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EFICIENCY OF ENVIRONMENTAL TAXES IN THE EUROPEAN UNION

Summary: *This research will attempt to give a theoretical contribution on the basis of the fundamental postulates of the empirical findings of other authors, who examined and tested the efficiency of environmental taxes and their abundance, and by verifying the new findings in this field. Taking into consideration the findings of other authors and the new findings obtained in this research, we have defined the following research question, to which we will try to provide an answer:*
Does the introduction of environmental taxes in the EU countries have any effect on the reduction in pollution, reduction in CO2 emissions, reduction in the production and consumption of energy?
By answering this question, we will assess whether the environmental taxes in the EU are efficient. In order to examine and test this correlation, we used the available secondary data on the environmental taxes and pollution in the EU. The data were taken from the official EU statistics, Eurostat, for the period from 2007 to 2015, and the data are therefore accessible in this database.
After collecting and analysing the data, we used the correlation and regression method to test the correlation between the total environmental taxes collected at the EU level, which represent the independent variable, and the household energy consumption, CO2 emissions and primary energy production, which represent the dependent variables. The paper examined whether higher income from environmental taxes reduces the energy consumption and the emissions of harmful CO2 in the environment. By using the correlation and regression method, we came to the conclusion that the environmental taxes in the EU in the period from 2007 to 2015 had an effect on reducing the production and consumption of energy and on CO2 emissions.

Key words: *environmental taxes, emissions, European Union, pollution*

JEL classification: *H23*

INTRODUCTION

Environmental taxes represent a modern form of tax, which is introduced in tax systems, and their objective is to exert influence on the behaviour of business entities, but also of natural persons towards the environment. Specifically, the introduction of environmental taxes aims at preventing the deterioration of the environment. The intensive use of natural resources in the last several decades has left a human footprint on the ground, which is reflected through the exhausted and destroyed natural resources. For these exact reasons, the number of countries paying attention to environmental management and protection has been increasing. All the EU countries have implemented certain instruments, environmental taxes, charges and similar levies with a view to establishing and implementing the EU environmental policy.
The first European country which introduced environmental taxes was Sweden, which implemented these taxes in 1990. The primary objective was to stimulate employment. The key principle of these reforms was orientated towards the reduction of the labour tax (Heine et al. 2012). Several years after these measures, the other EU countries also started introducing environmental taxes. The first reform in this domain was implemented in April 1999, and the

next steps were taken between 2000 and 2003. The primary objective of the introduction of such taxes in Germany was to reduce the energy consumption and the harmful gas emissions in the environment, and to promote the new technologies and increase the investments in innovations. The income from these taxes were used as a contribution to the pension insurance (Bach et al. 2002). At the same time, these measures resulted in a significant number of new jobs (around 250,000 jobs in 2003), i.e. in the growth of around 0.75% (European Environment Agency 2011). The analysis of the literature in the field of economics which studies the framework of environmental taxes shows that these taxes are mainly introduced with a view to avoiding and overcoming the problems in the environment, such as pollution or climate change. Such instruments are classified as a mechanism based on incentives, because it is suggested that taxes create incentives for companies, individuals and agents to refrain from pollution above the level which is "socially acceptable" by internalising the external costs. These taxes may be much more efficient than so-called command and control mechanisms, while the administrative costs of these taxes tend to be lower.

Pollution is an example of a negative externality which should be corrected, whereby taxes, fees and charges may affect the polluters to internalise the costs of pollution and to include them in the prices of their products and services, by which they transfer them to the final buyers. It means that consumers, due to higher prices, would use such products to a lesser extent, which would result in their lower production. Nevertheless, such debates and flows are much more complex in practice. It is not easy to reach a socially optimum outcome, and there is no clear formula for the introduction of an efficient tax rate (Parry and Small 2004). Apart from that, some studies have revealed that environmental taxes may also have some negative and unwanted effects. For example, Wier et al. (Wier et al. 2005) came to the conclusion that the environmental taxes in Denmark had unwanted effects in terms of the distributional effect, and these taxes therefore proved to be regressive. Other authors in Sweden (Brannlund and Nordstrom 2004) and the USA (West and Williams 2004) had similar findings. Such findings strengthen the importance of the compensatory mechanism which should be adopted along with the introduction of these taxes.

