AN IMPLEMENTATION FOR THE FUTURE OF MOTOR VEHICLE TAX IN THE SHADOW OF THE PARIS CLIMATE SUMMIT: THE EXAMPLE OF TÜRKİYE[1]

Kafkas University
Economics and Administrative Sciences Faculty
KAUJEASF
Vol. 15, Issue 30, 2024
ISSN: 1309 – 4289
E – ISSN: 2149-9136

Article Submission Date: 15.03.2024 *Accepted Date: 15.08.2024*

Yasin SÖĞÜT
Dr.
Sakarya University
Faculty of Political Sciences,
Sakarya, Türkiye
yasin.sogut1@ogr.sakarya.edu.tr
ORCID ID: 0000-0001-7274-0591

Veysel İNAL
Assoc. Dr.
Sakarya University
Faculty of Political Sciences,
Sakarya, Türkiye
veyselinal@sakarya.edu.tr
ORCID ID: 0000-0002-1143-4184

Hakan YAVUZ
Assoc. Dr.
Sakarya University
Faculty of Political Sciences,
Sakarya, Türkiye
hyavuz@sakarya.edu.tr
ORCID ID: 0009-0005-6956-6568

Ahmet BAĞCI
Dr.
Gazi University
Faculty of Economics and
Administrative Sciences,
Ankara, Türkiye
ahmtbgc81@gmail.com
ORCID ID: 0000-0002-2029-6641

ABSTRACT

Türkiye is committed to lowering its greenhouse gas emissions, adhering to the terms of the Paris Climate Agreement, which it has endorsed. In this context, there is significant interest in environmental tax reform that merges carbon regulation with reducing other taxes that are distorting. This study assesses the effects of motor vehicle tax (MVT), energy consumption, and economic growth on Türkiye's carbon footprint from 1995 to 2020, framed by the Environmental Kuznets Curve (EKC). The research uses the ARDL technique to analyze time series data, and reveals that the EKC hypothesis does not apply. Additionally, the study finds that MVT, as an included variable in the EKC model, does not significantly influence the carbon footprint. It is crucial to acknowledge that all variables in the model interact and collectively influence the analysis of variable relationships. As a result, crafting policy recommendations on this matter requires a comprehensive, multidisciplinary approach. Therefore, adjusting and implementing MVT in a manner consistent with the objectives of the Paris Climate Agreement could serve as a pivotal strategy for advancing both Türkiye's economic and environmental goals.

Keywords: *MVT, CO_2, EKC, environmental quality, ARDL*
JEL Code: *G18, H20, H21*

Scope: *Economics*
Type: *Research*

DOI: 10.36543/kauiibfd.2024.021

Cite this article: Söğüt, Y., İnal, V., Yavuz, H., & Bağcı, A. (2024). An implementation for the future of motor vehicle tax in the shadow of the Paris climate summit: The example of Türkiye. *KAUJEASF, 15*(30), 535-562.

[1] It has been declared that the relevant study complies with ethical rules.

PARİS İKLİM ZİRVESİ GÖLGESİNDE MOTORLU TAŞITLAR VERGİSİNİN GELECEĞİNE YÖNELİK BİR UYGULAMA: TÜRKİYE ÖRNEĞİ

Kafkas Üniversitesi
İktisadi ve İdari Bilimler Fakültesi
KAÜİİBFD
Cilt, 15, Sayı 30, 2024
ISSN: 1309 – 4289
E – ISSN: 2149-9136

Makale Gönderim Tarihi: 15.03.2024 *Yayına Kabul Tarihi: 15.08.2024*

Yasin SÖĞÜT
Dr.
Sakarya Üniversitesi
Siyasal Bilgiler Fakültesi,
Sakarya, Türkiye
yasin.sogut1@ogr.sakarya.edu.tr
ORCID ID: 0000-0001-7274-0591

Veysel İNAL
Doç.Dr.
Sakarya Üniversitesi
Siyasal Bilgiler Fakültesi,
Sakarya, Türkiye
veyselinal@sakarya.edu.tr
ORCID ID: 0000-0002-1143-4184

Hakan YAVUZ
Doç.Dr.
Sakarya Üniversitesi
Siyasal Bilgiler Fakültesi,
Sakarya, Türkiye
hyavuz@sakarya.edu.tr
ORCID ID: 0009-0005-6956-6568

Ahmet BAĞCI
Dr.
Gazi Üniversitesi
İktisadi ve idari Bilimler Fakültesi,
Ankara, Türkiye
ahmtbgc81@gmail.com
ORCID ID: 0000-0002-2029-6641

ÖZ

Türkiye, taraf olduğu Paris İklim Anlaşması çerçevesinde sera gazı emisyonlarını azaltmayı planlamaktadır. Bu bağlamda, karbon düzenlemesi ile mevcut çarpık vergilerin azaltılmasının birleşimi olan çevre vergisi reformu büyük ilgi görmektedir. Bu çalışmada, 1995–2020 dönemi için Türkiye'de Çevresel Kuznets Eğrisi (EKC) çerçevesinde motorlu taşıtlar vergisi (MTV), enerji tüketimi ve ekonomik büyümenin karbon ayak izi üzerindeki etkisi incelenmektedir. Zaman serisi tekniklerinden ARDL tekniğinin kullanıldığı çalışmada, ulaşılan ampirik bulgular, EKC hipotezinin geçerli olmadığı yönündedir. Ayrıca EKC modeline açıklayıcı değişken olarak dâhil edilen MTV'nin de karbon ayak izi üzerinde istatistiki olarak anlamlı bir etkisi söz konusu değildir. Değişkenler arasındaki ilişkilerin ortaya koyulmasında modele dâhil edilen tüm değişkenlerin birbirini etkilediği unutulmamalıdır. Dolayısıyla konuya ilişkin politik önerilerde multidisipliner bakış açısı ile yaklaşılması gerekmektedir. Bu doğrultuda MTV, Paris İklim Antlaşması hedefleriyle uyumlu bir şekilde düzenlenerek uygulanabilirse hem ekonomik hem de çevresel kalkınma yolunda stratejik bir hamle olarak değerlendirilebilir.

Anahtar Kelimeler: *MTV, CO_2, EKC, çevresel kalite, ARDL*
JEL Kodları: *G18, H20, H21*

Alan: *İktisat*
Türü: *Araştırma*

1. INTRODUCTION

Environment and environmental protection are among the issues that concern all humanity. Humans are the creatures that cause the most damage to the environment and are most affected by this damage. If the damage to the environment is not prevented, all humanity will be affected by this damage. For these reasons, international agreements are being made, and states are trying to produce standard global environmental policies (McCormick, 2023, p. 54). The United Nations Conference on the Human Environment, convened in Stockholm in 1972, marked the first inclusion of the right to the environment within an international legal framework (United Nations Environment and Sustainable Development, 2023). Following this landmark conference, efforts to protect the environment have persisted. The Kyoto Protocol, adopted by the United Nations Framework Convention in 1997, mandates the reduction of greenhouse gas emissions to levels that would prevent climate change (United Nations Climate Change, 2020). 2016 the Paris Climate Agreement was enacted as a legally binding international treaty addressing global climate change. The transition of the Motor Vehicle Tax in Türkiye is a notable example, where the tax structure has been adjusted to favor vehicles with lower emissions, thereby encouraging the adoption of more environmentally friendly transportation options. This shift reflects Türkiye's alignment with global environmental priorities and demonstrates the practical integration of environmental concerns into economic and fiscal policies (Ökde, 2022, p. 415).

Addressing the impacts of climate change necessitated by global warming requires reducing carbon and other harmful emissions (Şencan, 2021, p. 20). Using primary energy sources leads to the release of CO_2, which has detrimental effects on the environment (Özdemir, 2023, p. 2). The combustion of fossil fuels significantly contributes to the increase in CO_2 emissions, accounting for approximately 76% of greenhouse gases and exacerbating climate change. The Kyoto Protocol, established in 1997, strongly advocates for the shift from fossil fuels to renewable energy sources, mandating developed countries to reduce their CO_2 emissions (International Energy Agency, 2023). Taxation has emerged as the most prevalent and effective method for environmental protection (Grossman, 1999, p. 539). Consequently, there have been proposals for implementing global taxes to support the financing of global public goods (Betz & Hein, 2023, p. 241). Environmental taxes, referred to as ecological, pollution, or green taxes, vary in name but share the common goal of environmental preservation (Jamali, 2007, p. 80; Sarpong, Xu, Gyamfi, & Ofori, 2023, p. 337).

