Environmental Taxation and Its Role in Promoting Sustainable Economic Growth

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Abstract. Imposing taxes on environmentally harmful activities can be a powerful and effective move for governments to incentivize businesses and individuals to adopt more sustainable practices and support a green economy. Nowadays, it also becomes increasingly important to balance economic prosperity and environmental sustainability. In this context, this essay aims to investigate the relationship between environmental taxation and sustainable economic growth by conducting a regression analysis across 20 countries, with a comprehensive quantitative analysis that offers valuable insights for academics, policymakers, and business owners. By examining the impact of various environmental taxes on the annual GDP growth rate, this paper also quantifies how different taxes contribute to long-term economic sustainability. This research contributes to the academic landscape by providing statistical evidence on the effectiveness of environmental taxation in achieving sustainability goals. It is believed to offer a better understanding of the potential benefits of leveraging environmental taxation as a tool for achieving sustainable economic growth.

Keywords: Environmental taxation, sustainability, economic growth.

1 Introduction

Sustainable development has been attached with more importance as ecological problems continuously emerge in the pursuit of a booming economy. To mitigate these side effects, governments worldwide are therefore increasingly turning to environmental taxation as a strategy to balance economic growth with ecological responsibility. Environmental taxation refers to the imposition of taxes on activities, goods, or services that have a negative impact on the environment [1]. As indicated in its concept, the primary goal is to motivate businesses and individuals to reduce their environmental footprint by making environmentally harmful practices more costly. This approach is based on the principle of "polluter pays", which indicates that those who are accountable for environmental harm should accordingly undertake the costs of their actions [2]. By placing a financial burden on pollution and resource depletion, environmental taxes are designed to encourage a shift toward sustainable behavior and the adoption of cleaner technologies. In this way, taxation not only helps mitigate environmental damage but

Q. Wu et al. (eds.), *Proceedings of the 2024 3rd International Conference on Public Service, Economic Management and Sustainable Development (PESD 2024)*, Advances in Economics, Business and Management Research 309,
https://doi.org/10.2991/978-94-6463-598-0_47

also creates additional revenue that can be reinvested in sustainable development initiatives.

Examples of environmental taxes include [3]:

- Carbon taxes: Taxes levied on the emissions of greenhouse gases, such as carbon dioxide.
- Energy taxes: Taxes on gasoline, diesel, and other fossil fuels.
- Pollution taxes: Taxes on emissions of air, water, or soil pollutants.
- Resource taxes: Taxes on the extraction of natural resources, such as minerals or timber.

Another critical concept in this essay centers on sustainable economic growth. The concept is relatively new, but soon becomes well-known among the public. It originated in the 1970s amid growing concerns about the environmental impact of rapid industrialization. The idea of sustainable development was first formally introduced during the 1972 Stockholm Conference and the subsequent Brundtland Report [4]. It was defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [5]. Over the years, the concept has evolved to integrate economic, social, and environmental dimensions, with a particular emphasis on the need for balanced growth that not only drives economic prosperity but also preserves natural resources and promotes social equity. Recently, in 2015 the United Nations Sustainable Development Goals (SDGs) provided comprehensive guidance for achieving sustainable development. Goal 8 specifically calls for "inclusive and sustainable economic growth, full and productive employment, and decent work for all." [6]

Against this background, this essay delves into the quantitative relationship between environmental taxation and sustainable economic growth. Data analysis, particularly multivariate regression models, is widely used to highlight the complexities and variations in the impact of environmental taxes across different economic contexts, and paves the way for a methodological framework for future research. By integrating existing theories and empirical studies, our research also bridges gaps in the literature and provides a comprehensive overview of environmental taxation's role in promoting sustainability. The findings collectively enhance the understanding of how environmental taxes can be strategically used to foster sustainable economic growth, adding both theoretical and practical value to the academic landscape.

