The Relationship Between the Environmental Tax Revenues and the Greenhouse Gas Emission in Romania

Liviu Andrei Toader
Florentina Chițu
The Bucharest University of Economic Studies, International Business and Economics Doctoral School, Romania
liviutoader2005@yahoo.com
florentina.chitu@rei.ase.ro
Dorel Mihai Paraschiv
The Bucharest University of Economic Studies, The Faculty of International Business and Economics, Romania
dorel.paraschiv@ase.ro

Abstract

In order to meet the Paris Agreement target, mankind must reduce greenhouse gas emissions to unprecedented levels by 2030. Major global shifts towards a low-carbon economy and transformations of financial systems in each country are expected, changing new financial structures and processes, involving national governments, central and commercial banks, investors and financial actors. Romania has among the lowest environmental tax revenues as a percentage of GDP, according to Eurostat, and energy taxes are the most important category of environmental taxes, followed by transport taxes, pollution and resource exploitation taxes, etc. In this paper we aim to see the relationship between environmental tax revenues and greenhouse gas emissions in Romania, using correlation and regression analysis. The results of the study validate the main hypothesis, that is a strong inverse significant relationship between the two variables analysed and serve as a basis for further research on environmental taxes and charges in a given country (their amount and percentage of the country's GDP) and the evolution of greenhouse gas emissions (progress towards their reduction).

Key words: greenhouse gas emissions, revenues, taxes, Romania
J.E.L. classification: H23, E01, F64, P28

1. Introduction

Climate change and the negative impact of greenhouse gas emissions have become extremely important global issues. In this context, environmental taxes have become an effective way of analysing and evolving these issues by promoting reduction and stimulating the adoption of more sustainable practices.

At EU level, environmental taxes are defined as taxes whose tax base is a physical unit or indicator of something that has a proven and specific negative impact on the environment. As far as environmental tax revenues are concerned, they come from 4 types of taxes, the same as in Romania, as an EU Member State, namely: energy taxes, transport taxes, pollution taxes and resource taxes (European Commission, 2023).

The report published by the European Environment Agency in February 2022 and amended in January 2023 on the role of environmental taxation analyses both the trends in taxes and their ability to increase state revenues through a comparison with previous years, and the potential increase in revenues from energy taxes in the hope of achieving the EU's goal of becoming climate neutral.

In the EU, environmental taxes account for 5.9% of total taxes, down from 6.6% almost 20 years ago (EEA, 2023). Romania has historically performed rather poorly in complying with EU environmental directives (Radulescu, M., et al., 2017), this is supported today by the fact that total environmental tax revenues represent 1.96% in 2021, less than the EU average of 2.24% (Eurostat[1], 2023).

2. Literature review

A study published in 2007 (Sterner), highlights the positive long-term effect of introducing higher taxes on key environmental issues, claiming that carbon emissions will be cut in half.

According to the arguments presented by Ezcurra and Jessen (2015), they argue that environmental taxation can be a more efficient tool in stimulating sustainable economic development, but provided that it is accompanied by a system of government support for energy efficient areas.

In order to achieve an effective and efficient climate transition at country level, according to the National Macroprudential Oversight Committee (NMOC) Working Group on Supporting Green Finance, several implementation measures are proposed such as the development of sectoral decarbonisation plans through the development of public and private sector climate partnerships, as well as the development of climate partnerships with business in economic sectors that contribute significantly to greenhouse gas emissions (especially methane and carbon dioxide) with a view to setting long, medium and short-term targets (Presidential Administration, 2023).

According to International Energy Agency (IEA) estimates, about two-thirds of the carbon dioxide emission reductions in the 'sustainable development scenario', which assumes net zero emissions by 2070 (less ambitious than the EU's policy goal of achieving climate neutrality by 2050), come from technologies that are adopted but still in a developmental stage (IEA, 2020).