While taxes cover public expenses, they are also collected for the state to regulate economic and social life. Regulatory taxes collected aim to change people's preferences and behaviors without distinguishing between the public and private sectors. Therefore, ecological taxes, managed by targeting polluting activities without distinguishing between public and private sectors, are called regulatory taxes (Jamali, 2007, p. 100). Carbon taxes, the most common subcomponent of ecological taxes, constitute the majority of taxes collected to reduce CO_2. The carbon tax is an environmental tax implemented under the name "green tax reform" (Köppl & Schratzenstaller, 2023, p. 1353). Environmental taxes, often called "environmental taxes or green taxes," change the behavior of companies or individuals that disrupt the ecological order to protect the environment. Given that CO_2 gas constitutes the highest proportion of greenhouse gases contributing to climate change, it can be asserted that the majority of climate change is attributable to the accumulation of CO_2 (Raihan, 2023, p.9). The carbon tax is beneficial due to its predefined amount, simplicity, market-based nature, predictability in pricing, and its potential as a revenue source. However, when implementing a carbon tax, its drawbacks include political uncertainty, the unpredictability of benefits, exemptions from the tax, and the potential for unfair taxation (Köppl & Schratzenstaller, 2023, p. 1354).

Regarding the environment, taxes' regulatory and guiding feature comes to the fore. Most European Union countries collect motor vehicle tax as regulatory taxes. For this reason, they turned it into an environmental tax because it minimizes the damage of motor vehicles to the environment and reduces the emissions emitted due to transportation (Haywood & Jakob, 2023, p. 99). Thus, taxing cars according to their CO_2 has become critical. One of the most influential reasons for the greenhouse effect that causes climate change is the amount of CO_2 emitted from motor vehicles (Zhu, Lu, Song, Shao & Yue, 2023, p. 2). Since losses and evasion in taxation of motor vehicles are shallow, they constitute a severe source of income that must be addressed in the country's economy. For these reasons, MVT is the government's most preferred tax type (Demir, 2013, p. 133; Öncel, Çağan, Kumrulu & Göker, 2020).

MVT is a type of tax collected on wealth in Türkiye. Taxation of motor vehicles was first started in 1957 under the name of Private Automobile Tax. Later, the Motor Vehicle Tax Law No. 197 was enacted in 1963, which was changed to the Motor Vehicle Tax Law in 1980 with Law No. 2348. With this change, motor air and sea vehicles and motor land vehicles were also subject to tax. However, in 2009, sea vessels were excluded from the scope of the tax (Öncel et al., 2020; Gürdal, Demirtaş & Koç, 2024, p. 46). While the share of motor vehicle tax revenues in total tax revenues in Türkiye was 2% until 2014, it decreased to 1% after 2014. 2022, the question share fell below 1% (Revenue Administration, 2023). In Türkiye, a developing country, motor vehicles are taxed; taxes on expenditures (VAT and SCT) and wealth tax (MVT) are used. In developed countries, motor vehicles are taxed for social purposes such as environmental awareness rather than wealth and expenditure taxes (Gürdin, 2017, p. 39). Carbon emissions are not considered when taxing motor vehicles in Türkiye. Taxation is carried out by considering specific characteristics such as age, engine cylinder volume, number of seats, maximum total weight, and type of vehicle. However, it seems that environmental factors are considered in our country, and the amount of tax collected increases as the engine cylinder volume increases; this is not enough. Low taxes on older vehicles can be considered a sign that goals such as environmental awareness have not yet been adopted in Türkiye (Polat, 2014, p. 48).

Since the early 1980s, the Turkish economy has exhibited significant growth. With the global acceleration of globalization, Türkiye has seen an increase in energy use, foreign direct investments, resource consumption, and production-consumption volumes. Amidst these increases, Türkiye has grown awareness regarding environmental degradation, particularly CO_2 emissions, although it remains insufficient. In this context, it has been determined that MVT collected in Türkiye is not collected by fully considering environmental quality. Our study, undertaken to draw attention to this problem, investigates the relationship between motor vehicle taxation, energy consumption, economic growth, and CO_2 emissions in Türkiye. The study contributes to the literature by (i) using CO_2 emissions as an indicator of environmental quality, marking the first investigation into the relationship between motor vehicle tax, energy consumption, economic growth, and environmental degradation in Türkiye; (ii) arguing that environmental innovation and the adoption of clean energy are crucial for meeting the objectives of COP-26 and the Paris Climate Agreement, as expanding environmental taxes can increase clean energy use and reduce emissions. This expansion could enhance clean energy production and carbon capture storage, provided the motor vehicle tax is fully recognized as an environmental tax. Therefore, the motor vehicle tax should be promoted as a tax conducive to carbon neutrality in Türkiye; (iii) employing an innovative econometric method that yields robust results; and (iv) generating practical policy recommendations for Türkiye in terms of the relationship between motor vehicle tax, energy consumption, economic growth, and CO_2 emissions. The study initially highlights the role of environmental taxes in curbing CO_2 emissions to mitigate environmental pollution, examining motor vehicle tax within the framework of the Paris Climate Agreement. The literature on the topic is summarized in the second section. The third section describes the study's data and presents the findings from the econometric analysis. Finally, the last section discusses these findings and offers policy recommendations based on the study results.

2. THEORETICAL FRAMEWORK

Türkiye has no legal framework for establishing a taxation system to reduce carbon emissions caused by transportation. The motor vehicle tax system, in practice, is an application that considers the vehicle's age. No legal regulation will provide tax exemption or discount for cars with low greenhouse gas emissions and high energy efficiency (Ekinci & Gönüllüoğlu, 2012, p. 35). Therefore, while taxing motor vehicles, various regulations need to be made in the taxes collected from motor vehicles to reduce greenhouse gases, taking into account the damage caused to the environment. In recent years, some steps have begun to be taken to protect the environment in Türkiye, although it is delayed compared to the European Union countries. In this context, Türkiye signed the Kyoto Protocol within the scope of Law No. 5836 on February 5, 2009. This protocol entered into force by being published in the official gazette on 13.05.2009. Within the framework of the Kyoto Protocol, countries make commitments to reduce environmentally harmful greenhouse gas emissions between 2008 and 2012. Since Türkiye joined the protocol in 2009, there has been no reduction obligation for the targets set between 2008 and 2012 (Polat & Eser, 2014).

The Paris Climate Agreement stands out as the most significant and extensive initiative to safeguard the environment by curbing greenhouse gas emissions. Rooted in the United Nations Framework Convention on Climate Change, this agreement seeks to manage the climate change framework beyond the expiration of the Kyoto Protocol in 2020. Its overarching aim is to limit the global temperature rise to less than 2 degrees Celsius above pre-industrial levels, with a further ambition to maintain the increase at no more than 1.5 degrees. An essential feature of the Agreement that differs from the Kyoto Protocol is that developed and developing countries participate in the action to reduce greenhouse gases through National Contribution Declarations. National Contribution Declarations are contributions determined by the countries party to the Convention within their national conditions and consist of entirely voluntary targets that are not binding. In this context, Türkiye submitted the intended National Contribution Declaration to the Convention Secretariat on 15.09.2015, aiming to reduce greenhouse gas emissions by 21% in 2030, according to the reference scenario. It is essential for Türkiye to ratify the Paris Climate Agreement and for Türkiye to participate in global cooperation within the framework of achieving the Agreement's goals. Türkiye ratified the Paris Climate

Agreement. It has been acknowledged that the parties will be affected by climate change and the measures taken against climate change. Food security must be guaranteed against the adverse effects of climate change. Among the main goals are increasing the ability to adapt to the negative impacts of climate change, improving resilience to climate change, and encouraging low-emission development in a way that does not threaten food production. Türkiye has declared that it is sensitive to ending the nutritional problem in the world. It also acknowledged the importance of keeping the greenhouse gas sinks and reservoirs, which are emphasized in the Convention, under appropriate control and the participation of the Contracting Parties within the framework of their national legislation at every stage in the fight against climate change. In the Paris Climate Agreement, Türkiye is also a party, and each party is encouraged to set absolute emissions reduction targets throughout the economy and move towards these targets. All parties are trying to develop low-emission development strategies in the light of their national possibilities. At the same time, parties should take action to protect and strengthen greenhouse gas sinks and reserves, including forests. In addition, various incentives provided for sustainable development should support the reduction of greenhouse gases and carbon emissions, which have the largest share in greenhouse gases, and encourage participation by public institutions in reducing these emissions. At this point, Türkiye needs to innovate from the current motor vehicle tax to a more environmentally friendly tax structure due to its commitments to reduce greenhouse gases through international agreements to which it is a party[2].

