

PREDICTION OF ENVIRONMENTAL TAX REVENUES BASED ON CERTAIN ENVIRONMENTAL PROTECTION PERFORMANCE

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ABSTRACT

Significantly increased number of inhabitants, the practice of irrational consumption of resources and previously established patterns of production and business have put the preservation of the environment at risk. Respectful behaviour towards environment can and must preserve limited resources not only for existing, but also for future generations. In this sense, it is necessary to increase efforts for providing its sustainability. Environmental sustainability encourages a more responsible way of organizing production and people's lives in terms of using domestic materials, reducing the amount of waste, using recycled materials, using renewable energy sources and the like. Also, concern for environmental protection encourages state authorities to enact regulations and set fees in order to prevent long-term negative consequences for the environment. From environmental protection fees, the state can generate significant income that can be used for additional investments necessary for environmental sustainability. It is necessary to make key changes in the behavior of all stakeholders, because if the awareness of environmental protection is not awakened, the concept of sustainability can be threatened. In this sense, the aim of this paper is to examine the possibility of forecasting the income from environmental protection of countries, based on some of the key performance parameters, and to provide certain recommendations for policy makers.

Keywords: environment performance, environmental tax, sustainability

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INTRODUCTION

Society's aspiration to achieve economic progress through regular life activities, as well as awareness of the environment and natural resources, are key factors for its survival. Namely, these efforts aimed at economic progress cause direct damage to the natural system and its ecological function, in a way that reduces the ability to provide multiple benefits. Here, above all, we mean that we need to provide clean air, clean water, clean and productive land, which is the basis for a responsible social and economic system.

In this sense, great attention is paid to sustainability policy. Adopted and accepted at the global level, it quickly spread to the local levels and the levels of individual countries. The 1980 World Conservation Strategy introduced the term 'sustainable development' and the concept was elaborated by the World Commission on Environment and Development (WCED), proposing the following definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [1]

For a long time, sustainable development was understood as social and economic development. However, over time, the social and economic dimension was also added to the ecological dimension, from which the concept of "three pillars" arrived. The economic and social dimensions played a significant role, but it was necessary to examine in more detail and establish a connection with the environment and its sustainability. Environmental sustainability "seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans"[2]. Also, environmental sustainability may be a set of constraints on the four major activities regulating the scales of the human economic subsystem: "the use of renewable and nonrenewable resources on the source side, and pollution and waste assimilation on the sink side" [3]. Regardless of where the environmental dimension is, it is important to establish a good relationship with others, in order to respect the basic principles and fulfill the defined requirements.

In this sense, the paper first presents literature review and the theoretical basis of the concept of environmental sustainability, then research methodology is explained in the third part of the paper, while the results of the empirical research are analyzed in the fourth part. Concluding remarks, limitations of the study and further recommendations are presented in the fourth part.

THEORETICAL BACKGROUND

During recent years, there has been a growing need for the preservation and maintenance of the environment (Environmental sustainability). The issue of preservation and maintenance of the environment is important from the aspect of the national level as well as the level of business systems and individuals. This is especially important because everyone has a responsibility towards the environment regardless of the form in which they are organized [4]. Individuals can take small and effective steps to protect the environment, such as rational use of water, reducing meat consumption and switching to products made from recycled materials. Companies, on the other hand, can focus their activities on renewable energy sources, reducing gas emissions, reducing the use of harmful materials and the like [5]. Preservation and maintenance of the environment must be approached from a multidisciplinary aspect because it implies: positioning of the environmental policy in the overall business policy and strategy; compilation of environmental accounting reports and auditing of compliance with environmental rules [6]. Therefore, multidisciplinary is necessary due to the existence of different users of information. The lack of coordination between these levels as well as the neglect of certain aspects will lead to the endangerment of certain aspects and can significantly hinder activities and efforts to preserve the environment [7].