According to IRENA (International Renewable Energy Agency), there are six emerging or already available technology areas that require large-scale deployment or further investment in research and deployment to reduce greenhouse gas emissions by 2050 in line with the targets set by the Paris Agreement, such as: renewable energy, energy efficiency, hydrogen, bioenergy combined with carbon capture and storage, electrification of sectors of the economy that use fuels other than electricity, and storage of carbon emitted by fossil fuels (IRENA, 2022).

The IPCC 2022 report argues that there are various mitigation options that can be implemented on a large scale and in the short term, such as solar energy, wind energy, electrification of urban systems, green urban infrastructure, energy efficiency, energy demand management, improved management of forests, crops and grasslands, reduction of waste and food losses.

2.1 Evolution of the environmental tax revenues in Romania

Greater harmonization between countries has been justified by the need for common environmental regulation within the European Union, primarily as a response to pollution that transcends national boundaries (Sterner & Köhlin, 2004). European governments, aiming to establish more efficient tax systems and safeguard the environment, have recognized taxation as an instrument of environmental policy. Unlike traditional taxes primarily intended for revenue generation, environmental taxes are specifically designed to influence the behaviour of economic entities, including households and businesses (Delgado et al., 2022). Environmentally related taxes can also be utilized as a significant tool to influence the relative prices of goods and services. The characteristics of these taxes, including factors such as revenue, tax base, tax rates, exemptions, and more, are used to compile the environmentally related tax revenues. These revenues are categorized by various environmental domains, which encompass energy products (including vehicle fuels), motor vehicles and transport services, measured or estimated emissions to air and water, ozone-depleting substances, certain non-point sources of water pollution, waste management and noise, as well as the management of water, land, soil, forests, biodiversity, wildlife, and fish stocks (European Commission, 2013).

Governments can utilize the revenue generated from environmental taxes to fund projects aimed at environmental protection and the efficient management of natural resources. The environmental taxation regime in Eastern European countries serves as a successful example of this approach (Tsiantikoudis et al., 2022). Through the implementation of appropriate policies and actions, these countries have demonstrated resilience in tackling environmental degradation, restoring previously degraded lands, and funding programs to disseminate environmental information among local communities.

According to Eurostat[1] (2023), in 2021, the total environmental tax revenues in Romania represented around 1,96% of GDP, less than the EU's average of 2,24%.

Table no. 1 Evolution of the total environmental tax revenues in Romania (2012-2021)

Year	**Total environmental tax revenues in Romania** (mil. EUR) – variable ETR	**Year-Over-Year Growth** (% ETR_t / ETR_{t-1})	**Percentage of GDP** (%)
2012	2.667,48	-	1,91
2013	2.957,48	+10,87	2,07
2014	3.587,37	+21,30	2,38
2015	3.951,84	+10,16	2,47
2016	4.085,32	+3,38	2,44
2017	3.640,19	-10,90	1,95
2018	4.033,56	+10,81	1,96
2019	4.731,69	+17,31	2,11
2020	4.196,21	-11,32	1,90
2021	4.729,78	+12,72	1,96

Source: (own calculations based on data from Eurostat[1], 2023)

Since 2012, the total environmental tax revenues in Romania has increased by more than 77%, from €2.667,48 million in 2012, to € 4.729,78 million in 2021. However, the corresponding percentage of GDP registered a growth up to 2,44% and decreased back to 1,96% in 2021.

2.2 Greenhouse gas emissions in Romania

Within the framework of the European Green Deal (European Commission, 2019), the European Union has embraced ambitious targets to decrease greenhouse gas emissions, while also prioritizing the reduction of pollution and the promotion of a circular economy (Parravicini et al., 2022). In line with European climate legislation, the European Union has made a commitment to reduce emissions by a minimum of 55 percent below 1990 levels by 2030. This sets the stage for the EU to achieve its target of attaining a net-zero greenhouse gas emissions economy by 2050 and advancing towards a more sustainable and environmentally friendly future.