Many developed and developing countries, especially European Union member countries, use taxation as an effective environmental policy tool. However, Türkiye still has not implemented a tax policy change that considers the environment in the field of taxation. The most concrete example is the Motor Vehicle Tax still in force in Türkiye. Although there is no environmental tax in Türkiye other than the Environmental Cleaning Tax, which is directly applied for ecological purposes in combating pollution and protecting natural resources, various user fees are used to solve environmental problems. Some of the main ones are hunting fees, oil exploration and operation permit fees, and aircraft noise fees (Yalçın, 2013, p. 141). In Türkiye's current motor vehicle tax system, the taxation amounts for older model vehicles are lower. However, as vehicle models age, fuel consumption and carbon emissions gradually increase. European Union countries take fuel efficiency and carbon emissions into account in motor vehicle

[2] Proposal of Law Concerning the Approval of the Paris Agreement (Articles No. 2.4.5.6.14 of the Agreement)

taxation. In this context, it is possible to integrate the practices of European Union countries into our country in taxing low-carbon emission vehicles (Kaplan, 2012, p. 216).

One effective approach to protecting the environment involves individuals compensating for their environmental impact by contributing financially via environmental taxes. Environmental pollution presents a significant threat to all living beings. The primary objective of ecological taxes is to foster a pattern of consumption and production that is mindful of environmental considerations, aiming to reduce environmental pollution and achieve economic benefits through ecological improvements (Öner, 2014, p. 140). Environmental taxes are monetary charges levied on individuals and legal entities by public administrations to preserve environmental values, prevent ecological damage, and mitigate or reverse environmental degradation. These taxes adhere to the "polluter pays" principle, aiming to minimize the harm caused by environmental pollution (Reyhan, 2014, p. 113). In Türkiye, the taxation of motor vehicles that pollute the environment is not yet recognized as a part of modern taxation techniques. It does not align with trends in ecological taxation. Article 56/2 of the 1982 Constitution mandates, "The state and its citizens are obligated to enhance the environment, protect environmental health, and prevent environmental pollution." In line with this article, exercising taxation powers should consider environmental considerations. It is constitutionally mandated for the state to utilize taxation as a tool for environmental protection (Üstün, 2012, p. 175).

Eurostat classifies transportation taxes as the last tax type among environmental taxes (Europan Commission, 2023). If we look at the Turkish tax system, only motor vehicle tax can fall into the transportation tax category. In transportation, there is no type of tax other than the motor vehicle tax that can provide services to protect the environment. However, between 2003 and 2004, those who scrapped their passenger cars over twenty years old to reduce CO_2 were given a SCT discount when purchasing a new vehicle. Thus, 274,000 old passenger vehicles were scrapped (OECD, 2008, p. 147). Nowadays, due to the enormous investments made by especially developed countries in the transportation sector, while the industry in question is growing, it has also brought environmental pollution. Although the transportation sector ranks second in terms of industries emitting CO_2, CO_2 ranks first among the most significant air pollutants in today's world (TÜİK, 2022).

3. LITERATURE REVIEW

Most of today's carbon tax practices are seen in Europe. Carbon tax practices in the European Union are considered a significant financial tool for achieving environmental policy goals (Balı & Yaylı, 2019, p. 308). In the academic field, research on the environmental effects of motor vehicle taxation encompasses theoretical and empirical investigations. The majority of practical studies focus on countries within the European Union that have adopted national carbon taxes. Türkiye, on the other hand, does not have a national carbon tax; instead, it levies environmental taxes referred to as ecological taxes. Currently, there is a lack of empirical research examining the influence of these taxes on CO_2 in Türkiye. This study aims to bridge this gap in the existing literature.

3.1. The Relationship between Economic Growth and Environmental Pollution within the Scope of the Environmental Kuznets Model (EKC)

The Environmental Kuznets Curve (EKC) hypothesis, introduced by Grossman and Krueger in 1991, posits an inverted U-shaped relationship between economic growth and environmental degradation. This theory suggests that while economic progress initially leads to increased pollution, environmental impacts begin to decline once a certain income threshold is reached. This concept supports the idea that economic growth and environmental sustainability can be achieved simultaneously by fostering environmental awareness and encouraging technological innovation in the later stages of development. Research by Stern (2017) supports the presence of this inverted U-shaped correlation between national income and environmental degradation. Naimoğlu (2023) in the study tested the EKC hypothesis in 15 energy-importing developing economies. The study, using the ARDL approach with panel data from 1990 to 2019, confirmed the validity of the EKC model. Similarly, Aydın, Söğüt, and Altundemir (2023) examined the EKC hypothesis for 20 European Union countries using data from 1995 to 2018. Their panel cointegration tests indicated that the EKC hypothesis holds true for Austria, the Netherlands, Poland, and Slovenia. Several other studies, including those by Liddle (2015), Akkaya and Hepsağ (2021), Pata and Aydın (2020), Chen and Taylor (2020), Wang, Wang, and Li (2022), and Aydın, Söğüt, and Erdem (2024), have explored the EKC hypothesis under various conditions. This extensive body of research is crucial for understanding the nuanced relationship between economic growth and environmental pollution.

3.2. Relationship Between CO_2 and MVT

In their study, Walls and Hanson (1999) conducted a study on California using survey data from the US Department of Transportation, considering MVT within the scope of environmental taxes. Annual income and lifetime income were taken into consideration in the study. As a result, it was determined that the share of emission-based taxes paid was higher in the income of poor households. Additionally, as a result of the analysis, it was determined that poor households pay more per vehicle than non-poor households, and these results vary depending on the income taken into account. In their study, Chia and Phang (2001) evaluated the MVT implemented in Singapore from an environmental perspective. He suggested that the current MVT system should be re-harmonised regarding environmental and economic targets. Within this framework, there should be tax reductions for public vehicles and the promotion of environmentally friendly cars. Braathen (2012) compares carbon dioxide-related tax rate differentiation in motor vehicle taxes in OECD member countries in his study. In the survey, MVT was considered a tool for reducing carbon emissions, and various evaluations were made on incentive systems. In his research, Karadeniz (2009) compared MVT with practices in multiple countries and suggested that MVT in Türkiye should have a structure that considers environmental protection and income-generating aspects. As a result, the study reported that MVT was not implemented as a tax to protect the environment in Türkiye. Yalçın (2013) sees MVT as a potential environmental tax in his research. He also examined MVT practices in European Union countries and stated that extremely successful results were achieved within the environmental protection framework. This study indicates that MVT should be abandoned as a wealth tax in Türkiye and transformed into a tax for ecological protection. This transformation can be achieved with the state's minimum measures for environmental protection.

In their study, Polat and Eser (2014) stated that MVT is a wealth tax, but the applied tariff is insufficient to tax wealth because it does not consider the vehicle's wealth value. Considering world practices, it is suggested that MVT has started to be implemented from a more environmentally friendly perspective, and therefore, MVT in Türkiye should be implemented as two separate taxes, namely Motor Vehicle Wealth Tax and Emission Tax. In their study, Sugözü, Yıldırım, and Aydın. (2014) do not find the tax tariff in practice successful in Türkiye because they are subject to tax without considering the age of the vehicles and their values. In addition, Türkiye is criticized for applying the motor vehicle tax as a wealth tax instead of an environmental tax, unlike the practices in European Union countries. Er (2015), who discussed MVT from a theoretical perspective, evaluated the problems in the current tax system within the scope of taxation principles. In this context, he suggested that obsolete vehicles should be withdrawn from the market and the production of cars suitable for new technology and with low carbon emissions should be encouraged. Vardar (2016), who discussed the MVT practices in the UK and Türkiye and evaluated the criteria considered when regulating tax tariffs with a comparative method, stated that the MVT applied in Türkiye is behind the UK regarding environmental quality and low carbon emissions. In this context, it is more environmentally friendly and suggested increasing incentives for low-carbon emission vehicles.

