*Faculty of Economics, University of Niš*
*11-12 October 2017*

**International Scientific Conference**
**CONTEMPORARY APPROACHES IN THE ANALYSIS OF ECONOMIC PERFORMANCES**

# ENVIRONMENTAL TAXES AND EXPENDITURES IN SELECTED COUNTRIES: PANEL DATA ANALYSIS

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***Abstract:*** *The aim of this paper is to analyze the link between revenues from environmental taxes and government environmental expenditure in 8 European countries. By implementing a panel data analysis on a defined sample, we come to the conclusion that there is a positive link between the government expenditure in the field of environmental protection and revenues from environmental taxes. The obtained results indicate that this link is strong. Increase in environmental tax revenues by 1% has an impact on the increase in government environmental expenditures by 0.99%. In order to make the development sustainable, it is necessary that in the observed countries the growth of these expenditures be faster than the growth of revenues from environmental taxes.*

***Keywords****: environmental taxes, environmental expenditures, panel data analysis.*

## 1. Introduction

From the moment when sustainable development became a key component of the development strategy of almost all countries of the world, the care of the healthy environment was gaining in importance. Thus changed the role of individual instruments in the field of environmental protection. The command and controlling instruments, which had a dominant role for many years, proved to be insufficiently effective in solving accumulated environmental problems, which had the effect that since the 1970s market-based instruments were increasingly being applied.

Two important instruments which are used today in solving environmental problems are environmental taxes and pollution permits. Environmental taxes are

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UDC 504.05/.06:336.226

particularly important in countries that have implemented environmental tax reform, where they have proven to be very effective. In addition to solving ecological problems, environmental tax revenues have enabled some of these taxes to be used in solving the problem of unemployment. Also, increase in the sum of these revenues from year-to-year gave the ability to the states to allocate higher resources in the field of environmental protection, but also that through the appropriate mechanisms (tax rate differentiation, refund system, etc.) stimulate private sector to higher allocations in this area. All these efforts have had a positive impact on the decline in harmful emissions and the preservation of natural resources, which was the goal of the implementation of environmental tax reform.

## 2. Review of literature

Natural resources are considered to be common goods, or common pool resources. These goods provide usefulness to a greater number of people in society, they do not cost people anything, but in the long period they are outlined. Due to these characteristics of common pool resources, Gregory Mankiw (2007: 225-240) indicates that these resources are reminiscent of pure private property, but which are owned by a large number of people (members of the community).

Given that sustainable development is the main goal of economic policy of the most countries, which involves balancing between social, economic and environmental factors in order to create better, more developed and more peaceful society, this question of exhaustiveness and the need to make natural resources available to all members of the community in the long run, makes a crucial segment of contemporary economic policy and contemporary economic science (Pearce et al., 1990; Peacock, 2008). Incompatibility and competitiveness as a feature of natural resources have negative implications for the efficiency in allocating of common goods. This means that every individual who uses the common good, reduces welfare benefits to others (Berkes et al., 1989: 91).

Considering that the level of pollution is increasing and that humanity is on the verge of ecological ruin, and that homo economists, in most cases, only takes into account the growth of its profits, a large number of countries have decided to ecologize their tax systems in order to reduce the level of pollution and protect natural resources. In addition to providing funds for the supply of public goods (Leach, 2004), the tax system can also make a significant contribution to public goods protection. The introduction of eco taxes on those goods whose production and use leads to degradation of the environment, reduces their production and consumption. In this way, more rational use of natural resources is ensured.

When it comes to the relationship between environmental taxes and expenditures in the field of environmental protection, there is a certain lack in the literature as pointed out by Vincent, Aden, Dore, Adriana, Rambe and Walton (2010).However, the present research indicates that the participation of earmarked revenues in environmental taxes is important. In a survey conducted by Breet and Keen (2000), it was pointed out that dedicated revenue prevented politicians from using them for other purposes. This means that dedicated revenues from environmental taxes are used exclusively in the field of environmental protection. Jiang (2001) also points out that greater share of environmental expenditure in environmental tax revenues has a positive impact on achieving sustainable

development goals, and suggests that it is necessary to increase the participation of earmarked environmental taxes.