According to the UN Environment Programme, environmental sustainability refers to making life choices that will ensure an equal or better way of life for future generations [8]. This is necessary because the increased number of the population has influenced the increased use of limited resources for the economic activity of the countries. Namely, today more than ever it is necessary to provide energy and materials. Therefore, environmental sustainability has as its primary goal the improvement of people's quality of life, and this can be achieved through the rational use of natural resources [9] This primarily refers to the initiation of initiatives aimed at mitigating the risk of environmental pollution from the use of toxic materials, waste, fuel, and the like. The focus of environmental sustainability is on six key areas [2]:

- Climate systems (covering climate and climate change, climate risk management, mitigation and adaptation),
- Human settlements and habitats (covering cities, urbanization and transport),
- Energy systems (covering energy use, energy conservation, renewable energy, energy efficiency and bioenergy),
- Terrestrial systems (covering natural and managed ecosystems, forestry, food systems, biodiversity and ecosystem services),
- Carbon and nitrogen cycles (covering sources and sinks, feedback processes and links to other systems),
- Aquatic systems (covering marine and fresh water ecosystems, fisheries, currents and biodiversity).

Environmental sustainability includes three important aspects such as economic, social and ecological development. The key parameters of environmental protection performance by aspects can be explained as follows [10]:

- Economic sustainability refers to companies and other forms of business organization. Businesses are required to use resources responsibly and efficiently. Economically, that is operational parameters refer to measuring the efficiency and effectiveness of internal processes in the company. Here, above all, we mean the measurement of changes and progress that takes place in the company after the application of the sustainability concept. [11] Economic performance parameters can be viewed from the aspect of product quality, operating costs, time and flexibility. Product quality can be measured based on rejection rate, number of defects, reworking on the manufactured products and the quantity of scarp are other operational and economic parameters to measure the impact of green lean implementation in manufacturing industries [12]. Various types of costs (inventories, work, downtime, maintenance, information processing, waste, energy, etc.) that arise from the performance of activities in the company are classified as part of operating costs, while time is estimated as delivery time, lead time, cycle time, delivery to time and other. The company's willingness to invest in the development of new technologies and products represents flexibility as an economic parameter of performance [13].
- The social aspect is mostly important for individuals and society as a whole. Social parameters of performance represent a special challenge to measure. They relate to the safety, health and satisfaction of employees and customers as a result of the socially responsible behavior of the company. Social parameters can be: human rights, satisfaction of stakeholders (employees, suppliers, consumers, social communities, etc.), health care of employees, their satisfaction with the workplace and working conditions, etc. [14]
- Ecological parameters focus on the state of planet Earth and the environment. Environmental performance parameters assess whether the activities of individuals and companies are moving in a socially and environmentally responsible direction. Several measures have been identified in the literature that should be applied if a company wants to have environmentally friendly products and processes. They refer to: reducing the energy intensity of products, reducing the use of toxic materials, examining and applying the process of material recycling, maximizing the use of renewable energy sources, and the like. Some other environmental parameters can be: efficiency of use of raw materials, use of returnable packaging, percentage of raw materials that can be recycled, measurement of energy use, water consumption, percentage of losses in relation to total production, share of recycled waste, percentage of hazardous waste, as well as measures that include CO₂ emission performance [15].

The relationship between these aspects of environmental sustainability must be properly determined and measured. Some economists propagate the idea that environmental sustainability is primarily based on economic growth, neglecting people's health and rights. This view of environmental sustainability must change because the environment and the economy are systems that must cooperate with each other and take advantage of each other.