In his study, Karadeniz (2018) examined the tariff structure of the MVT applied from a theoretical perspective within the scope of tax justice. Evaluating the shortcomings in the current tariffs, they suggested a more fair MVT application, stating that while the same taxation criteria are applied to vehicles with different fuel types, vehicles with increasing age are subject to a lower tax rate even though they pollute the environment more. The study by Wappelhorst, Mock and Yang (2018) analyzes European vehicle taxation policies, examining how governments can steer consumers towards choosing low-emission vehicles. It reviews automobile taxation frameworks in European countries, focusing on France, Germany, the Netherlands, Norway, and the United Kingdom. The research evaluates the impact of taxation policies on the costs associated with selected vehicle models. It compares these policies across five markets to identify the most significant advantages for consumers opting for low-emission vehicles. The findings suggest several recommendations: substantial tax incentives at the time of purchase for low-emission vehicles, ongoing tax advantages for vehicles with low emissions throughout their usage, incorporating a vehicle's emissions into the company car tax system, and regularly adjusting the tax system to ensure its sustainability. He, Sun, Niu, Long, and Li (2021) utilized an autoregressive distributed lag (ARDL) model to empirically evaluate the collective influence of energy taxes, vehicle traffic taxes, and environmental taxes on energy efficiency, drawing on data from 1995 to 2016 across OECD countries. Their analysis showed that energy taxes significantly increase energy efficiency in the short term, vehicle traffic taxes have a notable positive impact on energy efficiency in the long term, and environmental taxes improve energy efficiency over both short and long terms, with a more substantial effect over the latter. Meireles, Robaina, and Magueta (2021) explored the relationship between vehicle taxation policies and the reduction of carbon emissions in Mediterranean countries, using panel data econometric techniques and vehicle registration data from 2008 to 2018. Their study modeled new vehicle demand and its sensitivity to carbon-based and circulation taxation changes, revealing that fiscal policies could play a critical role in reducing emissions in these nations. Natarajan, Wadhwa, Sri Preethaa, and Paul, (2023) conducted a study focusing on the observation and forecasting of emissions across different vehicle brands and types, utilizing sensor-based data from the Canadian government, which included observations of 7,384 light commercial vehicles between 2017 and 2021. Their predictive analysis offered valuable insights into choosing vehicles with lower CO_2 emissions, benefiting both consumers and manufacturers. Lastly, Ptak, Neneman, and Roszkowska (2024) examined CO_2 emissions from road travel, specifically targeting passenger and gasoline vehicle emissions in 28 EU member states, including the United Kingdom and Croatia, from 2010 to 2019. They also looked into the indirect tax rates on diesel in these countries, finding that fuel taxes generally have a slight but negative impact on CO_2 from passenger vehicles. Additionally, Montag (2015) mentions the inadequacy of taxes such as MVT in terms of environmental quality. He drew attention to fuel taxes and taxes such as MVT in the fight against environmental sustainability. Moreover, it mentioned the necessity of various regulations in this direction. Similarly, when reviewing the study results of Regalado, Quintero, and Villamar (2023) examined for Indonesia, environmental quality was ignored when collecting MVT. In addition, Eremina (2023) showed in his study that the current regulations on MVT do not meet humanity's needs in terms of greening.

While some studies confirm the EKC hypothesis, others, such as this study examining Türkiye's 1995-2020 data, suggest that the EKC hypothesis may not be universally valid. This suggests that more comprehensive, region-specific studies are needed to validate the EKC model in different contexts. The impact of MVT on reducing carbon emissions and promoting environmental sustainability is discussed. Studies such as Karadeniz (2009) and Yalçın (2013) show that MVT is not effectively implemented as an environmental tax in Türkiye. Considering the experiences of other countries, research is needed to explore how MVT can be better structured to achieve environmental goals. Many studies, such as Wappelhorst et al. (2018) and He et al. (2021), have compared vehicle taxation policies across countries. However, more detailed comparative analyses that consider different regions' unique socio-economic and environmental contexts are needed to derive best practices for implementing effective MVT systems. The literature suggests multidisciplinary approaches are needed in policy recommendations, considering the complex interplay between economic growth, environmental sustainability and social equity. This Research aims to integrate insights from economics, environmental science and social policy to develop holistic and effective environmental tax reforms. By addressing these gaps, future research can contribute to a more detailed understanding of the EKC hypothesis and the design of MVT systems that effectively balance economic, environmental, and social objectives.

4. RESEARCH HYPOTHESIS, DATA, MODEL, METHODOLOGY AND EMPIRICAL FINDINGS

4.1. Research Hypothesis

Nowadays, as economic activities continue to accelerate, environmental problems are increasing. In Türkiye, situations such as production, consumption, energy use, and depletion of natural resources trigger environmental problems. One of the most important environmental problems is the serious increase in carbon emissions. Based on these relationships, the study investigates whether there is any relationship between MVT, energy consumption, economic growth, and carbon footprint. The main problem of this research is the need to examine at what level a possible relationship occurs. The relationship between variables is tested through the EKC hypothesis. Based on the theory, the main hypothesis of the research and its sub-hypotheses were created as follows:

H1: The EKC hypothesis is valid in Türkiye.

H1a: MVT has an impact on CO_2.

H1b: EC has an impact on CO_2.

H1c: GDP has an impact on CO_2.

4.2. Data

The study investigates the effects of motor vehicle taxation, economic growth and energy consumption on the carbon footprint in Türkiye from 1995 to 2020 within the EKC framework. The availability and suitability of data guided the choice of representative variables. The analysis utilized annual GDP (in constant 2015 US dollars), motor vehicle tax (MVT), carbon footprint (CO_2), and energy consumption (in million tons) as data points. GDP figures were sourced from the World Bank database, CO_2 metrics from the Global Footprint Network database, and energy consumption and MVT information were retrieved from the OECD statistical database.

In order to test the EKC hypothesis, the model is formulated as follows based on Liddle (2015) and Akkaya and Hepsağ (2021);

$$\text{Model: } \ln CO_2\,it = \beta_0 + \beta_1 \ln GDPit + \beta_2 \ln GDP^2\,it + \beta_3 \ln ECit + \beta_4 \ln MVT_{it} + \varepsilon_{it}$$

In the model, β1, β2, β3, and β4 are the coefficients of lnGDP, lnGDP2, lnEC, and lnMVT. The error term is εit coefficients. According to the validity criteria of the EKC hypothesis, when we examine the relationship between economic growth and pollution, the coefficient of lnGDP should be positive; that is, as economic growth increases, environmental pollution also increases.

Likewise, the coefficient of $lnGDP^2$ should be negative, indicating that when economic growth reaches a certain threshold, there is a decrease in environmental pollution. Both lnGDP and $lnGDP^2$ are statistically significant, meaning that this relationship is reliable and essential.

Additionally, the fact that the established model is cointegrated indicates a long-term equilibrium relationship between the variables. In this context, the EKC hypothesis suggests that economic growth increases environmental degradation up to a point, but after a particular threshold value, it positively affects the environment. This emphasizes the importance of balanced management of economic growth and environmental protection measures to ensure a sustainable environment.

4.3. Methodology

This study adopted a three-stage econometric methodology. The first stage involved assessing the stationarity of the series via the Fourier Augmented Dickey-Fuller (ADF) unit root test. In the second stage, long-term associations among the variables were examined using the ARDL Bounds testing approach. The third stage was dedicated to identifying causality links among the variables with the help of the Fourier Toda Yamamoto causality test.

Time series can experience sudden changes known as structural breaks, often triggered by economic shocks, natural disasters, or political events. These breaks can profoundly alter the time series' stochastic properties. Thus, factoring in structural breaks is essential for accurate analytical outcomes. Literature on structural breaks reveals that these shifts can be abrupt or gradual. In this vein, Becker, (2004) introduced a method for detecting gradual structural breaks in time series through the use of Fourier terms. Specifically, they, along with Enders and Lee (2012), utilized Fourier terms to enhance the Augmented Dickey-Fuller (ADF) test, allowing it to account for gradual structural breaks. The following equation illustrates the method.

$$\alpha(t)=\alpha 0+\gamma_2\sin(2\pi kt/\mathrm{T})+\gamma_2\cos(2\pi kt/T) \qquad (1)$$

In the equation, k represents the frequency number of Fourier terms. The extended model proposed by Enders and Lee (2012) using the deterministic term in equation 1 is as follows:

$$\Delta yt=a_0+\beta\Delta y_{t-1}+\gamma_1\sin(2\pi kt/\mathrm{T})+\gamma_2\cos(2\pi kt/T)+\sum\nolimits^{p}{}_{i=1}=\theta i\Delta y_{t-i}+ut \qquad (2)$$

The Fourier ADF (FADF) unit root test adopts a two-step approach, as Enders and Lee (2012) recommended. Model 2 is estimated for $1 \leq k \leq 5$ in the initial step. The model that yields the lowest sum of squared errors (SSR) within this range is the most fitting. In the second step, the FADF test's effectiveness depends on the Fourier terms' statistical significance. The test's results are considered reliable when the Fourier terms are significant. If these terms are not significant, the Augmented Dickey-Fuller (ADF) test is recommended as the preferable method. The significance of the Fourier terms is determined using the standard F-test.