As stated by the Kyoto Protocol guidelines, greenhouse gases encompass a total of seven gases, namely carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and four fluorinated gases (F-gases). Each of these greenhouse gases remains in the atmosphere for varying durations, but the carbon dioxide is the most prevalent greenhouse gas released as a result of human activities (Kijewska & Bluszcs, 2016).

In 2021, greenhouse gas emissions in the European Union experienced a decrease of approximately 5,4% compared to the reduced levels caused by the COVID-19 pandemic in 2020, reaching a total of 3,54 billion tons. Despite this increase, emissions remained below the levels observed before the pandemic and were approximately 29% lower than the emissions recorded in 1990. Several factors have contributed to these reductions, including the implementation of policies and regulations, improvements in energy efficiency, and the establishment of the EU Emissions Trading System (European Commission, 2023). However, a significant driver of these reductions

has been the gradual phase-out of coal-fired power plants, which have been replaced by natural gas and renewable energy sources. As a result, emissions from the energy supply sector have decreased by over 40% since 1990. Although coal power carbon dioxide emissions have increased since 2020 due to the recovery from the COVID-19 pandemic and the Russia-Ukraine conflict, they are still nearly 40% lower than the levels observed a decade ago. Nevertheless, the energy supply sector remains the largest contributor to greenhouse gas emissions in the EU, with all of the most polluting facilities currently being coal-fired power plants, according to a Statista report (2023)

Table no. 2 Evolution of the greenhouse gas emissions in Romania (2012-2021)

Year	**Total greenhouse gas emissions in Romania** (excluding LULUCF and memo items, including international aviation, million tonnes) – variable GGE	**Year-Over-Year Growth** (% GGE_t / GGE_{t-1})
2012	131,10	-
2013	119,22	-9,06
2014	118,84	-0,32
2015	117,82	-0,86
2016	116,19	-1,39
2017	119,37	+2,74
2018	119,65	+0,23
2019	116,22	-2,86
2020	112,18	-3,48
2021	115,65	+3,10

Source: (own calculations based on data from Eurostat[2], 2023)

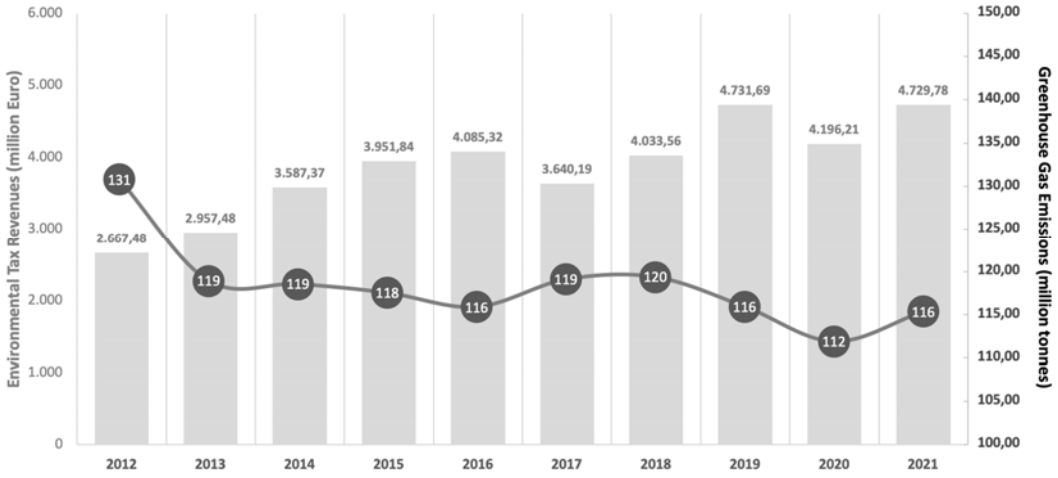
According to Eurostat[2] (2023), in 2021, Romania's greenhouse gas emissions accounted for less than 3,3% of the total emissions in the European Union. Since 2012, the greenhouse gas emissions in Romania experienced a decrease by approximately 11,8%, corresponding to 15,44 million tonnes.

