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Research Article

Role of Green Taxes on Economic Growth Goals of Sustainable Development Directly and Through Environmental Performance: A System GMM Approach*

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ABSTRACT

Based on the UN's Millennium Development Goals, the Sustainable Development Goals (SDGs) are a global call to action that have led to structural changes in the means and objectives of countries' economic policies since 2016. This study examines green tax policies that are crucial for achieving environmental goals and analyzes the impact thereof on economic goals. The role of green taxes in sustainable development is determined by analyzing the data of 32 selected Organisation for Economic Co-operation and Development (OECD) countries for 2000–2019 with the system generalized method of moments (GMM) approach. The model indirectly focuses on CO emissions per capita and econometrically analyzes the impact of green tax revenues on the growth rate of real GDP per capita. Moreover, this study was evaluated in light of the double dividend debate. The study results suggest that green taxes contribute to environmental efficiency and offer empirical evidence on economic sustainability indicators. Furthermore, as the ratio of green tax revenues in GDP increases in the selected countries, the economic goals of sustainable development are closer and the positive effect increases as the CO_2 amount per capita decreases. In conclusion, harmonizing the basic principles of environmental policies with fiscal policies is crucial for combating environmental problems and for national economies.

Keywords: Sustainable Development, Green Taxes, Double Dividend, System GMM

Jel Codes: C01, H23, Q01

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1. Introduction

In a world with limited resources, reconciling current and future needs is imperative for the continuity of generations from an integrated perspective (UNECE, 2009: 21). Thus, the necessity of a sustainability approach to protect the integrity and diversity of nature brought governments and non-governmental organizations together under the International Union for Conservation of Nature (IUCN) in 1948 and constituted the first step in the development of the concept of sustainability (IUCN, 2022; ADB, 2012: 1). Sustainable development stems from the 1972 United Nations Conference on the Human Environment, where it received its first major international recognition (SDC, 2022). As a concept, it gained momentum with the publication of the 1987 Brundtland Report by the World Commission on Environment and Development and the establishment of the UN Commission on Sustainable Development in 1992 (Segger Marie-Claire & Khalfan, 2004: 15). Prior to signing of the Paris Agreement, politicians called for gradual progress in areas that were considered less politically damaging, such as clean technology and the polluter pays principle. This was based on the idea that the political consequences of various issues, such as controlling consumption, reducing the rate of population growth, and turning to renewable energy, could be damaging (Goodland, 1995: 13-14).

The Brundtland Report emphasizes that by meeting the needs of the present without compromising the ability of future generations, development would become sustainable. In this context, development will be sustainable within the limits of the ability of social organizations, technology, and the ecosystem to absorb human activities. Thus, sustainable development is a process of change in which resource use, technological development, investment, and institutional transformation act in harmony. If humanity could consider the impact of its actions on others, we could talk about sustainable development without absolute limits. Therefore, governments need to ensure isolation through laws, taxes, subsidies, education, etc. (Brundtland, 1987). Functioning as a milestone, the report led to global acceptance of the concept of sustainable development, with many countries focusing on these principles in their policymaking and strategic planning. The report emphasized a holistic approach that included economic growth alongside environmental protection and social justice.

The Brundtland Report laid the foundation for various international efforts, such as the Rio Conference (UN, 1992), the "Millennium Declaration on Sustainable Development" adopted in 2000, and the "Sustainable Development Goals" (SDGs) adopted in 2015. These efforts led to the emergence of today's green economy concept by clarifying SDGs and calling for action at the global level. Today, green taxes are integral in achieving SDGs by supporting climate and energy policies in the fight against climate change, reducing greenhouse gas emissions and promoting a cleaner environment. Green taxes, or environmental taxes, refer to taxes on energy, transportation, pollution, and resources (Taxation and Customs Union EC, 2022). Green taxes are both a form of government intervention to reduce costs imposed on others that are not taken into account by those taking action, such as the Pigou tax, and an important tool for achieving SDGs, such as promoting renewable energy investments (OECD, 2001).