The autoregressive distribution lag approach (ARDL), which was introduced to the literature by Pesaran, Shin and Smith, (2001) due to its features, was used in the study. The ARDL approach has the following advantages compared to traditional methodology: This method provides solid predictions for I(0), I(1), and mixed stationarity orders (provided it is not I(2)). It presents short and long-term forecasts in a single model. It also offers consistent estimates in small samples. Finally, the ARDL approach makes predictions by considering endogeneity and autocorrelation issues (Usman, Balsalobre-Lorente, Jahangir & Ahmad, 2023). The ARDL method incorporates both explanatory and dependent variables, utilizing lagged values as regressors in a framework based on standard least squares regression. This method is further extended to test for long-term relationships or cointegration among variables through the ARDL-Bounds test. To achieve this, the model is transformed into an unconstrained error correction model using the ARDL approach and analyzed using the least squares (EKK) estimator. Subsequently, the Bounds test, which employs either an F or Wald statistic, is conducted to ascertain the presence of cointegration (Özdamar, 2015, p. 2).

Based on the model of the study, the ARDL-Bounds test equation created to determine the cointegration relationship between variables is as follows:

$$\Delta \ln CO2_t = a_0 + \sum_{i=1}^{m} a_{1i} \Delta \ln CO2_{t-i} + \sum_{i=0}^{n} a_{2i} \Delta \ln EC_{t-i} + \sum_{i=0}^{p} a_{3i} \Delta \ln GDP_{t-i}$$
$$+ \sum_{i=0}^{r} a_{4i} \Delta \ln GDP^2_{t-i} + \sum_{i=0}^{s} a_{5i} \Delta \ln MTV_{t-i} + \beta_1 \ln CO2_{t-1} + \beta_2 \ln EC_{t-1} + \beta_3 \ln GDP_{t-1}$$
$$+ \beta_4 \ln GDP2_{t-1} + \beta_5 \ln MTV_{t-1} + e_t \qquad (3)$$

The a coefficients in the equation expressed short-term dynamics, and the β coefficients represent long-term dynamics. In the Autoregressive "Distributed Lag (ARDL) methodology, the long-term relationship between variables is determined by the F statistic value, following the approach of Pesaran et al. (2001). The calculated F statistic is compared against the asymptotic significance levels, with distinct lower and upper bounds depending on the integration order of the variables, either I(0) or I(1). If the F statistic falls below the lower bound, it suggests the absence of a cointegration relationship. Conversely, an F statistic above the upper bound indicates the presence of cointegration. When the statistic lies between these bounds, a definitive conclusion on cointegration cannot be made (Westerlund, 2006, p. 120).

The final step of the econometric analysis involves examining the causal links between variables. This investigation utilized the Fourier Toda-Yamamoto (TY) causality method proposed by Nazlıoğlu, Görmüş, and Soytaş (2016). Enders and Jones (2016) pointed out that causal inferences from the Vector Autoregression (VAR) model could be flawed and inconsistent due to neglecting structural changes. Traditional Toda and Yamamoto causality tests also fail to account for structural breaks, which can lead to biased conclusions if a structural break is present. To address these issues, Nazlıoğlu et al. (2016) introduced the Fourier TY causality test, designed to accommodate smooth structural breaks, and deterministic terms were included in the TY causality test model as described by Aydın (2022, p. 470).

The equation for the Fourier TY causality test is as follows;

$$y_t = a_0 + \gamma_1 \sin(2\pi kT) + \gamma_2 \cos(2\pi kT) + \beta_1 y_{t-1} + ... + \beta_{p+d\max} y_{t-(p+\max)} + \varepsilon_t \quad (4)$$

4.4. Empirical Findings

This section of the study presents the empirical results obtained from econometric testing. Initially, the outcomes of the unit root tests for the variables are detailed. As indicated in Table 1 and affirmed by Enders and Lee, if the calculated F statistic is below the critical thresholds, traditional unit root tests are applicable. In our case, the calculated F statistic falls below the required levels, rendering the trigonometric terms insignificant and necessitating conventional tests. Among these traditional tests, the Augmented Dickey-Fuller (ADF) unit root test results demonstrate that all variables achieve stationarity at the I(1) level, except for lnMVT, which is stationary at the I(0) level.

Table 1: Unit Root Test Results

Variables	FADF					ADF	
	I(0)	I(1)	k	p	F-stat	I(0)	I(1)
$LnCO_2$	-0.2878	-2.8742	2	4	3.97	-1.2059	-5.7698*
lnEC	0.9239	-2.6682	3	4	3.77	-0.7855	-5.5789*
lnGDP	-0.2930	-3.7563	1	4	4.42	-1.7715	-4.3154*
$lnGDP^2$	-0.2311	-3.6173	1	4	4.42	-1.8077	-4.3748*
lnMVT	-4.9432	-1.5576	1	4	4.42	-2.6780*	-

Note: k refers to the number of available frequencies, and p refers to the appropriate delay length. Critical values: They are 12.21 (1%), 9.14 (5%), and 7.78 (10%). Fist. Essential values are taken from Enders and Lee (2012). * indicates statistical significance at 1%.

The variation in stationarity levels among the variables indicates the appropriateness of using the Autoregressive Distributed Lag (ARDL) method to explore their cointegration relationship. The model's dependent variable, $lnCO_2$, achieves stationarity at the I(1) level. Considering that the independent variables are stationary at both I(1) and I(0) levels, the ARDL approach was employed to examine the long-term cointegration relationship between the variables and to calculate their coefficients. The results of the bounds test, shown in Table 2, confirm that the ARDL method is apt for this analysis.

Table 2: Results of ARDL Bound Test

			Lower bound I(0)	Upper bound I(1)
F Statistics	**4.0515**	1%	3,29	4.37
k	**4**	5%	2.56	3.49
		10%	2,2	3.09
Diagnostic tests				
			Statistics	*Prob.*
Breusch-Godfrey LM test			*1.286*	*0.284*
White test			*0.490*	*0.870*
J-B Normality test			*2.070*	*0.355*
Ramsey Reset			*0.754*	*0.403*

Note: In the bounds test model, 'k' represents the number of independent variables. Diagnostic checks reveal that the model is free from autocorrelation as indicated by the Breusch-Godfrey LM test, exhibits constant variance as confirmed by the White test, and possesses normally distributed error terms as demonstrated by the Jarque-Bera test. Furthermore, the Ramsey RESET test results confirm the model's functional form is correctly specified, verifying that the model meets the necessary stability conditions.

In the first stage of the ARDL model, the appropriate lag length should be determined. At this stage, the variables are tested with different lag combinations, and the model with the lowest value according to the information criterion (according to AIC, SIC, or HQ criteria) is selected as the appropriate model. The maximum number of lags in the analysis is two, and the appropriate lag lengths for the variables are determined according to the Akaike information criterion. While selecting the proper lag length, using annual data in the study led us to keep the lag length short. In addition, the observational method allows the performance of models estimated with different lag lengths to be compared to determine the most appropriate lag length. The appropriate lag length chosen by taking these factors into account meets the relevant assumptions of the ARDL model. According to this criterion, the ARDL (2, 1, 2, 2, 0) model was determined. The results of the model estimated by the least squares method are presented in Table 3.

Table 3: ARDL (2, 1, 2, 2, 0) Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LNCO_2(-1)$	0.747583*	0.187795	3.980858	0.0018
$LNCO_2(-2)$	-0.106874	0.083394	-1.281556	0.2242
LNEC	0.952437*	0.100384	9.487948	0.0000
LNEC(-1)	-0.703570*	0.195453	-3.599688	0.0006
LNGDP	-0.731125	0.652487	-1.120520	0.2844
LNGDP(-1)	0.811270	0.640620	1.266383	0.2294
LNGDP(-2)	-1.511040**	0.509952	-2.963103	0.0119
LNGDP2	3.192625	2.794223	1.142581	0.2755
LNGDP2(-1)	-3.419661	2.727574	-1.253737	0.2338
LNGDP2(-2)	6.539710**	2.177255	3.003650	0.0110
LNMVT	-0.011776	0.007204	-1.634591	0.1281
C	-15.52463*	6.125406	-2.534465	0.0002

Note: *, **, and *** notations express significance at 1%, 5%, and 10%, respectively.

Since the calculated F statistic surpasses the upper boundary, it is deduced that the variables have a cointegration relationship. In the cointegration model, with $lnCO_2$ serving as the dependent variable, a long-term association has been found between the variables. The estimated long-term coefficients, reflecting the strength of this relationship, are detailed in Table 4.

Table 4: ARDL Long-Term Coefficients

Variables	Coefficient	t statistics	Probability value
lnEC	0.692664*	4.906788	0.0004
lnGDP	-3.982563	-1.479641	0.1647
lnMVT	-0.032776	-1.490602	0.1619
$lnGDP^2$	17.569854	1.497492	0.1601
C	-43.209172	-1.563384	0.1439

Note: *, **, and *** notations express significance at 1%, 5%, and 10%, respectively.