3. Research methodology

Environmental taxes can contribute to reducing greenhouse gas emissions by discouraging activities that emit high levels of greenhouse gases. Higher tax rates on carbon-intensive industries or products can encourage businesses to invest in cleaner technologies, adopt energy-efficient practices, and shift towards low-carbon alternatives. Environmental taxes are levied on activities or products that have negative environmental impacts. The revenue generated from environmental taxes can be allocated towards environmental initiatives, including investments in renewable energy, energy efficiency programs, research and development of clean technologies, and other measures to mitigate greenhouse gas emissions. This allocation of funds can further support the reduction of emissions and the transition to a more sustainable economy.

Therefore, we can formulate the following research hypothesis *(H): There is a negative correlation between the evolution of greenhouse gas emissions and the evolution of the environmental tax revenues in Romania.*

Figure no. 1 Evolution of the environmental tax revenues and greenhouse gas emissions in Romania (2012-2021)



Source: (Eurostat[1], 2023 and Eurostat[2], 2023)

Figure no. 1 shows the combined evolution of the environmental tax revenues (expressed in million Euro) and greenhouse gas emissions (expressed in million tonnes) in Romania for 2012 – 2021 (latest data available). The current analysis refers to data available from 2012 to 2021 and was performed using XLSTAT® statistical and data analysis solution.

The relationship between the environmental tax revenues (variable ETR) and greenhouse gas emissions (variable GGE) in Romania was determined using correlation and regression analysis. A general probabilistic model for simple linear regression was used for this purpose:

$$GGE_t = \beta_0 + \beta_1 \times ETR_t + \varepsilon_t$$

Where GGE_t represents the dependent variable (greenhouse gas emissions in Romania, in million tonnes), ETR_t represents the independent variable (environmental tax revenues, in million Euro), β_0 and β_1 are the coefficients of the regression function and ε_t is the residual component for the time series, t.

4. Findings

After researching the literature review on environmental tax revenues and greenhouse gas emissions, in order to test the research hypothesis and determine the nature of the relationship between the two variables, a visual inspection on the available time series data for Romania (2012 – 2021) was performed, followed by Pearson correlation and regression analysis.

Table no. 3 Normality tests for the model's variables

	Shapiro-Wilk test	
	GGE	*ETR*
W	0,798	0,938
p-value (two tailed)	0,014	0,530
alpha	0,05	0,05
Test interpretation: *H0: The variables follow a normal distribution; Ha: The variables do not follow a normal distribution. If the computed p-value is greater than the significance level alpha = 0,05, one cannot reject the null hypothesis H0. If the computed p-value is lower than the significance level alpha = 0,05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.*		

Source: (own, using XLSTAT®)

Figure no. 2 Pearson correlation analysis

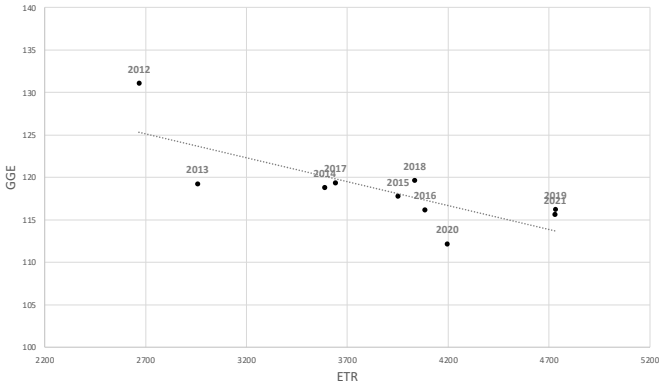
Pearson correlation matrix:

Variables	*GGE*	*ETR*
GGE	**1**	**-0,765**
ETR	**-0,765**	**1**

p-values:

Variables	*GGE*	*ETR*
GGE	0	0,010
ETR	0,010	0

Correlation is significant
for p-value < $\alpha = 0{,}05$.



