, 32, 431-43.

Meireles, M., Robaina, M., & Magueta, D. (2021). The effectiveness of environmental taxes in reducing CO_2 emissions in passenger vehicles: The case of mediterranean countries. *International Journal of Environmental Research and Public Health*, 18(10), 5442.

Meng, S., Siriwardana, M., & Mcneill, J. (2013). The environmental and economic impact of the carbon tax in Australia. *Environmental and Resource Economics, 54*(3), 313-332.

Miller, S., & Vela, M. (2013). *Are environmentally related taxes effective?* (Working Paper No. 467). IDB. https://www.econstor.eu/bitstream/10419/89191/1/IDB-WP-467.pdf

Morley, B. (2012). Empirical evidence on the effectiveness of environmental taxes. *Applied Economics Letters*, 19(18), 1817-1820. doi: 10.1080/13504851. 2011.650324

Morley, B., & Abdullah, S. (2010). E*nvironmental taxes and economic growth: evidence from panel causality tests* (Research Papers No. 04/10). Department of Economics, University of Bath.

OECD, https://data.oecd.org/envpolicy/environmental-tax.htm

Oral, B. G., & Sayın, F. (2015). Environmental problems from an economic and fiscal perspective: An empirical evaluation for Turkey and OECD countries. *European Journal of Scientific Research*, 131(3), 242-255. http://www.europeanjournalofscientificresearch.com

OWID (2023). O*ur world in data,* CO_2 *emissions*, https://ourworldindata.org/CO2 -emissions

Önder, H. (2017). Vergilemenin ve diğer kamusal müdahalelerin hava kirliliği üzerinde etkisi: OECD ülkeleri üzerine bir analiz. *Maliye Dergisi*, 172*,* 189-199. https://ms.hmb.gov.tr/uploads/2019/09/172-10.pdf

Özbek, S. (2023). Sürdürülebilir çevre: Çevre teknolojileri ve vergileri kapsamında ekonometrik bir inceleme. *Bingöl Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 7(Özel Sayı), 63-91. doi: 10.33399/biibfad.1253043

Özkaya, M.H. (2022). Ekonomik büyüme ve çevre vergi gelirlerinin karbon dioksit emisyonu üzerindeki etkisi: AB ülkeleri örneği. *International Journal of Applied Economic and Finance Studies*, *7*(1), 128-139. http://www.ijabms.com/wp-content/uploads/2022/07/08_OZKAYA.pdf

Öztürk, İ., & Acaravcı, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics,* 12(36), 262-267.

Pearce, D. (1991). The role of carbon taxes in adjusting to global warming. *Economic Journal*, 101(407), 938-948.

Ploeg, F. V., and Withagen, C. (2014). Growth, renewables, and the optimal carbon tax. *International Economic Review, 55*(1), 283-311.

Polat, O., & Eş Polat, G. (2018). Avrupa Birliği ülkelerinde karbondioksit emisyonu ve çevre vergileri: Panel veri analizi yaklaşımı. *Finans Politik & Ekonomik Yorumlar*, 55(639), 101-116.

Roberts, J. T., & Grimes, P. E. (1997). Carbon intensity and economic development 1962-91: A brief exploration of the environmental kuznets curve. *World Development*, 25(2), 191-198.

Rosiek, J. (2015). The impact of environmental tax policy on sustainable development of the EU economies: DEA approach In *11th International Conference of ASECU* (233-245). Cracow. https://www.asecu.gr/files/11th_conf_files/18.pdf

Safi, A., Chen, Y., Wahab, S., Zheng, L., & Rjoub, H. (2021). Does environmental taxes achieve the carbon neutrality target of G7 economies? Evaluating the importance of environmental R&D. *Journal of Environmental Management*, 293, 112908. doi: 10.1016/j.jenvman.2021.112908.