Energy consumption exerts a statistically significant positive impact on the dependent variable, whereas other independent variables in the model do not have a substantial effect. To explore the short-term dynamics of the model, an error correction model was estimated, with its estimates presented in Table 5.

Table 5: Error Correction Model

Variables	Coefficient	t statistics	Probability value
d(lnCO_2 (-1))	0.106874***	1.791356	0.0985
d(lnEC)	0.952437*	18.09578	0.0000
d(lnGDP)	-0.731125***	-1.843668	0.0901
d(lnGDP(-1))	1.511040*	3.975117	0.0018
d(lnGDP^2)	3.192625***	1.883249	0.0841
d(lnGDP^2(-1))	-6.539710*	-4.018046	0.0017
CointEq(-1)	-0.359290*	-6.064772	0.0001

Note: *, **, and *** notations express significance at 1%, 5%, and 10%, respectively.

Table 5 presents the results from the error correction model. The error correction term is negative and statistically significant, indicating that approximately 35% of deviations from equilibrium in the model are adjusted in the long term. Similar to the long-term analysis, the net effect in the short term is also positive and significant.

Additionally, the diagnostic tests for the ARDL model include assessing the presence of structural breaks through the Cusum and Cusum-sq structural break tests, as devised by Brown et al. (1975). These tests are designed to detect the long-term stability of consecutive error estimations, particularly whether they consistently share the same sign or remain unchanged over an extended period. The findings, with Cusum and Cusum-sq test statistics falling within the 5% critical value range, indicate that the model's coefficients are stable over the long term without any structural breaks. This outcome further underscores the consistency of the estimated coefficients within the model.

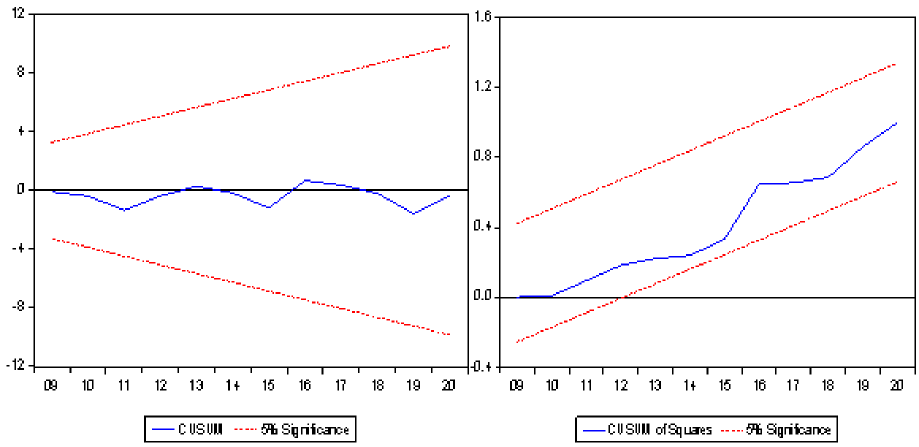

Figure 1: Cusum and Cusum-sq Test

The concluding part of the econometric analysis in this study involves presenting the results of the Fourier Toda-Yamamoto (TY) causality test. In order to assess the reliability of the ARDL results and the causal relationship between the variables included in the model, FTY causality analysis is used. The empirical outcomes are documented in Table 6. The test reveals a one-way causal link from CO_2 to MVT and another one-way causal relationship from energy consumption to CO_2. These findings indicate that the variables may function as predictors of each other. Consequently, future measures should adopt a comprehensive approach, considering these causal relationships when addressing the issue.

Table 6: Fourier Toda-Yamamoto Causality Results

Causality	Test Statistics	P value	k	p
$lnco_2$ –>lnmvt	8.762***	0.087	1	3
lnmvt –> $lnco_2$	2.876	0.470	1	3
$lnco_2$ –>lnec	0.786	0.383	1	1
lnec–>$lnco_2$	26.524*	0.000	1	3
$lnco_2$ –>lngdp	0.206	0.977	1	3
lngdp –>$lnco_2$	9.087	0.071	1	3

Note: * and *** indicate that the null hypothesis is rejected at 1% and 10% significance levels, respectively.

5. CONCLUSION AND POLICY RECOMMENDATIONS

The Paris Climate Agreement, an essential international treaty enacted in 2016, aims to mitigate global climate change. It involves commitments from various countries to limit worldwide greenhouse gas emissions and advance sustainable development goals. As a signatory to the Paris Climate Agreement, Türkiye has pledged to cut greenhouse gas emissions and promote a sustainable future. In this regard, the motor vehicle tax (MVT) is seen as a crucial instrument for diminishing the adverse environmental effects of carbon emissions and facilitating the shift towards a greener transportation infrastructure. The MVT's purpose within the Paris Climate Agreement framework is to bolster efforts to curb greenhouse gas emissions through various policy initiatives and tax regulations.

This research focused on assessing the impact of the motor vehicle tax, energy consumption, and economic growth on Türkiye's carbon footprint from 1995 to 2020, using the EKC framework. While numerous studies have tested the EKC hypothesis in the Turkish context, only a few have incorporated MVT as an explanatory variable. The study employed the ARDL Bounds Test to evaluate the EKC hypothesis. The empirical results did not support the EKC hypothesis. The anticipated negative impact of MVT on pollution was observed, but the obtained coefficient, though negative, was not statistically significant. Moreover, the coefficients required to validate the EKC hypothesis were not achieved. The failure to confirm the EKC hypothesis reveals that environmental pollution does not decrease after a certain growth threshold in Türkiye. These findings indicate that the EKC hypothesis does not hold for Türkiye. This conclusion aligns with the research findings of Ceylan and Karaağaç (2020), Öztürk and Acaravcı (2010), and Akbostancı, Türüt-Aşık, and Tunç (2009). The fact that economic growth does not create pollution after a certain stage reveals the need to review Türkiye's production composition. Particularly, the fact that technological and institutional development is not at the desired levels is one of the most important reasons for this result. Another important reason why the EKC hypothesis cannot be verified in Türkiye is the low environmental awareness and sustainability awareness. Collecting motor vehicle tax in the wealth tax category without taking environmental sustainability into account is one of the concrete examples of this. In addition, one of the other important reasons is that economic activities in Türkiye are based on non-renewable energy-intensive industries and the construction sector. According to the 2020 energy consumption data, the industrial sector relies heavily on fossil fuels, which account for approximately 83% of its total energy use (Ministry of Energy and Natural Resources, 2024). The construction sector, making up about 6% of the GDP and providing employment for 1.5 million people, plays a crucial role in Türkiye's economic development. When considering its direct and indirect effects on other sectors, the construction industry's share of the Turkish economy reaches up to 30%. Given the significant pollution emissions from construction materials and structures, it is inevitable that the EKC is not validated. On the other hand, rapid urbanization and population growth suppressing the unconscious use of natural resources are among the factors why the EKC hypothesis has not been realized for Türkiye. According to World Bank data, the proportion of the population living in urban areas in Türkiye has increased significantly from around 30% in 1960 to 77% in 2022 (Minister of Environment, Urbanisation and Climate Change, 2024). This rise in urbanization has led to issues such as irregular urban development and increased environmental pollution. R&D activities in Türkiye need to be expanded in all areas, especially economic activities, with the aim of environmental sustainability. On the other hand, increasing resource diversity is one of the steps that will ensure the validity of the EKC hypothesis. The main reasons for the findings obtained for Türkiye are the deficiencies in terms of steps to improve efficiency and positive green initiatives in terms of sustainability. Moreover, the model's findings suggest that energy consumption positively correlates with CO_2 emissions. The results imply that Türkiye needs to adopt more effective environmental and sustainability measures. Enhancing the effectiveness of MVT from a tax policy perspective and rapidly advancing necessary investments and R&D for green energy transition is imperative.