As demonstrated by the upcoming literature review, studies on sustainable development and green taxes focus more on countries' environmental performance. However, economic goals are as important as environmental goals in sustainable development. The fiscal policies of countries help in achieving economic goals. Recently, whether green tax policies are an important driving force in achieving the economic goals of sustainable development such as, "decent work and economic growth" has become a topic of debate. In this direction, studies are directly related to growth and employment rather than development. Some of these studies have been defended with the double dividend argument, which claims that green taxes can have a positive impact on combating environmental problems as well as growth and employment. However, limited studies have examined these possible effects of green taxes with empirical evidence. In fact, econometric studies investigating this integrated relationship have been even more limited. Hence, this study econometrically analyzes the extent to which green tax revenues in selected countries in the Organisation for Economic Co-operation and Development (OECD) influence sustainable economic growth directly and through environmental performance. Unlike prior limited studies, an innovative dimension of this study is that it focuses on variables representing the economic dimension of sustainable development (e.g., annual growth rate of GDP per capita) rather than macroeconomic variables representing employment and direct growth (e.g., unemployment, GDP, and GDP per capita). Furthermore, the indirect inclusion of CO_2 per capita in the econometric model—one of the factors determining the environmental performance of countries—will enable the study to be evaluated from a different perspective regarding the double dividend theory. Moreover, sustainable development has become an important and urgent issue for countries to take action in their fields of practice as well as in the literature. Therefore, the evaluation of a development strategy based on the harmonization of sustainable growth targets and environmental policies via empirical studies will guide countries in developing policy measures.

With these objectives, the study comprises four sections. In the introduction section, the study's purpose and economic

importance are emphasized. Further, brief preliminary information regarding the study is provided by distinguishing it from other studies and emphasizing its contribution to the literature. The literature review subsequently examines the limited empirical literature on the study subject. The third section presents the study's methodology, econometric model, and findings. Finally, in the conclusion section, the study findings are interpreted by comparing the literature, and the importance of the study is emphasized.

2. Literature Review

The relationship between green taxes and sustainable development represents an important point in how environmental policies can achieve a balance between economic growth and environmental sustainability. From a literature perspective, theoretical and empirical studies on this relationship has developed over the last 30 years. However, these studies have mostly focused on the impact of green taxes on SDGs such as clean water, clean air (SDG 6), and clean energy use (SDG 7) (Larsen & Nesbakken, 1997; Baranzini, Goldemberg & Speck, 2000; Andersen, 2004; Aldy, Ley & Parry, 2008; Lin & Li, 2011; Jeffrey & Perkins, 2013; Jeffrey & Perkins, 2015; Fernando, 2019).

Reaching a consensus in the literature on the role of green taxes on the economic dimension of sustainable development is difficult. Some studies argue that environmental taxes may adversely affect economic growth by causing cost increases and emphasize that economic activity suffers from green tax practices due to the constraints created by environmental regulations, especially on the production side. While studies in this direction have shown that taxes have negative effects on macroeconomic indicators (Mcdougall, 1993; Van Der Ploeg & Ligthart, 1994; Siriwardana, Meng & Mcneill, 2011), other studies have argued that green taxes contribute to environmental protection objectives while also contributing to non-environmental welfare (e.g., growth and employment) by reducing pre-existing tax distortions. For instance, Tullock (1967), being the first to put forward this argument, argued that green taxes can bring various economic gains by reducing other distorting taxes and creating a more efficient tax system without creating an excessive burden like other taxes. This hypothesis, which is also known as the double dividend argument and first accepted as a theory with Pearce (1991), has been tested since the 1990s by using simulation scenarios and a few regression techniques based on these simulation studies rather than econometric modeling due to the difficulty of accessing macroeconomic data. Pearce's theory refers to an approach that suggests that a two-tiered benefit can be achieved by the imposition of environmental taxes.

- The first is environmental benefit:
  The main purpose of policies such as environmental tax practices is to increase environmental quality by reducing pollution and protecting natural resources. Green taxes promote using environmental resources in a more sustainable way by internalizing environmental costs.
- The second is economic benefit:
  Green tax practices may also be economically beneficial. Specifically, green taxes can minimize economic losses due to environmental degradation by internalizing environmental costs and directing economic agents toward cleaner and increasingly efficient production and consumption methods, thereby contributing to the sustainability of economic growth.

Pearce's double dividend theory has led to similar approaches to assessing the environmental and economic impacts of green taxes. Andre, Cardenete & Velázquez (2005), Bosquet (2000), Goulder (1995), Markandya, González-Eguino & Escapa (2012) and Maxim, Zander & Patuelli (2019) have investigated the positive secondary effect of taxes by focusing on employment and unemployment. Furthermore, Andersen et al. (2007) and Ricci (2007) have examined the empirical and theoretical support for the hypothesis by focusing on growth. These studies have explored whether green taxes can reduce environmental impacts and bring about a positive change in macroeconomic factors.