In the text below, an analysis of the volume of these taxes will be made in Germany, the Netherlands, Norway, Estonia, Slovenia, Denmark, Finland and Sweden, as well as an analysis of environmental expenditures, which will be used in the regression panel data analysis as a variables.

## 3. An analysis of the volume of environmental taxes in selected countries

Seven of the eight countries that are the subject of the analysis are EU members, with the exception of Norway. As such, these countries were required to comply with the relevant standards when environmental taxation was in question. These standards are laid down in the field of energy products through the European Directive on Taxation of Energy (Council Directive 2003/96 / EC). In the case of other areas, in accordance with the defined objectives at the EU level and in line with the environmental problems faced by countries, they have independently determined and introduced appropriate instruments.

Despite the corresponding differences between the countries that are the subject of the analysis, when it comes to environmental taxation, there are many similarities. Namely, all mentioned countries except Estonia have an environmental tax that is subject to CO2 emissions (Specks, Yilkova, 2009). The income earned through this tax is used as a basis for reducing wage taxes, with the aim of reducing unemployment (International Institute for Labor Studies, 2011). Also, all countries earn most of the revenue from environmental taxes through energy taxation, while the smallest fiscal volume have taxes on pollution and resources (OECD, 2006).

**Table 1. Chain indices of environmental tax revenues in selected countries, 2001-2013**

| Year | Germany | Denmark | Netherlands | Sweden | Finland | Slovenia | Estonia | Norway |
|---|---|---|---|---|---|---|---|---|
| 2003 | 6.08 | -2.10 | 4.44 | 4.99 | 5.97 | 6.25 | 6.43 | -4.29 |
| 2004 | -2.37 | 8.68 | 6.76 | 2.27 | 5.90 | 5.89 | 23.91 | 3.48 |
| 2005 | -1.54 | 3.74 | 7.14 | 3.32 | -1.27 | 2.22 | 25.43 | 10.13 |
| 2006 | 1.02 | 0.69 | 8.10 | 2.58 | 2.80 | 1.57 | 15.73 | 8.86 |
| 2007 | -2.85 | 4.90 | -0.55 | 2.48 | -1.17 | 11.14 | 20.18 | 6.10 |
| 2008 | 0.66 | -8.92 | 6.55 | 0.80 | 1.21 | 7.83 | 7.53 | -1.46 |
| 2009 | 1.26 | -8.35 | -2.52 | -8.09 | -8.79 | 12.63 | 7.95 | -11.29 |
| 2010 | -1.09 | 5.77 | 2.94 | 15.28 | 9.35 | 2.35 | 3.39 | 17.09 |
| 2011 | 6.70 | 1.93 | -0.39 | 1.72 | 18.54 | -3.45 | -0.06 | 3.90 |
| 2012 | -0.71 | 1.42 | -4.67 | 4.45 | 0.07 | 8.17 | 13.50 | 3.84 |
| 2013 | -1.17 | 6.47 | 1.53 | 1.19 | -0.34 | 3.84 | -1.02 | -0.87 |

Source: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_tax&lang=e, autors

The absolute data do not give a full picture of the significance of these taxes in the given countries, so in the text below will be analyzed the chain indexes of income trends from these taxes, as well as their share in GDP. About the movement of revenue from environmental taxes, significant conclusions can be made by observing the chain indices. They are shown in Table 1. As can be seen from this table, there are appropriate oscillations in the movement of these revenues. In most of the countries observed, negative trends are particularly noticeable after 2008, when the economic crisis from the USA moved to Europe. The largest drop in 2009 was recorded in Norway, where revenues from these taxes decreased by 11.29% compared to the previous year. There was also a decline in Sweden, Finland, the Netherlands and Denmark. In contrast, in Germany, the decline was noticed in 2010, while in 2011 only a slight drop in revenues was recorded in Slovenia and Estonia.

When it comes to the highest value of chain indexes, they are most noticeable in Estonia. By aligning its tax system with the tax system of the European Union, new environmental taxes were introduced, which had a positive impact on the growth of these revenues (Poltimae, 2014). As can be seen from the table in the period from 2004 to 2007, the value of chain index ranged from 15.73% to 25.43% in Estonia.