Policy suggestions such as considering environmental impacts in calculating MVT, increasing incentives for environmentally friendly vehicles, and excluding vehicles with low carbon emissions from taxation can enable essential steps to create a tax policy more suitable for Türkiye's environmental and sustainability goals. Considering the amount of emissions emitted by vehicles into the environment in the MVT calculation can promote sustainability. In this context, tax advantages and incentives can be applied to vehicles with low carbon emissions. Increasing these incentives could increase demand for environmentally friendly vehicles as emissions decrease. Excluding vehicles that cause low carbon emissions from taxation may make ecologically friendly vehicles more attractive. This can contribute to promoting sustainable transport. Excluding electric vehicles from MVT could encourage transitioning to a transportation system based on renewable energy sources. In addition, additional taxes may be collected from luxury vehicles with an engine power of 2000 and above, and vehicles with high carbon emissions may be held under additional financial liability. Considering the vehicle mileage during the year when determining the MVT amount may ensure that the vehicles are taxed based on their actual use. This could offer additional benefits to less used and greener vehicles. Using MVT revenues to develop public transportation infrastructure and finance sustainable transportation projects can be effective in reducing private vehicle dependency. High MVT rates can be applied in city centers to reduce vehicle use. This could reduce traffic congestion and air pollution in city centres. In terms of urban planning strategies, especially the planning of density and mixed-use areas allows people to carry out their vital activities without the need for special vehicles. In addition, supporting alternative transportation models will be included in the planning of cities and will pave the way for broader political interventions.

Finally, discounts or incentives applied to environmentally friendly vehicles can be made more visible by creating a unique incentive program called "environmentally friendly vehicle discount." Such incentives can encourage the adoption of sustainable transportation. These recommendations can contribute to building a comprehensive tax policy to reduce environmental pollution, promote sustainable transportation, and increase energy efficiency. In this context, regulations envisaged under the Paris Climate Agreement should consider incentives for scrapping old vehicles, mileage-based annual taxation, differentiated taxation for urban and rural use, incentives for the use of renewable energy fuels, and measures to reduce private car usage by promoting public transportation and car-sharing.

As a result, regulating and implementing Türkiye's motor vehicle tax policies in line with the Paris Climate Agreement targets can be part of the steps taken by the country towards sustainable development. These measures can be considered part of a strategy to increase environmental sustainability and contribute to efforts to combat global climate change. The policy recommendations developed in light of the findings of this study serve as a precursor to future research that addresses gaps in the literature and enables the expansion of the scientific field.

6. CONFLICT OF INTEREST STATEMENT

There is no conflict of interest between the authors.

7. FINANCIAL SUPPORT

No funding or support was received from this information.

8. AUTHOR CONTRIBUTIONS

YS, HY: Idea
YS, VI: Design
AB, YS: Processing and/or processing of resources;
VI: Analysis and/or interpretation;
YS, AB: Literature review;
YS, VI: Written by;
HY, AB: Critical review

9. ETHICS COMMITTEE STATEMENT AND INTELLECTUAL PROPERTY COPYRIGHTS

Ethics committee approval is not required for the study.

10. REFERENCE

Akbostancı, E., Türüt-Aşık, S. & Tunç, G.İ. (2009). The relationship between income and environment in Türkiye: Is there an environmental Kuznets curve?. *Energy Policy*, *37*(3), 861-867. doi: 10.1016/j.enpol.2008.09.088.

Akkaya, Ş., & Hepsağ, A. (2021). Does the fuel tax decrease Turkey's carbon dioxide emissions? Evidence from an asymmetric nonlinear cointegration test and error correction model. *Environmental Science and Pollution Research*, *28*, 35094-35101.

Aydın, M. (2022). The impacts of political stability, renewable energy consumption, and economic growth on tourism in Türkiye: New evidence from fourier bootstrap ardl approach. *Renewable Energy*, *190*, 467–473.

Aydın, M., Söğüt, Y., & Altundemir, M. E. (2023). Moving toward the sustainable environment of European Union countries: Investigating the effect of natural resources and green budgeting on environmental quality. *Resources Policy*, *83*, 103737.

Aydın, M., Söğüt, Y., & Erdem, A. (2024). The role of environmental technologies, institutional quality, and globalization on ecological sustainability in European Union countries: new evidence from advanced panel data estimations. *Environmental Science and Pollution Research*, 1-13. doi: 10.1007/s11356-024-31860-x.

Balı, S., & Yaylı, G. (2019). Karbon vergisinin Türkiye'de uygulanabilirliği. *Third Sector Social Economic Review*, *54*(1), 302-319.

Becker, J. (2004). Making sustainable development evaluations work. *Sustainable Development*, *12*(4), 200–211.

Betz, J., & Hein, W. (2023). *Global governance. In globalisation: Prerequisites, effects, resistances*. Wiesbaden: Springer Fachmedien Wiesbaden. 241–258.

Braathen, N.A. (2012). *CO2-Based Taxation of Motor Vehicles.* In: Zachariadis, T. (eds) Cars and Carbon. Springer, Dordrecht.

Brown, A. L. (1975). *The development of memory: Knowing, knowing about knowing, and knowing how to know.* Advances in child development and behavior, *10*, 103–152.

Ceylan, R., & Karaağaç, G. E. (2020). Türkiye'de çevresel Kuznets eğrisi hipotezinin test edilmesi: Yapısal kırılmalı eşbütünleşme testi ile hata düzeltme modelinden kanıtlar. *Pamukkale Journal of Eurasian Socioeconomic Studies*, *7*(2), 75-85.

Chen, Q., & Taylor, D. (2020). Economic development and pollution emissions in Singapore: Evidence in support of the environmental Kuznets curve hypothesis and its implications for regional sustainability. *Journal of Cleaner Production*, *243*, 118637.

Chia, N. C., & Phang, S. Y. (2001). Motor vehicle taxes as an environmental management instrument: the case of Singapore. *Environmental economics and policy studies*, *4*, 67-93.

Demir, İ. C. (2013). *Türkiye'de vergi yükü*. Bursa: Dora Yayıncılık.

Ekinci, F., & Gönüllüoğlu, S. (2012). Binek otomobil tüketicilerinin motorlu taşıt vergisi ve bu vergide yapılması planlanan yasal düzenlemelere ilişkin bilgi düzeyinin ölçülmesine yönelik bir araştırma. *Uluslararası Alanya İşletme Fakültesi Dergisi*, *4*(3), 35-43.

Enders, W., & Jones, P. (2016). Grain prices, oil prices, and multiple smooth breaks in a VAR. *Studies in Nonlinear Dynamics & Econometrics*, *20*(4), 399-419.

Enders, W., & Lee, J. (2012). A unit root test using a fourier series to approximate smooth breaks. *Oxford Bulletin of Economics and Statistics*, *74*(4), 574-599.

Er, A. (2015). Motorlu taşıtlar vergisi sistemindeki aksaklıklar ve vergi adaletinin sağlanması için bir öneri. *Vergi Sorunları, 38* (327), 121-131.

Eremina, I. V. (2023). Taxation of motor transport as a tool for environmental management. Ural State University of Railway Transport, Yekaterinburg, Russian Federation. Retrieved january 5, 2024, from https://www.scitepress.org/Papers/2022/115845/115845.pdf.

Europan Commission, (2023). Environmental tax statistics. Retrieved January 5, 2024, from https://www.google.com/search?q=Eurostat+classifies+transportation+taxes+as+the+last+tax+type+among+environmental+taxes.&oq=Eurostat+classifies+transportation+taxes+as+the+last+tax+type+among+environmental+taxes.&aqs=chrome..69i57.844j0j15&sourceid=chrome&ie=UTF-8

Grossman, B. (1999). Pollution tax. *Encyclopedia of Law and Economics, 2500,* 539–568.

Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement. *National Bureau of Economic Research*, 3914.

Gürdal, T., Demirtaş, N. & Koç, S. (2024). 7456 sayılı kanunla getirilen ek motorlu taşıtlar vergisinin anayasa mahkemesi kararları çerçevesinde incelenmesi. *Vergi Raporu*, *293*, 46-58.

Gürdin, B., (2017), Yeşil pazarlama kapsamında motorlu taşıtların çevre vergisi kapsamına alınması*, Uluslararası Beşeri ve Sosyal Bilimler İncelme Dergisi, 1*(1). 39-49.

Haywood, L., & Jakob, M. (2023). The role of the emissions trading scheme 2 in the policy mix to decarbonize road transport in the European Union. *Transport Policy*, *139*, 99-108.

He, P., Sun, Y., Niu, H., Long, C. & Li, S. (2021), The long and short-term effects of environmental tax on energy efficiency: Perspective of OECD energy tax and vehicle traffic tax, *Economic Modelling, 97*, 307-325.

International Energy Agency, (2023). Carbon dioxide emissions from fuel combustion. Retrieved february *12*, 2024, from https://www.iea.org/reports/world-energy-outlook-2023.

Jamali, T. (2007), *Ekolojik vergiler (çevre vergileri).* Ankara: Yaklaşım Yayıncılık.

Kaplan, R. (2012). Motorlu taşıtlar vergisinde otomobillerin tarife yapısının vergi adaleti ve çevre politikaları açısından değerlendirilmesi. *Vergi Sorunları Dergisi*, *289*, 211-218.