Majority of the aforementioned studies debate whether environmental taxation improves the environment and generates increased employment. The debate on whether taxes lead to gains in achieving development goals remains relatively weak in the literature. As a result of the literature review, among the econometric studies directly related to the subject of this study, Morley and Abdullah's (2014) study, which used panel cointegration and error correction techniques alongside the Granger causality approach for 25 European Union (EU) countries across 1995–2006, provides evidence that environmental taxes have no effect on economic growth in the long run but increase it, albeit slightly, in the short run.

Although not directly related to this study, another econometric study on similar topics, He et al. (2019), employed the unit root, cointegration, and Granger causality tests to investigate the impact of environmental taxes on economic and environmental performance in 36 OECD countries between 1994 and 2014 using the panel ARDL model. The results determined a long-term cointegration relationship between environmental taxes and GDP, unemployment rate,

greenhouse gas emissions, nitrous oxide emissions, and sulfur oxide emissions. However, it failed to offer evidence that environmental taxes reduce GHG emissions and unemployment.

Another empirical study analyzed the relationship between environmental taxes and economic growth in 28 EU countries from 1994 to 2018 (Mirovic, Kalas & Milenkovic, 2021). Based on panel data analysis, the revenue from environmental taxes was concluded to have a statistically significant and positive effect on the GDP ratio in the long run.

All these studies demonstrate that green tax policies can positively or negatively affect economies, both directly and indirectly. Unlike the aforementioned studies, this study focuses on sustainable economic growth indicators based on the theme of "decent work and economic growth" (SDG 8) in achieving SDGs instead of using the concept of growth. Furthermore, it includes the aim of "making economic growth sustainable per capita in accordance with national circumstances" (SDG 8.1) in the subtargets. Moreover, the research model, including the 13th SDG, entitled "Climate Action," is linked indirectly with the objective of "integrating climate change measures into national policies, strategies, and planning" (SDG 13.2), underlying this main goal. The inclusion of the annual growth rate of real GDP per capita (SDG 8.1.1), which an indicator of sustainable growth and indirectly the environmental performance values of countries (CO_2 emissions per capita; SDG 13.2.2) in the econometric model will enable the study to be evaluated from an innovative perspective regarding the double dividend hypothesis.

3. Methodology and Findings

3.1. *Data Set and Hypotheses*

This study analyzes the impact of green tax practices on sustainable development using a panel data set. The selected OECD countries cover 2000–2019 and include the countries' annual data. Table 1 presents the variables used.

Table 1. Identification of Variables

Code	Description	Type	Source
gg	Annual growth rate of real GDP (per capita)	Dependent	OECD https://stats.oecd.org/Index.aspx
sgdp	Environmentally related tax revenue as a share of each country's GDP	Independent	OECD https://stats.oecd.org/Index.aspx
oecd_c	Based on CO_2 emissions per capita (tonnes), it is given for countries below the OECD (European Region) average (value 0), for countries above it (value 1)	Dummy	It was created with data obtained from the OECD dataset on greenhouse gas emissions. https://stats.oecd.org/Index.aspx
sgdp_oecd_c	Based on sgdp and oecd_c variables	Interaction term	Created in the STATA program

Alongside the above dependent and independent variables, a derivative hypothesis was formed with the dummy variable and interaction term created in the model. The main hypothesis examines the following.

"Whether the ratio of green tax revenues to GDP has an effect on the annual growth rate of real GDP per capita."

Meanwhile, the derivative hypothesis seeks to answer the following.

"If this effect exists, whether this effect differs in countries with CO_2 emissions per capita below or above the OECD average."

Since almost 80% of the countries covered in the study are from Europe, the data averages are based on the average of the OECD European region. The data on the countries' per capita CO_2 emissions throughout the analysis period are shown in Figure 1. When the countries that emitted CO_2 emissions below the OECD average between 2000 and 2019 are analyzed, Latvia, Lithuania, and Turkey top of the list, followed by Sweden, Hungary, Portugal, France, Switzerland, Spain, Slovakia, Iceland, and Italy. However, the countries that emit more CO_2 than the OECD average are the developed countries, particularly the United States, Australia, and Canada (see Figure 1).