Environmental taxes also have the political costs which complicate their implementation. Nevertheless, the countries introduced these taxes, although they were not introduced for the reason of preservation of the environment, but they treated them in a similar manner as the taxes for the environment. One of the most frequent forms of these taxes are taxes on the use of fossil fuels (petroleum and gasoline), which are widespread, often because they ensure a high level of fiscal income (Miller and Vela 2013).

The efficiency and the distributional effects of these taxes have been analysed and examined in many studies. Nevertheless, environmental taxes are permanently restricting agents in economy, which may affect the consumption of fossil fuels and the consumption of other pollutants.

This research gives an overview of the empirical findings of other authors, who examined and tested the efficiency of environmental taxes, as well as their abundance. Taking into consideration the findings of other authors, we define the following research question to which we will try to provide an answer:

- Does the introduction of environmental taxes in the EU countries reduce the pollution by reducing CO2 emissions and reducing the level of production and consumption of energy?

By answering this question, we will assess whether the environmental taxes in the EU are efficient. The tax forms and tax rates of environmental taxes vary from country to country.

While some countries introduce high rates of these taxes, as part of their environmental policy, other countries may provide high subsidies for the use of fossil fuels or the use of some other pollutants, i.e. they may behave in a completely opposite manner (Miller and Vela 2013). These differences are quite easily detected when the income level is compared on the basis of environmental taxes. When analysing the available studies on the efficiency of

environmental taxes, it is evident that there are findings which confirm their efficiency, i.e. which verify that the introduction of environmental taxes may result in efficient pollution control, although there are different findings as well. Guided by these findings, we have decided to examine the level of abundance of the environmental taxes in the EU countries, i.e. to explore whether the environmental taxes in the EU have an effect on reducing pollution.

1. METHODOLOGY

In the research and the development of the research, we used several scientific research methods. We applied the inductive-deductive method, which represents the method of conclusion and verification (Duvnjak 2018). The inductive method represents systematic application of the inductive manner of conclusion, whereby the analysis of individual facts results in the conclusion on the general judgment, and the perception of specific individual cases results in drawing general conclusions. The deductive method represents systematic application of the deductive manner of conclusion, whereby specific and individual conclusions are drawn from general judgments.
The analysis method was also used in the research. It is the procedure of scientific research through a breakdown of the complex notions, judgments and conclusions in their smaller integral parts and elements.
The comparative method was also applied in the research, in order to detect similarities, joint features or differences between events, occurrences or objects. The data were analysed using the statistical method of correlation and regression.
In order to answer the research question, we took the available secondary data from the official Eurostat statistics. We also used the data on the total CO2 emissions for all the EU countries, and the data for the collected taxes on the basis of CO2 emissions at the EU level. Emissions of CO2 are viewed through the following three variables:

- Household energy consumption at the EU level;
- Total CO2 emissions for all the EU countries;
- Primary energy production at the EU level.

The analysed period is the period from 2007 to 2015. The data were analysed using the statistical method of correlation and regression. The independent variable referred to the collected environmental taxes at the EU level in the analysed period, while the dependent variables included the household energy consumption at the EU level, the total CO2 emissions for all the EU countries and the primary energy production at the EU level. The relation between the analysed variables was tested by correlation, and the strength of the relation was tested by regression. It is of crucial importance to examine whether higher income from environmental taxes results in reducing the energy consumption and the emissions of harmful CO2 in the environment

2. RESEARCH RESULTS

2.1. Overview of literature

2.1.1. Development of the environmental tax policy in the EU

The economic instruments, including the taxation policy, may assist the policymakers in the path towards satisfying the objectives set in the environmental policy. The efficiency of the economic instrument depends on the selected instruments which are implemented (Costantini and Mazzanti 2012). The EU is the world leader in designing, approaching and implementing strict environmental policies (Costantini and Mazzanti 2012). Nevertheless, there have been numerous concerns and potential unwanted effects of the impact of the tax reform and the