THE ROLE AND SIGNIFICANCE OF ENVIRONMENTAL TAXES REVENUE IN ENVIRONMENTAL SUSTAINABILITY

The importance of environmental sustainability is also indicated by the fact that the United States Environmental Protection Agency (EPA) has published environmental regulations and this agency has the authority to monitor the implementation of laws in this area. Regulations are mandatory for businesses, individuals, non-profit organizations, state and local governments. Strict application of regulations creates responsibility and raises the awareness of all participants in economic activity about environmental sustainability. A problem can arise if the state infrastructure fails to perform all the defined activities and indicate the importance of environmental protection. Failure to adequately protect the environment has numerous adverse effects on the ecosystem. Uncontrolled consumption of resources leads to a disruption of the ecological balance, so ecosystems lose their resilience, which ultimately leads to a decrease in biodiversity and puts numerous species at risk of extinction. In this way, the primary role of the ecosystem is violated, which can lead to significant pollution and climate change. Thus, for example, excessive deforestation destroys the natural habitats of numerous animals and reduces the potential for minimizing the harm of CO₂ emissions. Another harmful activity that significantly affects climate change is industrial production, which leads to soil degradation and groundwater depletion, which increases the risk of increased flooding. These examples are just some of those that illustrate how the destruction of natural habitats not only reduces biodiversity but also disrupts ecosystems, some of which play an essential role in protecting our planet from environmental disasters. All these activities taken together can have immeasurable consequences for the environment [16].

As one of the good practices in the way of environmental protection, the state can determine environmental protection fees that will be paid primarily by companies that are the biggest polluters, and then on that basis generate income from environmental protection fees that can then be invested in numerous projects that will provide benefits for the environment.

In addition to the above, there are some other problems that make it difficult for the concept of ecological sustainability to be accepted and implemented in its entirety. They can be systematized as follows [17]:

- Lack of environmental awareness - a large number of people do not see the connection between their daily activities and the environment and its preservation;
- Lack of visible benefits - investments in environmental protection are not clear and precisely visible and directly measurable, so most organizations consider them unnecessary costs;
- Lack of government pressure - non-compliance must be followed with a defined clear and measurable penalty to force individuals and organizations to care about all aspects of environmental protection.

When it comes to examining significance of introducing the concept of environmental taxes revenue, Barrett and Stavins [18] emphasize the role of international agreements and fiscal tools in enhancing global environmental governance. They argue that environmental taxes, when effectively designed, can significantly influence compliance and participation in environmental protection efforts. Goulder and Parry [19] further refine this understanding by evaluating different environmental policy instruments, highlighting how the choice of fiscal tools, including taxes, impacts economic efficiency and environmental outcomes. To deepen the understanding of the specific relationship between environmental performance and tax revenues, Andersson [20] explores how environmental performance can influence the effectiveness and yield of fiscal instruments over time. Ekins and Speck [21] advocate for environmental tax reforms as a strategy for green growth, emphasizing the need for careful design and implementation of such reforms to maximize their dual benefits of environmental improvement and revenue generation. It is necessary to apply econometric models to assess the revenue impacts of indirect environmental policy instruments, demonstrating the practical application of these models in policy analysis.

This underscores the multifaceted nature of predicting environmental tax revenues based on environmental protection performance, integrating theoretical insights, empirical evidence, and advanced modeling techniques to guide future research in this critical area of environmental economics.

If the regulations are adequately implemented and the state prescribes environmental maintenance fees on the basis of which it will generate income, the benefits that the community can have are multiple [22]. First of all, it is the protection of the ecosystem, the protection of endangered species, the reduction of the effect of global warming and the like. On the other hand, at the level of one country, the benefits of complying with environmental protection regulations can be reduced electricity consumption, reduced amount of waste, use of domestic materials, use of renewable energy sources and the like [23].

RESEARCH METHODOLOGY

Based on theoretical findings presented above, the goal of our conducted research is to analyze the key variables that influence the realization of revenues from taxes for the protection of the environment of a country (Environmental tax revenues). Following the defined goal, we set up a hypothesis:

H1: It is possible to predict Environmental tax revenues based on environmental protection performances such as Domestic material consumption per capita, Production of electricity and derived heat by type, Waste treatment, National expenditure on environmental protection, Share of renewable energy in gross final energy consumpt.