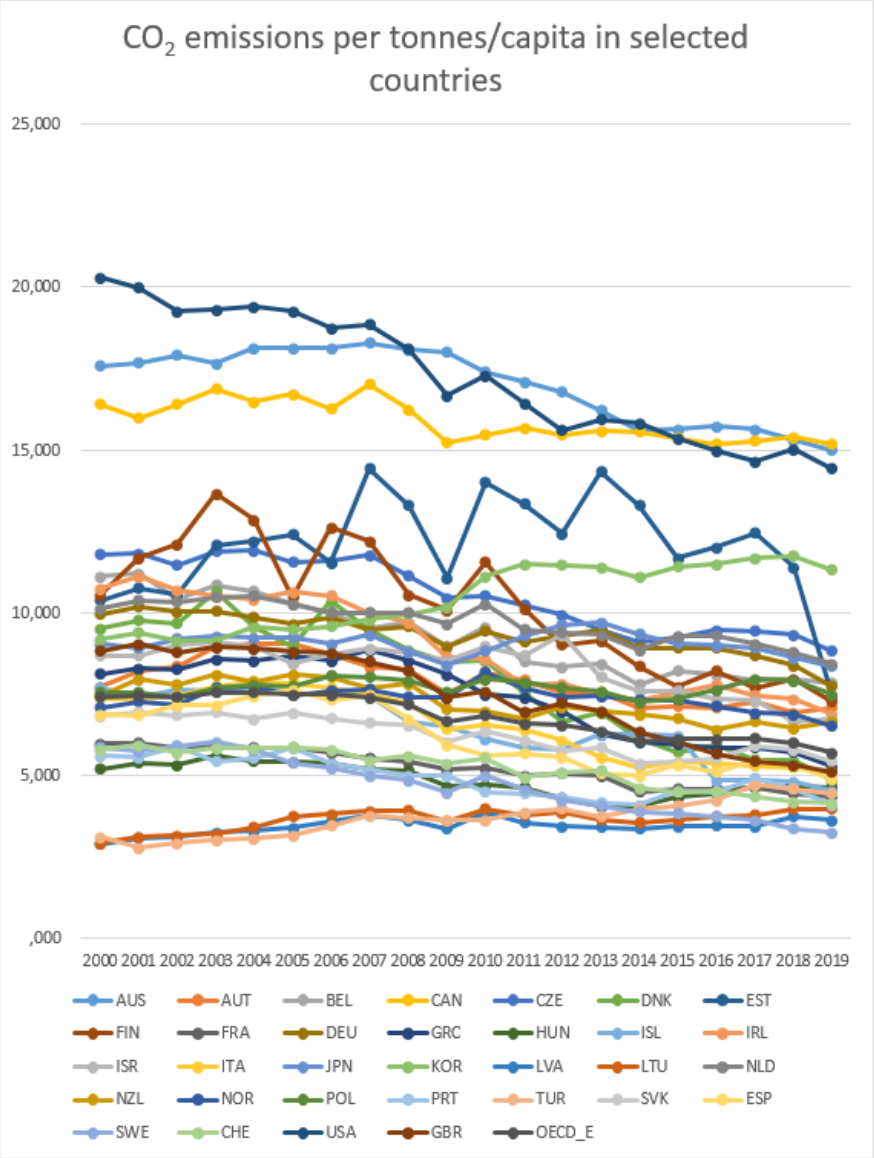

Figure 1. CO_2 emissions per capita in OECD countries between 2000 and 2019

3.2. *Method and Econometric Model*

Compared with static panel data models, dynamic panel data models analyze economic relations by incorporating the lagged values of variables as explanatory factors (Yerdelen Tatoğlu, 2020: 115).

Autoregressive panel data models come to mind when dealing with dynamic models. In this study, the autoregressive panel data model in which the lagged values of the dependent variable are included as independent variables is preferred. Numerous estimators are used in autoregressive panel data models and various methods are proposed to obtain consistent estimates. Several criteria need to be considered in choosing these estimators. The first criterion is the presence or absence of autocorrelation in the error term. Another criterion is whether the independent variables have endogeneity issues. Finally, the values of N and T might offer guidance regarding the preferred method (Yerdelen Tatoğlu, 2020: 155). Thus, this study employs a two-stage system generalized method of moments (GMM) estimator, which is a dynamic panel data analysis method. It is one of the most efficient methods used in unbalanced panel data models and when $T < N$, particularly for small samples. In response to the difference GMM approach's significant weaknesses, the approach developed by Arellano and Bover/Blundell and Bond by introducing forward orthogonal deviations for the loss of observations in unbalanced panel data provides more consistent estimates than most estimators (Arellano & Bover, 1995; Blundell & Bond, 1998; Bond, Hoeffler & Temple, 2001). Accordingly, the system GMM approach is

preferred, and the following econometric model is used to analyze the impact of green taxes on sustainable development.