introduction of environmental taxes on employment, income distribution, economic growth and export. The efficiency of the introduction of environmental taxes depends on several components: tax base, tax rate, tax policy (Costantini and Mazzanti 2012).
The design of environmental taxes (i.e. the application of tax rates, the manner of application, and the scope) and their implementation are different among the EU countries. The differences among the countries are mostly the result of the applied approach. Some countries focus on a narrow tax base, while other countries adopt a much broader base (Institute for European Environmental Policy 2013).
For example, most EU countries apply taxes on cars, i.e. on fuel consumption, as one of the most important elements of the environmental policy, which attempts to reach the target level in the climate policy. Lithuania and Estonia are two countries which have not applied taxes on cars. Poland and Bulgaria use taxes on cars, but without differentiation in relation to harmful CO2 emissions. Based on that, the European Commission believes that these four countries may expand their tax base by including taxes on cars in their tax system. That could also help them in terms of the reduction in CO2 emitted by cars.
The same environmental taxes, as well as taxes on CO2 emissions, should be applied to all taxpayers and to all energy products, with a view to ensuring the effectiveness of the economic sector.
In any case, the practice among the countries and the tax models is different. The significantly different application of environmental taxes among the EU member countries actually shows that there is no harmonisation in this segment (Kurtinaitytė-Venediktovienė et al. 2014).
The evolution of environmental taxes in the EU is one of the crucial, i.e. one of the most important issues in the part of approach and efficiency of the environmental policy. Table 1 shows the development of the environmental tax policy in the EU in the last four decades.

Table 1. Chronology of environmental taxes (Kurtinaitytė-Venediktovienė et al. 2014)

User costs					
Allocated costs					
Fiscal environmental taxes					
Environmental tax reforms					
Green tax commissions					
EU 2020 Strategy					
Years	*1970*	*1980*	*1990*	*2000*	*2020*

The user charges and the allocated costs predominated until the middle of the 20th century, which represents the initial environmental policy steps. During the period 1990-2000, the focus was shifted to fiscal tax frameworks and environmental taxes, and environmental reforms. The two key objectives of these activities were promotion of public and political discussions on the environment and the economic significance, as well as the use of communication activities with a view to developing a comprehensive framework of the tax reform in the domain of the environment. In that context, the “green tax commissions” had an important role in providing support for this system in many countries (European Environment Agency 2010). As of 2010, there has been an increased emphasis on the orientation towards the EU 2020 Strategy. The primary objective of the EU 2020 Strategy is inclusion of the

economic, social and environmental agendas in a common successful mode. This strategy is based on the following (Council of the European Union 2010):

- Employment rate of 75% of the able-bodied population;
- 3% of the EU's GDP should be invested in research and innovations;
- The "20/20/20" is the climate and energy target (cut in greenhouse gas emissions by at least 20%, an increase in the share of the final consumption of energy from renewable sources by 20%, and the satisfactory energy efficiency ratio of 20%);
- Improvement of the education level (a decrease in the number of early school leavers, and an increase in the number of people who have completed a tertiary or equivalent education);
- Promotion of social inclusion, including the reduction of poverty.

2.1.2. Difficulties in the implementation of environmental taxes

According to some studies, the barriers in the implementation of environmental taxes are mainly cognitive and behavioural (Dresner et al. 2006). These findings show that the very term "tax" is perceived with a negative connotation, and that such are also its effects on public perception and acceptance in terms of the environmental framework.

Other authors came to similar conclusions (McCaffery and Baron 2003), who tested the very term "tax" in their research and concluded that whenever something is labelled as a tax, it often causes a negative attitude of people towards it.

The research conducted by Kallbekken and Aasen aimed at comparing the environmental tax schemes with different options of income redistribution (Kallbekken and Aasen 2010). The research results indicate that there are no major differences in popularity between the schemes due to a surprisingly high number of votes against the tax. Moreover, almost one half of the voters opposed to the tax schemes, which would even bring them material benefit and increase the overall benefit. Apart from such cases of opposition to taxes, another barrier which occurs is the barrier of a political nature. In terms of political determinants, many studies emphasised the importance of the government's trust in the acceptance and introduction of the environmental tax. Clinch (Clinch 2006) conducted research in which he analysed the political issue of the environmental tax, and he concluded that there was lack of the Government's trust, which is the key barrier in all the countries as regards the introduction of environmental taxes, and which is particularly pronounced when analysing the income collected through taxation.