Saqib, N., Radulescu, M., Usman, M., Balsalobre-Lorent, D., & Cilan, T. (2023). Environmental technology, economic complexity, renewable electricity, environmental taxes and CO_2 emissions: Implications for low-carbon future in G-10 bloc. Heliyon, 9(6), e16457. doi: 10.1016/j.heliyon.2023.e16457

Shahbaz, M., & Sinha, A. (2019). Environmental kuznets curve for CO_2 emissions: A literature survey. Journal of Economic Studies, 46(1), 106-168. doi: 10.1108/JES-09-2017-0249

Shahbaz, M., Loganathan, N., Muzaffar, A.T., Ahmed, K. & Ali Jabran, M. (2016). How urbanization affects CO_2 emissions in Malaysia? The application of stirpat model. *Renewable and Sustainable Energy Reviews*, 57, 83–93. doi: 10.1016/j.rser.2015.12.096

Silajdzic, S., & Mehic, E. (2018). Do environmental taxes pay off? The impact of energy and transport taxes on CO_2 emissions in transition economies. *South East European Journal of Economics and Business*, 13(2), 126-143. doi: 10.2478/jeb-2018-0016

Stiglitz, J. E. (2000). Economics of the public sector (3th ed.). NY: W. W. Norton & Company.

Şimşek, D. & Kesbiç, C. Y. (2020). Çevresel riskleri azaltmada çevre vergilerinin etkisi: Avrupa Birliği ve Türkiye örneği. *Sosyal ve Beşerî Bilimler Araştırmaları Dergisi*, 21 (46). 46-20.

T.C. Ticaret Bakanlığı (2023a). *Yeşil mutabakat eylem planı ve çalışma grubu*. https://ticaret.gov.tr/dis-iliskiler/yesil-mutabakat/yesil-mutabakat-eylem-plani-ve-calisma-grubu

T.C. Ticaret Bakanlığı (2023b). AB *sınırda karbon düzenleme mekanızması*. https://ticaret.gov.tr/dis-iliskiler/yesil-mutabakat/ab-sinirda-karbon-duzenleme-mekanizmasi

Tekin, A., & Vural, İ.Y. (2004). Global kamusal malların finansman aracı olarak global vergi önerileri. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 12, 323-337.

Torras, M., & Boyce, J. K. 1998. Income inequality and pollution: A reassessment of the environmental kuznets curve. *Ecological Economics*, 25(2), 147-160.

Turkish Statistical Institute (TurkStata). Ç*evre ve enerji istatistikleri.* https://data.tuik.gov.tr/Kategori/GetKategori?p=cevre-ve-enerji-103&dil=1

Turkish Statistical Institute (TurkStatb). N*üfus ve demografi istatistikleri.* https://data.tuik.gov.tr/Kategori/GetKategori?p=nufus-ve-demografi-109&dil=1

United Nations (UN). *Conferences-environment and sustainable development*. https://www.un.org/en/conferences/environment

United Nations Climate Change (UNCC). (2023). C*limate change, process and meetings*. https://unfccc.int/process-and-meetings

United Nations Development Programme (UNDP). *Sustainable development goals*. https://www.undp.org/sustainable-development-goals

United Nations Environment Programme (UNEP). (2023a). *The Montreal protocol*. https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

United Nations Environment Programme (UNEP). (2023b). *Ozone secretariat*. https://ozone.unep.org/

Uyduranoğlu, A., & Öztürk, S. S. (2020). Public support for carbon taxation in Turkey: Drivers and barriers. *Climate Policy*, 20(9), 1175–1191. doi: 10.1080/14693062.2020.1816887

Yavuz, E., & Ergen, E. (2022). Çevre vergilerinin çevre kirliliği üzerindeki etkisi: Seçilmiş G20 ülkeleri üzerine bir uygulama. *International Journal of Public Finance*, *7*(1), 113-136. doi: 10.30927/ijpf.1066728

Yılmazcan, D., & Çakmak, H. (2018). İklim değişikliğinin önlenmesinde mali/iktisadi araç olarak: Karbon emisyon vergisi mi? Karbon emisyon ticareti mi?. *In Proceedings of The International Congress on Business and Marketing, 2018.* İstanbul: Doğuş Üniversitesi.

Zhang, X.P., & Cheng, X.M. (2009). Energy consumption, carbon emissions and economic growth in China. *Ecological Economics*, 68, 2706-2712.