Multiple regression analysis was used to assess the environmental protection performance that affects the amount of Environmental tax revenue. The initial sample included European countries whose data on environmental protection performance can be found in the Eurostat database (<https://ec.europa.eu/eurostat/data/database>) in the period from 2018 to 2022. There were 38 countries on the first list of countries for testing. As complete data were not available for the countries of the Western Balkans, the United Kingdom and some others, those countries were excluded from the research. For 2022, a large number of missing data were observed, so after the implementation of all the mentioned criteria, there were 27 European countries in the final sample whose data were observed in the period from 2018-2021. year, a total of 108 observations. According to Mijailović, Marković [22] one of the key elements in the formation of a multi-criteria model is the determination of adequate criteria for comparing alternatives.

The collected data were analyzed in the statistical package for social sciences IBM SPSS Statistics 20.0 (Statistical Package for Social Sciences - SPSS, Version 20.0), including dependent and independent variables. Environmental tax revenue was used as a dependent variable. Initially, the independent variables are Domestic material consumption per capita, Production of electricity and derived heat by type, Waste treatment, National expenditure on environmental protection, Share of renewable energy in gross final energy consumption. An explanation of the variables is given in Table 1.

Table 1. Selected variables for analysis

Variable	Explanation	Acronym
Domestic material consumption per capita	The indicator is defined as the total amount of material directly used in an economy and equals direct material input (DMI) minus exports. DMI measures the direct input of materials for the use in the economy.	DMI
Production of electricity and derived heat by type	Amount of electricity produced in one country	PEH
Waste treatment	Management of waste by waste management operations and type of material	WT
National expenditure on environmental protection	Annual amount of expenditure for protection in million euro	NEEP
Share of renewable energy in gross final energy consumpt	The indicator measures the share of renewable energy consumption in gross final energy consumption according to the Renewable Energy Directive. The gross final energy consumption is the energy used by end-consumers (final energy consumption) plus grid losses and self-consumption of power plants.	RE

Source: Authors

EMPIRICAL RESULTS WITH DISCUSSION

Conducting the analysis in the SPSS program began with the calculation of descriptive statistics for all variables. After that, the correlation coefficients were calculated to assess the strength, shape and direction of the correlation. At the end, the testing of the assumptions for the application of multiple linear regression and the selection of variables to enter the final model were carried out. Table No. 2 shows the results of descriptive statistics for the selected variables.

Table 2: Results of descriptive statistics

Variable	Number of observations	Mean	Median	Min	Max	SD
Environmental tax revenues	108	11.930,1	4.986,8	276,58	65.179	17.209,2
Domestic material consumption per capita	108	17,7866	15,9325	7,72	47,13	7,84
Production of electricity and derived heat by type	108	9.199,8	4.282,26	164,10	55.070,34	12.286,3
Waste treatment	108	10,11	10,13	6,97	12,71	1,57
National expenditure on environmental protection	108	11.037,1	3.561,5	0,1	83.102,9	17.874,3
Share of renewable energy in gross final energy consumpt	108	22,27	19,42	7,05	62,69	11,76

Source: Author's processing in SPSS

Testing the hypothesis, i.e. the prediction of Environmental tax revenues with defined variables, requires running a regression analysis. As the dependent variable is numerical as well as the selected independent variables, for the purposes of this analysis it is necessary to apply multiple logistic regression. The assumptions of the application of the regression model imply the examination of the correlation between the independent and dependent variables.