Irrespective of the existing theoretical consensus on the economic and environmental rationalities in terms of environmental taxes, the implementation of this tax and the law, as well as the results of their application, are still limited by numerous problems related to political and public acceptance. Indeed, many initiatives towards the taxation of CO2 emissions through taxes did not have sufficient support among the public and the politicians due to the opposing attitudes – while one side opposes the increase in taxes and the increase in the funds for the implementation of the climate policies, the other side expresses doubts about the effectiveness of this fiscal instrument (Sénit 2012).

The limitations of the efficient application and implementation of environmental taxes are primarily of a cognitive nature and they are associated by how policymakers traditionally envisage taxation (which is primarily guided by budget initiatives). The low level of acceptance of the taxation of environmental taxes, and particularly the tax on CO2 emissions, is also the result of political decisions and technical design of instruments. In France, for example, the modality of this form of taxation refers to the tax base and the recycling mechanism, which is agreed upon by the government, while the simultaneous improvement of the political feasibility opens the path for endless discussions on the justifiability of taxation, as well as the deterioration of the social acceptance of the tax. Finally, the political factors, such as administrative conflicts and poor marketing by the politicians on this issue, had a

great deal of influence on the poor acceptance of the policy of taxation of CO2 emissions in France (Sénit 2012).

2.1.3. Effectiveness of environmental taxes

If the available literature on the effects of environmental taxes on the environment is analysed, they mainly come to taxes on the harmful CO2 emissions, which is charged for fossil fuels and other products based on their carbon content, with a view to reducing CO2 emissions.
Bruvoll and Larsen conducted research in which they analysed the effects of carbon taxes on the level of emissions of this gas in Norway (Bruvoll and Larsen 2004). They came to the conclusion that the introduction of the tax on CO2 emissions had a moderate effect on the reduction in CO2, and that it contributed to the reduction in this emission by 2%. The emission reduction per unit of GDP is significant, but the main effect was still in the part of the reduction in the energy intensity and the emission process.
The main argument shared by most of the studies is that the introduction of the tax on CO2 has zero positive effect on the environment, if these taxes are accompanied by taxes on energy intensive industries and if they are applied in sectors with a high level of inelastic demand (Miller and Vela 2013).
In the studies conducted with a view to estimating the effects of the taxes on the use of energy and CO2 in the tax system of Japan, the authors Nakata and Lamont support the idea that these taxes are an appropriate instrument for the reduction in CO2 emissions (Nakata and Lamont 2001).
Wissema and Dellink conducted similar research on the example of Ireland and they came to the conclusion that the reduction in CO2 emissions by 25% as of 1998 may be reached by introducing the tax on CO2 in the amount of 10 to 15% per tonne of CO2 (Wissema and Dellink 2007). Di Cosmo and Hyland also analysed the case of Ireland, but they used a different scenario for taxes with a view to determining the effects of energy demand and CO2 emissions (Di Cosmo and Hyland 2011). In the scenario in which the tax on CO2 increases to 21.5 euros in 2012, and to 41 euros in 2025, the authors came to the conclusion that CO2 emissions are reduced by 861,000 tonnes in comparison with the case when the tax on CO2 emissions is not applied.
Some authors emphasise the importance of tax on fossil fuels. For example, Sterner showed that there was a positive correlation, i.e. a positive long-term effect, between the tax on fossil fuels in Europe and the decrease in the demand for these fuels, as well as the reduced CO2 emissions (Sterner 2007). The author explains that the CO2 emissions were reduced by more than one half after the introduction of high rates of the fuel tax, while the content of CO2 in the atmosphere was reduced by more than 1 ppm. Similarly, Yan and Crookes explain about the importance of the research in which they analysed the effect of the tax on fossil fuels and the effect on the increase in the use of vehicles and the energy demand in China (Yan and Crookes 2009). According to their findings, the introduction of the tax leads to a decrease in the energy demand by 16.3%, a decrease in the gasoline demand by 18.5%, and a decrease by 16.2% in GHG emissions by 2030 in comparison with the standard situation and scenario.

2.2. Empirical research results

After analysing the available literature, which indicates that environmental taxes may or may not have an impact on the reduction in pollution, we examined if the environmental taxes in the EU were abundant in terms of reducing the use of energy. By applying the method of regression and correlation, we examined if there is any relation between the total environmental taxes collected at the EU level and the level of CO2 emissions, as well as the levels of production and consumption of energy in the EU countries.