gg_{it}= Annual growth rate of real GDP (per capita)
α_0= Intercept term in the model
β_0= Coefficient associated with the lagged dependent variable (gg_{it-1})
β_1= Coefficient associated with the environmentally related tax revenue($sgdp_{it}$)
β_2= Coefficient associated with the dummy variable ($oecd\_c_{it}$), which is based on CO_2 emissions per capita
β_3= The coefficient associated with the interaction term ($sgdp\_oecd\_c_{it}$), which is the product of (sg) and ($oecd\_c_{it}$). This interaction term allows for the possibility that the impact of environmentally related tax revenue on economic growth may depend on whether a country is above or below the OECD average in CO_2 emissions per capita.
ε_{it}= Error term

$$gg_{it} = \alpha_0 + \beta_0 gg_{it-1} + \beta_1 sgdp_{it} + \beta_2 oecd\_c_{it} + \beta_3 sgdp\_oecd\_c_{it} + \varepsilon_{it} \qquad \text{(Model 1)}$$

Considering the availability of data for the variables in Model 1, data from the OECD countries in Table 2 were included in the analysis.

Table 2. Countries Included in the Model

USA	France	Turkey	Belgium	Finland	S. Korea	Norway
UK	Netherlands	Austria	Denmark	German	Ireland	New Zealand
Italy	Canada	C.Republic	Greece	Slovakia	Portugal	Poland
Japan	Iceland	Letonia	Spain	Estonia	Lithuania	Sweden
	Israel	Hungary	Switzerland	Australia		

The numeric data of the variables for the countries in question are simply defined in Table 3.

3.3. *Findings*

Table 3 presents that the number of observations for the annual growth rate of real GDP per capita and the dummy variable for countries with CO_2 emissions per capita above and below the OECD average is 640, while the number of observations for the ratio of green tax revenues to GDP is 625. Therefore, model's estimation is based on an unbalanced panel data set. The mean value of the annual growth rate of real GDP per capita, which is the dependent variable, is 1.97015. Moreover, its standard deviation, minimum value, and maximum value are 3.212743, -14.45649, and 24.02172, respectively. The average value of the ratio of green tax revenues to GDP, which is the independent variable, is 2.42466663. Its standard deviation, minimum value, and maximum value are .7339901, .5644765, and 5.095356, respectively. The mean value of the oecd_c dummy variable, which is based on the per capita CO_2 emissions of the countries, is .625. Further, its standard deviation, minimum value, and maximum value are .4845016, 0, and 1, respectively.

Table 3. Descriptive Statistics of the Data Set

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
gg|	640	1.97015	3.212743	−14.45649	24.02172
sgdp |	625	2.424663	.7339901	.5644765	5.095356
oecd_c|	640	.625	.4845016	0	1

To ensure the accuracy of the econometric model's estimation, the presence of multicollinearity among independent variables should be analyzed. Therefore, the relationship between the independent variables is presented in Table 4.

Based on the correlation matrix, although there is a statistically significant relationship between the independent variables, there is also a negative correlation of 4%. Since the mean variance inflation factor has a value less than 5 or 10, there is no multicollinearity problem among the explanatory variables (Menard, 2001: 76).

Table 4. Correlation Matrix and VIF Criteria

	Sgdp	oecd_c	VIF	1/VIF
sgdp	1.000		1.00	0.997955
oecd_c	−0.0452	1.000	1.00	0.997955
			Mean VIF	
			1.00	

Consequently, the two-stage system of the GMM method was employed in the econometric model established by considering the characteristics of the variables within the scope of the analysis and their relationships. Table 5 presents the model estimation results.

Considering the model estimation results presented below, checking the assumptions are necessary. The independent variables are found to be significant in explaining the dependent variable when the Wald test result is first analyzed. Subsequently, when the Sargan test results are analyzed to determine whether the instrumental variables create endogeneity problems, the instrumental variables are found to be exogenous. Furthermore, the presence of first-order negative autocorrelation is confirmed in the model as expected, while second-order autocorrelation is absent. Finally, when the number of instrument variables is examined, the number of instrument variables (31) is, as expected, less than the unit size (32).