When the share of revenue from environmental taxes in GDP is concerned, it varies considerably between the countries that are the subject of the analysis. The largest share in 2013, was in Denmark in the amount of 4.25%. Besides Denmark, the high participation was present in Slovenia and the Netherlands. The share of environmental tax revenues in GDP in these countries is above the OECD average, where this participation ranges from 2-3% (Withana et al., 2014). Germany had the lowest share in the same year despite the largest amount of environmental tax revenues in absolute amount ( 2.05%).

All presented data indicate the high fiscal importance of these revenues for the countries surveyed, regardless of the fluctuations and differences between them. However, if the collected revenues have a positive impact on the allocation of the state in the field of environment, an analysis will be carried out after reviewing the level and structure of expenditures in the field of environmental protection.

## 4. Expenditures in the field of environmental protection

Environmental protection in modern conditions requires the allocation of significant resources in order to solve accumulated environmental problems. This need is certainly noticed in the countries that are the subject of the analysis. In all these countries, there is a tendency of growth of funds allocated in the field of environmental protection both by the state sector and by the corporate sector and by specialized environmental service providers, whether they are publicly or privately owned (Szirony, Steurer, 2012).

Environmental protection expenditures are funds spent on all activities and actions aimed at the prevention, reduction and elimination of pollution, as well as any other form of environmental degradation resulting from the production process or the consumption of goods or services (Eurostat, 2011). The corporate sector in the field of environmental protection participates with the allocated funds of about 10%. (Eurostat, 2015). In order to test the hypothesis of this paper, the most significant are the state allocations.

Certainly those countries that have the highest revenues from environmental taxes have the biggest opportunities for allocation in the field of environment, so the largest

allocations in this area have Germany and the Netherlands. Unlike them in absolute terms, the lowest allocations are in Estonia.

These expenditures by the state sector include current expenditures and investments for environmental protection (Eurostat, 2007). Current expenditure for environmental protection refers to labor costs, expenditure on operation and maintenance of environmental protection equipment, as well as payments to third parties for environmental services, while investments imply investments related to environmental protection activities (OECD,2006). Of the observed countries, only in Estonia, when the structure of the state's environmental expenditure is concerned, there is a higher share of investments compared to current expenditure on environmental protection. The share of these investments is also significant in Slovenia, while in other analyzed countries the share of current expenditures is dominant (Eurostat, 2015).

## 5. Defining the research model

In this part of the paper, by using the mentioned variables, a statistical analysis is performed with the aim of proving the hypothesis that there is a strong positive statistical connection between the revenues from environmental taxes and government environmental protection expenditures.

The time period for the analysis is from 1997-2008. years. The main reason why the period after 2008 was not taken into account in the research is the global economic crisis, which was felt in all the countries that were the subject of the analysis, which had an impact on the movement of observed variables in the research. For this research, countries from the European continent were selected. The main criterion for selecting countries was to consider them as advanced when environmental taxation is concerned.

The survey is conducted over electronically collected data on realized revenues from environmental taxes and environmental protection expenditures by the state that have been downloaded from the Eurostat site. An analysis of the impact of environmental tax revenues on government allocations in the field of environment was carried out by using the EViews software package.

For the assessment of the influence of the independent variable on the dependent variable, in the observed countries, the model of the panel linear regression was used. The Hausman test was used to determine which model should be used in regression analysis: a model of fixed effects or a random effect model. The model of fixed effects is characterized by the fact that it takes into account the internal dimensions of data (the difference within the same state), while the model of random effects takes into account both internal differences and differences between individual subjects (Verbeek, 2008).

In order to define a model for the impact of environmental tax revenues on state environmental expenditure, the following general linear regression model (Yan, Gang Su, 2009) was used:

$$y_{it} = ß_0 + ß_1 x_{it} + Ɛ_{it} \quad (1)$$

For i = 1, ..... .N observation for T time periods t = 1, ... .T.; Where: $y_{it}$ - dependent variable; $X_{it}$ - independent variable; $Ɛ_{it}$ - a random error mark; $ß_0$ - a section on the y axis, most often not interpreted; $ß_1$ - is also called the coefficient of inclination and

shows the change of the dependent variable y, when the independent variable x increases by one of its units.