2 Literature Review

The relationship between environmental taxation and sustainable economic growth has long been a central theme in academics, which offers a robust theoretical basis for this research. This paper conducted a thorough search of relevant academic databases, such as Google Scholar, JSTOR, and Web of Science, using keywords related to environmental taxation, sustainable development, and economic impacts. Scholars have used various econometric models, including regression analysis and panel data techniques, to assess how environmental taxes affect both economic output and environmental per-

formance. According to Pigou's theory (1920), environmental taxes internalize the negative externalities associated with pollution [7]. By taxing activities that harm the environment, Pigovian taxes aim to correct market failures, and thus prompt a shift toward cleaner production and consumption. Quantitative studies building on this theory focus on how such taxes influence economic behavior, reduce pollution, and contribute to long-term sustainability. Other empirical studies have attempted to quantify the impact of environmental taxes on economic growth. Ekins (1999) found a positive correlation between green taxes and GDP growth in countries that reinvested tax revenues into renewable energy and sustainable infrastructure [8]. Similarly, Andersen (2010) used panel data from OECD countries to demonstrate that environmental taxes, when paired with innovation in green technologies, support sustainable economic growth without sacrificing short-term economic performance [9].

According to the Double Dividend Hypothesis, proposing environmental taxes on the society can produce two benefits: improved environmental quality and enhanced economic efficiency. Quantitative analyses of this hypothesis often focus on simulations to evaluate tax shifts. For instance, Fullerton and Metcalf (2001) used general equilibrium models to show that environmental tax revenues can be recycled into the economy by reducing other distortionary taxes, and creating both environmental and economic gains [10].

Carbon taxation is widely recognized as a core element of environmental tax regimes, for it directly relates reduced carbon emissions with economic gains. OECD (2018) found that carbon taxes imposed in several European countries led to a measurable reduction in carbon emissions, and the economic impact was largely positive or neutral, provided the tax revenues were used to support technological innovation and mitigate negative distributional effects [11]. Moreover, Metcalf and Stock (2020) analyzed the impact of carbon pricing in various countries, reaching the conclusion that carbon taxes had minimal negative effects on economic growth when implemented with complementary policies such as green technology subsidies [12].

However, some studies also identify potential challenges and pose several doubts about the effectiveness of environmental taxation, which might vary depending on factors such as the specific tax design and the economic context. Sterner (2007) pointed out that the effectiveness of environmental taxes is highly context-dependent, with results varying across countries depending on the tax design, economic structure, and the use of revenues [13]. Heine et al. (2012) identified challenges in developing countries, where environmental taxes could disproportionately affect lower-income populations, thus requiring redistributive policies to mitigate regressive impacts [14]. On the other hand, environmental taxes can increase costs for businesses and consumers, leading to potential job losses and reduced economic growth [7] [15].

3 Research Methodology

3.1 Data

This study uses data collected from 20 countries for the year 2022 to explore the relationship between environmental taxation and sustainable economic growth. The decision to focus on data for a single year rather than a longer period can be attributed to

several factors. Data collection methods and standards may have evolved, which can cause potential discrepancies in data quality for earlier years. Therefore, data for a single year may be more reliable and consistent, since it helps to control for these confounding factors. Additionally, this paper aims to assess the immediate impact of recent policy changes, analyzing a single year can provide more valuable insights. The selected 20 countries are mostly developed economies with a few leading developing countries, and they offer a diverse and representative dataset for this study. Developed countries, including the United States, the United Kingdom, and several Eurozone countries, typically have established environmental tax systems and higher GDP per capita, which facilitates understanding the effectiveness of environmental taxation in mature economies. Meanwhile, the inclusion of emerging economies adds more depth to the analysis by showcasing how different stages of economic development impact the relationship between environmental taxes and sustainable growth. This diversity enhances the study's generalizability and relevance across various economic contexts.

In this paper, the dependent variable is the real GDP rate of change compared to the previous year, which represents the economic growth rate in each country. The independent variables consist of environmental tax statistics across four categories: energy, transport, pollution, and resources. A detailed description is shown in Table 1. These variables reflect the amount of revenue generated from taxes aimed at reducing environmental harm. The data is sourced from World Bank Open Data and Eurostat, both reputable databases providing detailed environmental tax statistics. The descriptive statistics are shown in Table 2.

Table 1. Study variables' descriptions.