Table 3: Pearson correlation coefficient results

Variable	Environmental tax revenues	Domestic material consumption per capita	Production of electricity and derived heat by type	Waste treatment	National expenditure on environmental protection	Share of renewable energy in gross final energy consumpt
Environmental tax revenues	1	- 0,34	0,92	0,64	0,954	- 0,16
Domestic material consumption per capita		1	-0,26	0,1	-0,29	0,48
Production of electricity and derived heat by type			1	0,6	0,95	0,103
Waste treatment				1	0,6	0,043
National expenditure on environmental protection					1	-0,14
Share of renewable energy in gross final energy consumpt						1

* - ниво значајности 5%

Source: Author's processing in SPSS

The correlations indicate strong positive links between environmental tax revenues and several key environmental performance metrics. Therefore, we conducted the correlation analysis with the aim of determining the similarity of the change between the two variables, i.e. whether there is a connection between the variables and how they change. The highest statistically significant correlation is achieved by the dependent variable Environmental tax revenues with the variable National expenditure on environmental protection ($r= 0.954$) and the variable Production of electricity and derived heat by type

($r=0.92$). There is a strong positive relationship between the dependent and the mentioned independent variables, which means that with an increase in National expenditure on environmental protection and Production of electricity and derived heat by type, Environmental tax revenues also increase. There is a weak negative relationship with the variable Domestic material consumption per capita ($r = -0.34$), while there is an insignificant correlation with the variable Share of renewable energy in gross final energy consumpt ($r=-0.16$). Also, the correlation built by the variable Waste treatment with the variable Share of renewable energy in gross final energy consumption is not statistically significant, so we omitted these variables from further research.

In the next step, multicollinearity was examined, i.e. possible interconnection of independent variables. In this sense, it was necessary to examine the Variance Inflation Factor (VIF) and Tolerance. Tolerance indicates how much of the variance of a given independent variable is not explained by the variances of the other independent variables in the model. When this value is very small, it indicates a huge correlation with other variables, i.e. multicollinearity. VIF is the reciprocal of Tolerance and shows how high correlation increases the instability of the defined variables. Acceptable values for Tolerance are less than 0.10 and VIF should not exceed 10. Table 4 shows the results of multicollinearity testing.

Table 4. Results of multicollinearity testing of Coefficients^a

Model	Collinearity Statistics	
	Tolerance	VIF
Domestic material consumption per capita	.913	1.096
Production of electricity and derived heat by type	.198	1.095
National expenditure on environmental protection	.297	3.367

a. Dependent Variable: Environmental tax revenues

Source: Author's processing in SPSS

For all the variables that remained in our model, the values of Tolerance and VIF are appropriate. The multicollinearity test results suggest that while there is some correlation among the predictors, it is within manageable limits for most statistical analyses. Variable Domestic Material Consumption per Capita has very little multicollinearity, indicating its coefficient is reliable, Production of electricity and derived heat by type and National expenditure on environmental protection show more signs of multicollinearity, but their VIF values are still below the typical threshold of, meaning their coefficients should still provide meaningful insights. Despite some inter-correlation among variables, the model does not appear to be severely affected by multicollinearity, allowing for cautious interpretation of regression coefficients.

The next step of the analysis is to evaluate the model. In this, a great help is provided by r^2 ie. coefficient of determination that shows how much of the variance of the dependent variable is explained by the model. In our case, $r^2 = 0.92$, which means that the defined model explains 92% of the variance of Environmental tax revenues. The model in our example achieves statistical significance (Sig= 0,0000, $p < 0,05$).

For the purpose of testing the hypothesis, the following regression model will be used:

$$\text{Environmental tax revenues} = \beta_0 + \beta_1(\text{DMI}) + \beta_2(\text{PEH}) + \beta_3(\text{NEEP}) + \varepsilon$$

The next thing we want to find out is how much each variable in the model contributed to the prediction of the dependent variable Environmental tax revenues. For that assessment, we need standardized Beta coefficients, while for compiling the regression equation we will later use unstandardized coefficients from column B. Table 5 shows the standardized and unstandardized coefficients.