By including the defined variables in the previous equation, we obtain the model:

$$\ln P_{it} = ß_0 + ß_1 * \ln I_{it} + Ɛ_{it} \quad (2)$$

Where: $\ln P_{it}$ - logarithmic revenues from environmental taxes, for i = 1, ..... .N observation for T time periods t = 1, ..... .T; ln $I_{it}$ - logarithmic expenditures for environmental protection, for i = 1, ..... .N observation for T time periods t = 1, ..... T.

## 6. The results of the panel data analysis and discussion

Before we entered the logarithmic data transformation and afterwards entered into the corresponding application of the Eviews software, in order to determine the panel data regression model, we presented the results of the descriptive statistics before the transformation in table 2.

The table shows that in the observed period, the average collected environmental tax revenues in the analyzed countries amounted to 12,327.58 million Euros annually, while the average expenditure amounted to an average of 3,178.786 million.

The median is 7.083,910 when the revenue is concerned, i.e. in the case of expenditures 1.041,450. It shows the mean value of revenues or expenditures, if the data are line up from the lowest to the highest and vice versa. The largest annual income in one of the analyzed countries amounted to 57.833 million euros, while 15.320 million euros were the highest expenditure for environmental protection by the state during one year. When it comes to the smallest amount, it is 68.18 million euros when the revenue is in question, or 31.90 million euros when the expenditures are in question.

**Table 2 Descriptive statistics of observed variables in selected countries in millions of euros**

| | ENV_TAX_REVENUES | GOV_EXP_IN_ENV_PRO |
|---|---|---|
| Mean | 12327.58 | 3178.786 |
| Median | 7083.910 | 1041.450 |
| Maximum | 57833.00 | 15320.00 |
| Minimum | 68.18000 | 31.90000 |
| Std. Dev. | 16034.10 | 4703.394 |
| Skewness | 1.898857 | 1.524439 |
| Kurtosis | 5.340699 | 3.756560 |
| Jarque-Bera | 79.60602 | 39.47218 |
| Probability | 0.000000 | 0.000000 |
| Sum | 1183448. | 305163.4 |
| Sum Sq. Dev. | 2.44E+10 | 2.10E+09 |
| Observations | 96 | 96 |

Source: Authors, by using the EViews software package based on a defined set of the data.

Data variability, measured through standard deviation, indicates the distance of data from the mean value, indicating that some countries are collecting significantly higher revenues on the basis of environmental taxes, that is, allocating considerably more funds for environmental protection in relation to the determined average.

The Skewness coefficient is positive in both cases and shows that the distribution is moved to the right side relative to the center point, while the coefficient of flattening (Kurtosis) is greater than 3, indicating the pronounced outflow of the distribution curve. The Jarque-Bera test in the case of both observed variables shows that the distribution of revenues and expenditures in the observed countries varies considerably from the normal distribution. In this test, the null hypothesis assumes that there is normalcy distribution of data (Ruppert, Matteson, 2015: 91-92). Since the significance level p = 0 has been realized, in the case of both variables, the null hypothesis on the normality of the distribution is rejected.

**Table 3. F statistics for the defined data panel in selected countries**

| | | | | |
|---|---|---|---|---|
| Dependent Variable: LN_IZDACI | | | | |
| Method: Panel Least Squares | | | | |
| Sample: 1997 2008 | | | | |
| Periods included: 12 | | | | |
| Cross-sections included: 8 | | | | |
| Total panel (balanced) observations: 96 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -1.129039 | 0.294610 | -3.832322 | 0.0002 |
| LN_PRIHODI | 0.942641 | 0.034109 | 27.63637 | 0.0000 |
| R-squared | 0.890413 | Mean dependent var | | 6.857168 |
| Adjusted R-squared | 0.889248 | S.D. dependent var | | 1.688332 |
| S.E. of regression | 0.561868 | Akaike info criterion | | 1.705514 |
| Sum squared resid | 29.67541 | Schwarz criterion | | 1.758938 |
| Log likelihood | -79.86469 | Hannan-Quinn criter. | | 1.727109 |
| **F-statistic** | **763.7689** | Durbin-Watson stat | | 0.257150 |
| **Prob(F-statistic)** | **0.000000** | | | |

Source: Authors, by using the EViews software package based on a defined set of the data.