Variables	Description
Dependent Variables Real GDP rate of change*100	percentage change compared to the previous year*100
Independent Variables	
T - Transport tax	the total tax imposed on transportation activities
E - Energy tax	the total tax imposed on energy consumption and production
PRs - pollution and resource tax - published as an aggregate	an aggregate of pollution and resource taxes

	T	**E**	**PRs**	**GDP**
Mean	5090	25762	2500	753
Median	1934	8039	605	875
Minimum	12	207	18	62
Maximum	24389	98087	15281	1360
Standard Deviation	7506	32240	4718	475
Count	20	20	20	20

3.2 Model Selection

$$GDP = \beta_0 + \beta_1 T + \beta_2 E + \beta_3 PRs + \mu \quad (1)$$

To make the finding clearer and more precise, this model is designed under the following assumptions: 1) the relationship between GDP per capita and the independent variables is assumed to be linear; 2) the observations are assumed to be independent of each other; 3) the variance of the error term is assumed to be constant across all values of the independent variables; 4) the error term is assumed to be normally distributed. β0 is the diagonal, and μ is an accident that happens randomly.

Since each tax component may impact GDP differently, this essay adopts a multivariable regression model, as shown in (1), to capture the complex relationship between GDP growth (dependent variable) and various environmental tax components (independent variables). This multivariable approach allows us to isolate and quantify the individual contributions of each type of tax on economics with an improved accuracy and reliability of the analysis.

4 Result and Discussion

Table 2. presents the regression results for our analysis. It is clear that there is a strong positive correlation between the dependent variable and the independent variables (transport tax, energy tax, pollution tax, and resource tax). This means that sustainable economic growth and environmental taxation are closely related. Approximately 74.59% of the variation in GDP per capita can be explained by the independent variables, suggesting a reasonably good fit of the model. The adjusted R-squared value is still positive, indicating that the model explains a significant portion of the variation in GDP growth, even after accounting for the number of independent variables.

Table 2. Regression Statistics.

Regression Statistics	
Multiple R	0.863661149
R Square	0.745910581
Adjusted R Square	0.59345693
Standard Error	303.3898941
Observations	20

Table 3. ANOVA Results.

	df	**SS**	**MS**	**F**	**Significance F**
Regression	6	1351053	450351	4.8927	0.0599
Residual	10	460227	92045		
Total	16	1811280			

Table 4. Coefficients Results.

	Coefficients	Standard Error	t Stat	P-Value
Intercept	333.1381	142.8485	2.3321	0.0670
3110	0.0336	0.0157	2.1369	0.0857
8533	0.0054	0.0035	1.5633	0.1787
583	0.0154	0.0259	0.5937	0.5786

In Table 3, the ANOVA results display the F-statistic for the overall model. A significant F-statistic (p-value < 0.05) indicates that at least one of the independent variables is significantly related to the dependent variable. Here, the F-statistic indicates that the model is significant at a 10% level but not at the more conventional 5% level (since the p-value is slightly above 0.05). This suggests that the model has some predictive power, but there's a borderline significance. Table 4 suggests that a 1-unit increase in transport tax is associated with a 0.0336 increase in GDP rate of change, a 1-unit increase in energy tax is associated with a 0.00543648 increase in GDP rate of change, and a 1-unit increase in pollution and resource tax is associated with a 0.01539441 increase in GDP rate of change.

Based on this regression analysis, there is evidence to suggest that transport tax has a positive and statistically significant impact on GDP growth in the 20 countries. However, the impact of energy tax and pollution and resource tax is not statistically significant. This suggests that while transport tax may be an effective policy tool for promoting economic growth, the impact of environmental taxes may vary depending on the specific type of tax and the economic context.

5 Conclusions

Overall, the impact of environmental taxation on sustainable economic growth is profound and ongoing. This essay has examined the quantitative relationship between environmental taxation and sustainable economic growth in 20 countries. Our findings suggest that while environmental taxation can be an effective tool for promoting sustainable economic growth, the specific type of tax and its implementation may play a crucial role in determining its specific impact. The results of this study highlight the importance of the careful design and implementation of environmental taxation policies to ensure that they achieve their desired objectives while minimizing negative economic consequences. By understanding the intricate relationship between environmental taxation and sustainable economic growth, policymakers can make informed decisions to promote a more sustainable and prosperous future.

Further research is needed to explore the potential benefits and challenges of different environmental taxes in various economic contexts. This analysis is based on a sample of 20 observations, which may limit the generalizability of the findings. Future research with a larger sample size and additional variables could continue to provide more robust insights into the relationship. Moreover, it is important to note that analyzing a single year may also limit the ability to assess long-term trends and the cumulative effects of environmental taxation on economic growth. If the goal is to understand the

long-term relationship between these variables, analyzing a longer time period may be necessary.

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