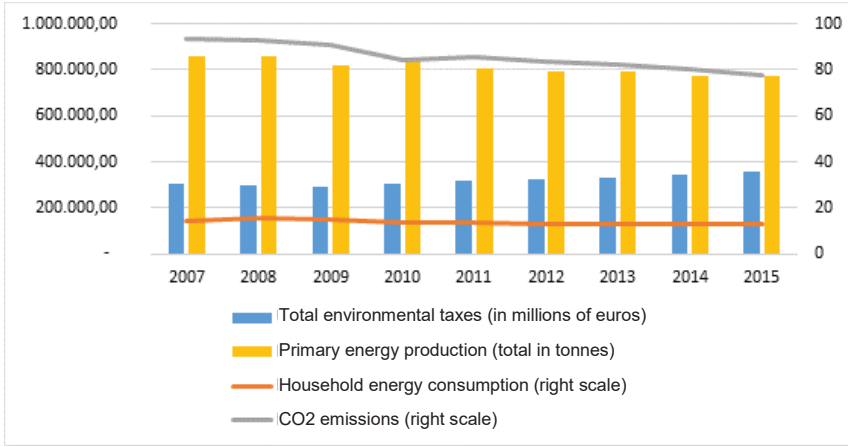

Image 1. Environmental taxes, CO2 emissions, production and consumption of energy in the EU from 2007 to 2015 (Eurostat)

The total environmental taxes, i.e. the total value of the collected environmental taxes increased gradually during the observed period, as shown in the given image. The primary energy production was on a downward trend, as well as the household energy consumption and the CO2 emissions. By analysing such a presentation, it is possible to come to the conclusion that the environmental taxes contributed to the reduction in the emission of harmful substances in the environment, i.e. it is suggested that the environmental taxes were abundant. The relation between these variables was tested by correlation and regression. Table 2 shows the matrix of correlation between the analysed variables.

Table 2. Correlation matrix (Author)

	Total environmental taxes	Household energy consumption	CO2 emissions	Primary energy production
Total environmental taxes	1,000			
Household energy consumption	-0,831	1,000		
CO2 emissions	-0,890	0,910	1,000	
Primary energy production	-0,866	0,871	0,898	1,000

There is a high negative correlation between the environmental taxes and the level of household energy consumption, CO2 emissions and primary energy production. It means that the growth in the environmental taxes results in the reduction in the use of energy and the level of emissions of harmful substances in the environment. After confirming that there is a strong negative correlation, a regression analysis was conducted to examine the strength and the direction of this relation, as shown in the images below.

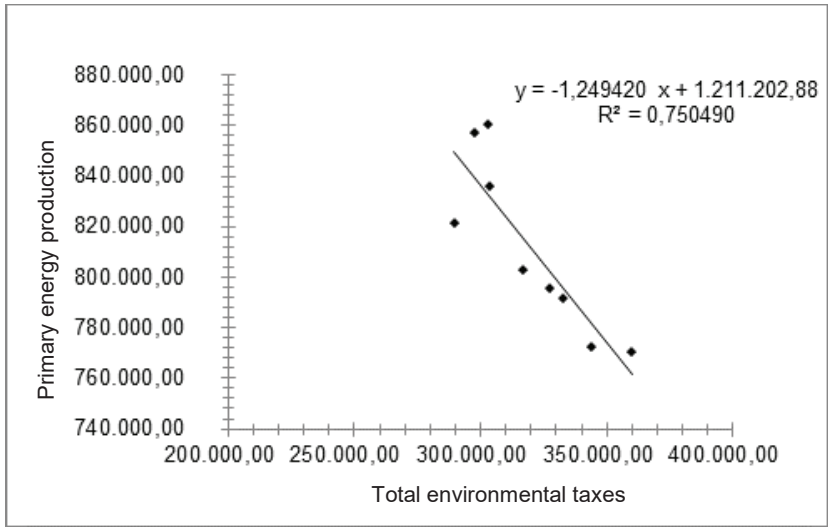

Image 2. Regression model: environmental taxes and primary energy production (Author)

Table 3. Regression statistics – environmental taxes and primary energy production (Author)