Karadeniz, H. K. (2018). Otomobiller üzerinden alınan motorlu taşıtlar vergisinin vergi adaleti açısından incelenmesi. *International Journal of Public Finance*, *3*(2), 193-204.

Karadeniz, H.K. (2009*), Türk motorlu taşıtlar vergisinin çeşitli ülke uygulamaları ile karşılaştırılması ve bir model önerisi*. Unpublished doctoral thesis. *Hacettepe Üniversitesi*, Ankara.

Köppl, A., & Schratzenstaller, M. (2023). Carbon taxation: A review of the empirical literature. *Journal of Economic Surveys*, *37*(4), 1353-1388.

Liddle, B. (2015). What are the carbon emissions elasticities for income and population? Bridging STIRPAT and EKC via robust heterogeneous panel estimates. *Global Environmental Change*, *31*, 62–73.

McCormick, J. (2023). The role of environmental NGOs in international regimes. *In The Global Environment*, 52–71, Routledge.

Meireles, M.; Robaina, M.; Magueta, D. (2021). The effectiveness of environmental taxes in reducing co2 emissions in passenger vehicles: the case of mediterranean countries. *International Journal of Environmental Research and Public Health, 18*(10), 5442.

Ministry of Energy and Natural Resources, (2024). Primary Energy Consumption, Retrieved July 22, 2024, from https://enerji.gov.tr/arama-sonuc?q=Birincil%20Enerji%20T%C3%BCketimi.

Ministry of Environment, Urbanization and Climate Change, (2024), Urban-Rural Population Ratio, Retrieved July 22, 2024, from https://cevreselgostergeler.csb.gov.tr/kentsel---kirsal-nufus-orani-i-85670.

Montag, J. (2015). The simple economics of motor vehicle pollution: A case for fuel tax. *Energy Policy, 85,* 138–149.

Naimoğlu, M. (2023). The effect of energy prices, energy losses, and renewable energy use on CO2 emissions in energy-importing developing economies in the presence of an environmental Kuznets curve. *Environmental Science and Pollution Research, 30*(20), 58755-58772.

Natarajan, Y., Wadhwa, G., Sri Preethaa, K. R., & Paul, A. (2023). Forecasting CO2 of light-duty vehicles with different machine learning algorithms. *Electronics, 12*(10), 2288.

Nazlıoğlu, S., Görmüş, N. A., & Soytas, U. (2016). Oil prices and real estate investment trusts (REITs): Gradual-shift causality and volatility transmission analysis. *Energy economics*, 60, 168-175.

OECD. (2008). Environmental performance reviews, Türkiye. Retrieved December 23, 2023, from http://www.oecd.org/env/environmentalcountryreviews/42198785.pdf.

Özdemir, A. C. (2023). Decomposition and decoupling analysis of CO2 in electricity generation by primary fossil fuels in Türkiye. *Energy*, *273*, 127264.

Özturk, I., & Acaravcı, A. (2010). CO2 emissions, energy consumption, and economic growth in Türkiye. *Renewable and Sustainable Energy Reviews*, *14*(9), 3220- 3225.

Ökde, B. (2022). Differences between Turkey and EU Countries on taxation policy for electric vehicles. *Journal of Accounting and Taxation Studies*, *15*(2), 415-435.

Öncel, M., Çağan, N., Kumrulu, A. & Göker, C. (2020). *Vergi hukuku.* Ankara: Turhan Kitabevi.

Öner, C. (2014). Çevre vergileri üzerine kavramsal bir deneme: terminoloji ve uyumlaştırma problemleri. *Ankara Barosu Dergisi*, *3*, 135-157.

Özdamar, G. (2015). Türkiye ekonomisinde döviz kuru geçiş etkisi: ardl-sınır testi yaklaşımı bulguları. *Akdeniz İİBF Dergisi*, *15*(32), 66-97.

Pata, U. K., & Aydın, M. (2020). Testing the EKC hypothesis for the top six hydropower energy-consuming countries: evidence from fourier bootstrap ardl procedure. *Journal of Cleaner Production*, *264,* 121699.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289-326.

Polat S. (2014), *Çevre vergisi bağlamında motorlu taşıtlar vergisi: Türkiye için bir model önerisi*. Unpublished master's thesis. Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Maliye Anabilim Dalı, Trabzon

Polat, S., & Eser, L.Y. (2014), Motorlu taşıtlar vergisinde değişim ihtiyacı: Türkiye için bir model önerisi. *C.Ü. İktisadi ve İdari Bilimler Dergisi*, *15*(2), 269-289.

Ptak, M., Neneman, J., & Roszkowska, S. (2024). The impact of petrol and diesel oil taxes in EU member states on CO2 emissions from passenger cars. *Scientific Reports*, 14(1), 52. doi: 10.1038/s41598-023-50456-y

Raihan, A. (2023). The dynamic nexus between economic growth, renewable energy use, urbanization, industrialization, tourism, agricultural productivity, forest area, and CO2 in the Philippines. *Energy Nexus*, 9, 100180.

Regalado, J. G., Quintero, C. F., & Villamar, J. P. (2023). Analysis of the tax collection of the environmental tax on vehicular pollution and how it affects the tax on environmental promotion from 2012 to 2020 in the case of Ecuador. *Migration Letters,* 20(11), 348-357.

Reyhan, A. S. (2014). Çevre ekonomisinde çevre vergileri uygulama. *Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 7(1), 110-120.

Sarpong, K. A., Xu, W., Gyamfi, B. A., & Ofori, E. K. (2023). A step towards carbon neutrality in E7: The role of environmental taxes, structural change, and green energy. *Journal of Environmental Management*, *337,* 117556.

Stern, D. I. (2017). The environmental Kuznets curve after 25 years. *Journal of Bioeconomics*, *19,* 7–28.

Sugözü, İ.H., Yıldırım, H. & Aydın, H.İ. (2014), Vergi adaleti açısından motorlu taşıtlar vergisinin analizi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *32,* 115-128.

Şencan, D. (2021). Çevresel sorunların önlenmesinde karbon vergisi üzerine genel bir bakış. *Türkiye Mesleki ve Sosyal Bilimler Dergisi*, *6,* 50-58.

TÜİK, (2022), Retrieved December 9, 2023 from https://data.tuik.gov.tr/Bulten/Index?p=Sera-Gazi-Emisyon-Istatistikleri-1990-2020-45862.

United Nations climate change (2020). Kyoto protocol. Retrieved December 25, 2023 from https://unfccc.int/kyoto_protocol.

United nations environment and sustainable development, (2023). Retrieved December 25, 2023 from https://www.un.org/en/conferences/environment.

Usman, M., Balsalobre-Lorente, D., Jahangir, A. & Ahmad, P. (2023). Are mercosur economies going green or moving away? An empirical investigation of the relationship between technological innovations, energy use, natural resources, and greenhouse gas emissions. *Gondwana Research*, *113,* 53-70.

Üstün, Ü. S. (2012). Motorlu taşıtlar üzerinden alınan vergilerin çevreyi korumaya yönelik ve adil olarak düzenlenmesi. *Ankara Hacı Bayram Veli Üniversitesi Hukuk Fakültesi Dergisi*, *16*(1), 153-190.

Vardar, M. K. (2016). Motorlu taşıtlar vergisi üzerine karşılaştırmalı analiz: Türkiye ve İngiltere uygulamaları. *Vergi Sorunları Dergisi*, *39*(338), 113-117.

Walls, M., & Hanson, J. (1999). Distributional aspects of an environmental tax shift: the case of motor vehicle emissions taxes. *National Tax Journal*, *52*(1), 53–65.

Wang, Q., Wang, X., & Li, R. (2022). Does urbanization redefine the environmental Kuznets curve? An empirical analysis of 134 countries. *Sustainable Cities and Society*, 76, 103382.

Wappelhorst, S., Mock, P., & Yang, Z. (2018). Using vehicle taxation policy to lower transport emissions. *Communications*, *49*(30), 847129-848102.

Westerlund, J. (2006). Testing for panel cointegration with multiple structural breaks. *Oxford Bulletin of Economics and Statistics*, *68*(1), 101-132.

Yalçın, A.Z. (2013). Potansiyel bir çevre vergisi olarak motorlu taşıtlar vergisi: Avrupa Birliği ve Türkiye arasında karşılaştırmalı bir analiz. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *27*(2), 141-158.

Zhu, J., Lu, Y., Song, Z., Shao, X., & Yue, X. G. (2023). The choice of green manufacturing modes under carbon tax and carbon quota. *Journal of Cleaner Production*, *384,* 135336.