Source: (own, using XLSTAT®)

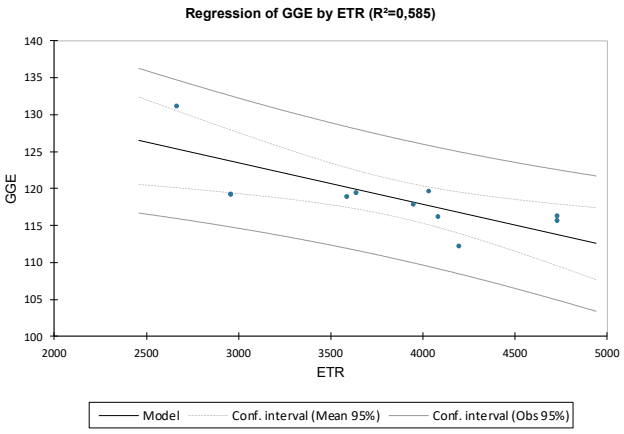
The correlation analysis performed demonstrates the existence of a linear strong negative relationship between the environmental tax revenues (variable ETR) and the greenhouse gas emissions (variable GGE) in Romania, as shown in Figure no. 2.

The Pearson correlation coefficient used to determine the statistical correlation between the two data series (r=-0,765) indicates a negative linear correlation of high intensity (Rodgers & Nicewander, 1988), being statistically significant for a significance level of 5%, p-value < $\alpha = 0{,}05$).

Figure no. 3 Regression analysis

Regression of variable GGE
Goodness of fit statistics:

Observations	10
Sum of weights	10
DF	8
R^2	0,585
Adjusted R^2	0,533
MSE	11,427
RMSE	3,380
MAPE	2,045
DW	2,356
Cp	2,000
AIC	26,129
AICC	27,843
SBC	26,734
PC	0,623



Analysis of variance (GGE):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	1,000	128,850	128,850	11,276	**0,010**
Error	8,000	91,419	11,427		
Corrected total	9,000	220,269			

Note: Computed against model Y = Mean (Y).

Model parameters (GGE):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	140,311	6,546	21,434	**<0,0001**	125,216	155,407
ETR	-0,006	0,002	-3,358	**0,010**	-0,009	-0,002

Source: (own, using XLSTAT®)

The regression model used to analyse the relationship between the environmental tax revenues (variable ETR) and the greenhouse gas emissions (variable GGE) in Romania, as illustrated in Figure no. 3, has the following equation:

$$GGE_t = 140{,}3115 - 0{,}0056 \times ETR_t$$

The model (Figure no. 3) explains 58,5% of the variation of greenhouse gas emissions in Romania ($r^2 = 0{,}585$) and is statistically significant for a significance level of 5%.

The results of the statistical model validate the research hypothesis and show a significant inverse strong relationship between the evolution of greenhouse gas emissions and the evolution of the environmental tax revenues in Romania for the analysed period. Moreover, according to the research model, an increase with 1 percentage point of the total environmental taxes in Romania might determine a decrease in the greenhouse gas emissions by 0,0056 percentage points. The result can be used as a general guideline for estimating the future impact of environmental taxation policies on the greenhouse gas emissions in the context of the European Union's commitment to build a more sustainable and environmentally friendly future by achieving a net-zero greenhouse gas emissions economy by 2050.

5. Conclusions

Environmental taxes in EU member countries are designed to reduce pollution and its negative effects on the environment and at the same time provide economic incentives to promote sustainable activities, reducing greenhouse gas emissions.

In conclusion, the results obtained from the statistical analysis confirm the research hypothesis and demonstrate the existence of a significantly inverse relationship between the evolution of greenhouse gas emissions and the evolution of revenues from environmental taxes in Romania over the period analysed.

The results of the study highlight the country's efforts to raise its environmental standards, with environmental tax revenues increasing steadily in recent years and the implicit energy tax rate remaining lower than the EU average, indicating that Romania is an energy-consuming economy and has great potential to improve energy efficiency.

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