Regression Statistics	
Multiple R	0,866308
R Square	0,75049
Adjusted R Square	0,714846
Standard Error	18029,66
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6,84E+09	6,84E+09	21,05503	0,002518
Residual	7	2,28E+09	3,25E+08		
Total	8	9,12E+09			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1211203	87172,83	13,89427	2,36E-06	1005072	1417334
Environmental taxes	-1,24942	0,272289	-4,58858	0,002518	-1,89328	-0,60556

The data confirm that there is a linear negative correlation between the environmental taxes and the level of primary energy production. Image 3 shows the regression model which tests the correlation between the environmental taxes and the level of CO2 emissions.

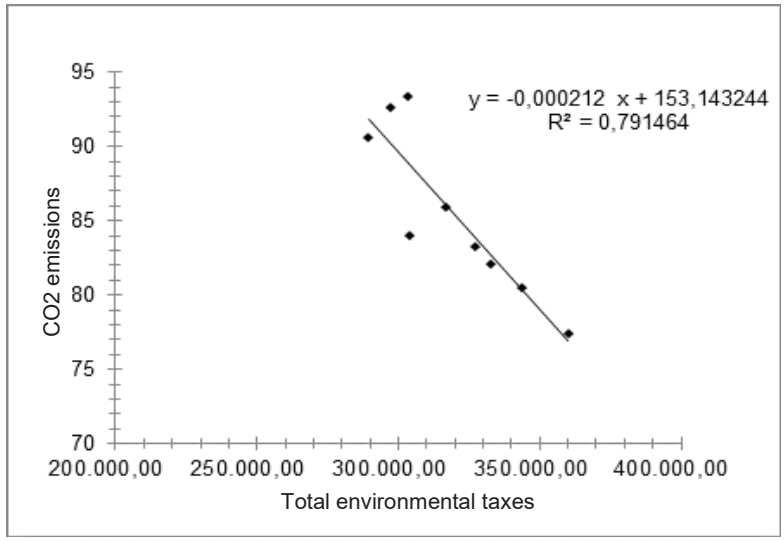

Image 3. Regression model: environmental taxes and CO2 emissions (Author)

Table 4. Regression statistics – environmental taxes and CO2 emissions (Author)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,889642
R Square	0,791464
Adjusted R Square	0,761673
Standard Error	2,719428
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	196,473	196,473	26,56731	0,001318
Residual	7	51,76703	7,395291		
Total	8	248,24			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	153,1432	13,14835	11,64734	7,77E-06	122,0523	184,2341
Environmental taxes	-0,00021	4,11E-05	-5,15435	0,001318	-0,00031	-0,00011

The regression analysis showed that there is a linear negative correlation between the environmental taxes and the level of CO2 emissions.
Image 4 shows the regression model which tests the correlation between the environmental taxes and the level of household energy consumption.

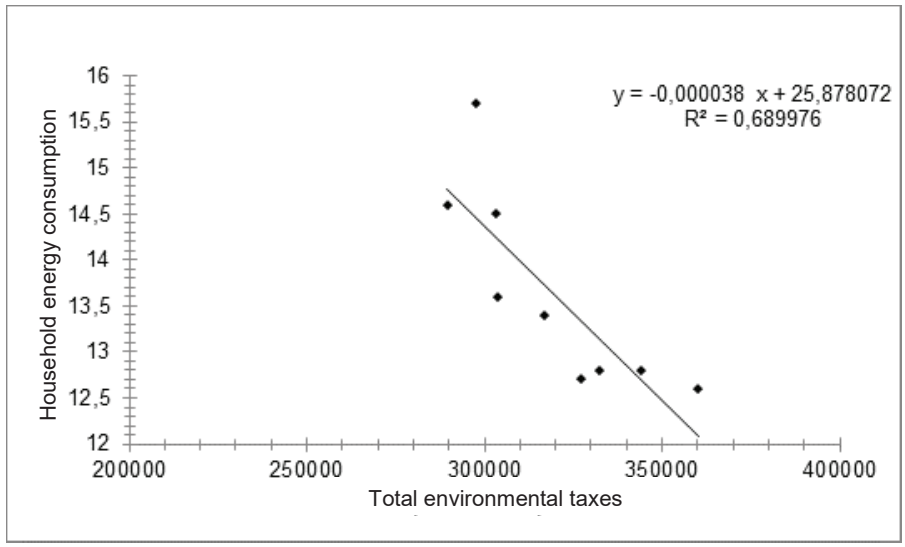

Image 4. Regression model: environmental taxes and household energy consumption (Author)