Thus, the findings of the two-stage system GMM estimation method suggest that the lagged values of the dependent, independent, and dummy variables as well as the interaction term are statistically significant. Table 5 shows that a single unit increase in the ratio of green taxes to GDP results in an increase of approximately 1.2 units in the annual growth rate of real GDP per capita. This positive effect is higher in countries with carbon per capita below the OECD average (see Figure 1). Furthermore, considering the effect of the dummy variable, the annual growth rate of real GDP per capita is higher in countries with CO2 emissions per capita above the OECD average (see Figure 1).

Table 5. Model Estimation Results

Variables	Coef.
gg(−1)	0.1092619 (0,000)*
sgdp	1.258018 (0,000)*
oecd_c	9.505221 (0,000)*
sgdp_oecd_c	−3.466508 (0,000)*
Key Assumptions	
Wald	χ^2 (8) = 13846.67 (0,000)*
Sargan	χ^2 (23) = 27.23811 (0.2460)*
AR(1)	z = − 2.6953 (0.0070)*
AR(2)	z = 0.45306 (0.6505)*
Number of Instruments	31
N	32

Note. The two-stage system GMM estimator of Arellano and Bover/Blundell and Bond was used. All results show statistical significance at the 1% level. *Values in parentheses are probability values.

Both green taxes and the indirect low level of CO2 emissions positively affect sustainable growth rates. In this respect, when the effect of the interaction term found by multiplying CO2 emissions and green tax revenues is analyzed, the green taxes paid by countries with high carbon emissions (as seen in Figure 1) slow down the sustainable growth rate. Essentially, the effect of green taxes on sustainable growth rates increases positively as CO2 emissions per capita decrease. The findings are expressed in Figure 2.

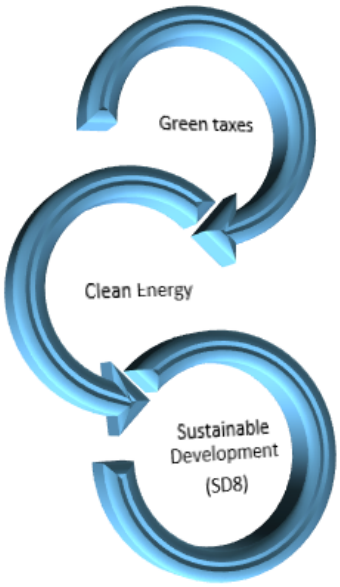

Figure 2. Summary of the econometric model

4. Conclusion

This study aimed to analyze the role of green taxes on sustainable development from an economic perspective and by indirectly including the environmental performance of countries. Thus, the system GMM approach was used. The effect of green taxes on the growth rate of annual GDP per capita, representing the economic aspect of sustainable development, was positively confirmed. Moreover, the amount of CO_2 emissions per capita in the countries indirectly included in the analysis changes the contribution of green taxes to sustainable growth. Thus, green taxes contribute more to sustainable growth with lower emissions. According to these results, the hypothesis of the double dividend theory—green taxes provide double dividends—is indirectly supported by this study. Consequently, the double dividend theory, which entered the literature through Pearce (1991), is also supported by the study's empirical findings. Moreover, green tax policies, which are mostly associated with clean water, air (SDG 6), and energy use (SDG 7) goals in the literature (Larsen & Nesbakken, 1997; Baranzini et al., 2000; Andersen, 2004; Aldy et al., 2008; Lin & Li, 2011; Jeffrey & Perkins, 2013; Jeffrey & Perkins, 2015; Fernando, 2019), are linked to the "economic growth" and "climate action" subtarget indicators in this study to reveal their contribution to SDGs. The study findings reveal that efforts to reduce carbon footprint—one of the subtargets (SDG 13.2)—are crucial factors that positively strengthen the impact of green taxes on a sustainable economy.

Fiscal policies that can enable a sustainable life in the present urgency of environmental measures have become a requirement rather than a preference. Therefore, based on the study results, including green energy in sustainable development objectives and implementing an optimal green tax policy will facilitate countries' achievement of sustainable growth. Hence, implementing a complementary tax system to achieve economic and environmental objectives will enable greater returns from both areas.

Future studies may focus on further examining the green tax policies of countries with CO_2 per capita below the OECD average and identifying examples of good practices. Specifically, studying Latvia, Lithuania, Turkey, Sweden, Hungary, Portugal, France, Switzerland, Spain, Slovakia, Iceland, and Italy could be fruitful. The fact that countries with worse environmental performance observe examples of good practice will further increase the contribution of green tax revenues to sustainable economies.

In conclusion, the hypothesis of this study can be re-evaluated using different variables and alternative analysis

methods that can represent the economic aspect of sustainable development and environmental policy instruments, including different country groups.

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