Table 5. Variables in the Equation

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	4270.470	1349.290		3.165	.002	1594.777	6946.163
Domestic material consumption per capita	-151.250	63.669	-.069	-2.376	.019	-277.509	-24.992
Production of electricity and derived heat by type	.300	.115	.232	2.622	.010	.073	.528
National expenditure on environmental protection-	.687	.086	.714	8.012	.000	.517	.858

Dependent Variable: Environmental tax revenues_a

Source: Author's processing in SPSS

Considering the Beta column, we can see that the highest coefficient is 0.714 for the variable National expenditure on environmental protection. This variable individually contributes the most to the explanation of the dependent variable in our model. The Beta coefficient for the variable Production of electricity and derived heat by type is 0.23, while the variable Domestic material consumption per capita with a beta coefficient of -0.69 contributes the least to the inclusion of the dependent variable in our model. All observed variables in the model make a significant unique contribution to the prediction of the dependent variable because Sig is greater than 0,05 ($p = 0,019$; $p = 0,010$, $p = 0,0000$).

After the conducted analysis, the model is presented below:

$$\text{Environmental tax revenues} = 4.270 - 151,25 (\text{DMI}) + 0,3 (\text{PEH}) + 0,68 (\text{NE}) + \varepsilon$$

According to our model, we can say that if we increased the amount of the variable Domestic material consumption per capita by one standard deviation, Environmental tax revenues would decrease by 151.25 standard deviation units. An increase in other variables by one standard deviation unit would increase Environmental tax revenues by 0.3 and 0.68 standard deviation units..

The model shows that while domestic material consumption per capita negatively affects environmental tax revenues, both the production of electricity/heat and national expenditure on environmental protection have positive impacts. The model appears robust, given the significance levels and the magnitude of the standardized coefficients. The confidence intervals provide additional insights into the precision and reliability of these estimates.

CONCLUSION

Environmental sustainability is a multifaceted field that integrates theoretical, empirical, and policy-oriented perspectives. It requires a holistic approach that considers ecological, economic, and social dimensions. As the challenges of environmental sustainability continue to evolve, so too must the strategies and solutions to address them. This research highlights the critical importance of interdisciplinary research, innovative policy frameworks, and the adoption of sustainable technologies to ensure a viable future for the planet. Environmental sustainability is a critical area of study that has garnered increasing attention due to the escalating challenges of climate change, resource depletion, and ecosystem degradation.

Better environmental protection performance not only enhances ecological health but also influences the economic dynamics of environmental taxes. By studying a range of variables from policy implementation to public compliance and ecological outcomes, we intended to develop a robust model that predicts environmental tax revenues based on these factors. Our research draws on a comprehensive dataset encompassing various countries and regions, integrating diverse environmental protection indicators seeking to unravel the complex interdependencies between environmental protection achievements and the resultant financial returns from environmental taxes. Certainly, some limitations of the study arised, in the

fact that it covers only certain number of European countries within short period of time having some incomplet data, but still providing relevant conclusions.

The future of environmental sustainability research is focused on innovation, technology, and interdisciplinary approaches. Technology and innovation play a crucial role in advancing sustainability. The findings of this study are expected to offer valuable insights for policymakers, enabling them to fine-tune environmental tax structures and optimize revenue generation while achieving desired ecological outcomes. This work contributes to the broader discourse on sustainable fiscal strategies, highlighting the interplay between economic instruments and environmental stewardship. Policies should be designed to encourage reductions in domestic material consumption per capita, as this study reveals its negative impact on environmental tax revenues. Encouraging recycling and the use of sustainable materials can be effective and also governments should promote investments in renewable energy infrastructure and incentivize energy-efficient production methods. The strong positive impact of national expenditure on environmental protection on tax revenues suggests that increasing these expenditures can be financially and environmentally beneficial. Targeted investments in areas that yield high returns in terms of environmental health should be prioritized. By adhering to these recommendations, policymakers can more effectively harness the potential of environmental taxes to achieve sustainable development goals while ensuring economic stability and growth.

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