Table 5. Regression statistics – environmental taxes and household energy consumption (Author)

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,830648
R Square	0,689976
Adjusted R Square	0,645687
Standard Error	0,643164
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6,444379	6,444379	15,57893	0,005553
Residual	7	2,895621	0,41366		
Total	8	9,34			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	25,87807	3,109677	8,321787	7,08E-05	18,52485	33,23129
Environmental taxes	-3,8E-05	9,71E-06	-3,94701	0,005553	-6,1E-05	-1,5E-05

The obtained results confirm that there is a linear negative correlation between the environmental taxes and the level of household energy consumption.

3. ANALYSIS

The empirical research results, tested by the method of correlation and regression, confirm the findings of the studies which showed that environmental taxes have an effect on the reduction in the energy consumption. In this case, we tested the correlation between the total environmental taxes in the EU and their effect on energy production, CO2 emissions and household energy consumption. The findings are as follows:

- Environmental taxes have an effect on the reduction in the primary energy production. That is verified by the correlation (-0,866), as well as by the regression analysis, which showed that there is a negative correlation between these variables. It means that the growth in environmental taxes has an effect on the reduction in the energy production. This impact of taxes on the energy production is explained by 75% of variability, i.e. a total of 75% of variations of the primary energy production was explained by environmental taxes. The regression model presented on this occasion is reliable, which is indicated by the low level of the F significance indicator during the ANOVA test, which is below 0.05, because the regression was done with the reliability level of 95%, while the regression coefficients are also highly reliable, which is indicated by the p-value for the regression elements, which is also below 0.05 in both cases.
- Environmental taxes have an effect on the reduction in the level of CO2 emissions, which was verified by the regression model. The obtained results show that there is a negative linear correlation between these variables, which means that the growth in environmental taxes results in the reduction in CO2 emissions. The determination coefficient is high, and it totals 79%, which confirms the reliability of the regression model. The determination coefficient shows that the total variation of CO2 emissions is explained by 79% variations in environmental taxes. The regression model is reliable according to the measures shown in Table 4.
- Environmental taxes have an effect on the household energy consumption in the EU. The regression model verifies that there is a linear negative correlation between these two variables. The determination coefficient totals 68.99%, which is quite high. This shows that the total variation of the energy consumption is explained by 68.99% variations of environmental taxes. The regression model presented in Table 5 is reliable.

CONCLUSION

On the basis of an overview of the empirical findings of numerous authors, and on the basis of the author's empirical research conducted by applying the scientific methodology, this research examined the efficiency of environmental taxes. In this case, the efficiency was analysed by estimating the degree to which environmental taxes had an impact on the reduction in the emission of harmful substances in the environment. Depending on the time period which was analysed and the economy used in the analysis, many authors came to different conclusions. Some of them showed that environmental taxes indeed result in the reduction in the emission of harmful substances in the environment, which produces a full effect, while others came to the conclusion that these taxes do not have such an effect. In the context of these studies, we examined the available literature and conducted empirical research with a view to obtaining the answer to the question whether the introduction of environmental taxes in the EU countries reduces pollution demonstrated through the reduction in CO2 emissions, and through reduced production and consumption of energy.

This question was examined by drawing a comparison between the collected environmental taxes at the EU level from 2007 to 2015 and the levels of energy production, energy consumption and CO2 emissions in the analysed period. By applying the method of correlation and regression, we came to the conclusion that the environmental taxes in the EU,

in the period from 2007 to 2015, had an effect on the reduction in the production and consumption of energy and the CO2 emissions.

However, it is important to emphasise the restrictions of this analysis. First of all, the series of data and the time interval were quite short for the evaluation of this type. It means that if the series of data was longer, the obtained results might be different. In addition to that, the analysis included all the EU countries, and if the analysis included individual countries, the results might be different. Apart from that, this research tested the impact of environmental taxes on three variables, and if some other variables were analysed, the obtained results might be different.

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