The effect of environmental tax revenues on environmental protection expenditures by the state can be assessed by fixed effect model or random effect model. The first step in selecting the model is to determine the significance of all data in the model.

The F test is used to determine the significance. The null hypothesis in this test is pessimistic and indicates that independent variable is not associated with a dependent variable. While rejecting of the null hypothesis and accepting an alternative hypothesis indicates that the model is statistically significant and that further analysis can be carried out. On the basis of the obtained results of F statistics, shown in Table 3, as well as the realized level of significance (p-value of F-statistics <5%), it can be concluded that the null hypothesis is rejected. This means that the hypothesis for of existence of a connection between a dependent and an independent variable is accepted.

**Table 4. Results of Hausman's test**

| Correlated Random Effects - Hausman Test | | | | |
|---|---|---|---|---|
| Test Summary | | Chi-Sq. Statistic | Chi-Sq. d.f. | Prob. |
| Cross-section random | | 0.211641 | 1 | 0.6455 |
| Cross-section random effects test comparisons: | | | | |
| Variable | Fixed | Random | Var(Diff.) | Prob. |
| LN_PRIHODI | 1.010641 | 0.993101 | 0.001454 | 0.6455 |

Source: Authors, by using the EViews software package based on a defined set of the data.

In order to determine which of the two models is more appropriate for the given analysis, the Hausman test is applied. Its application assumes the setting of the following hypotheses (Cameron, Trivedi, 2013, 219): 1) H0: The random effect model is appropriate; 2) H1: The fixed effect model is appropriate.

**Table5. Results of random effect test**

| Dependent Variable: LN_IZDACI | | | | |
|---|---|---|---|---|
| Method: Panel EGLS (Cross-section random effects) | | | | |
| Sample: 1997 2008 | | | | |
| Cross-sections included: 8 | | | | |
| Total panel (balanced) observations: 96 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -1.556537 | 0.595814 | -2.612455 | 0.0105 |
| LN_PRIHODI | **0.993101** | 0.065503 | 15.16104 | **0.0000** |

| Effects Specification | | | |
|---|---|---|---|
| | | S.D. | Rho |
| Cross-section random | | 0.611300 | 0.9268 |
| Idiosyncratic random | | 0.171825 | 0.0732 |
| **Weighted Statistics** | | | |
| R-squared | 0.711480 | Mean dependent var | 0.554576 |
| Adjusted R-squared | 0.708411 | S.D. dependent var | 0.316863 |
| S.E. of regression | 0.171103 | Sum squared resid | 2.751964 |
| F-statistic | 231.8011 | Durbin-Watson stat | 0.579945 |
| Prob(F-statistic) | 0.000000 | | |

Source: Authors, by using the EViews software package based on a defined set of the data.

The null hypothesis is accepted in those cases where this test gives p (probability) > 0.05, and vice versa, the hypothesis H1 is accepted in those cases where the realized level of significance is less than 5%. Since p (probability) in a given data panel is greater than 5%, as can be seen in Table 5, we accept the null hypothesis and reject the H1 hypothesis. In this analysis random effect model is appropriate.

On the basis of the applied regression model of stochastic effects, it is seen that the regression coefficient $ß_1$ has a positive sign (0,993101) with the realized significance level p = 0.0000 <0.05 (Table 5). This means that between the revenues from environmental taxes and environmental protection expenditures in the selected countries, there is a positive and significant link (change in average environmental tax revenues for 1% leads to the increase of average environmental expenditures by the state in the amount of 0.99%).

However, in order to make the environmental performance results more powerful, it is necessary to increase this participation in the future, i.e. that expenditure in this area has a faster growth than the revenues from the environmental taxes which the states collect.

## 6. Conclusion

Preservation and improvement of a healthy environment is one of the basic goals of the overall economic policy of the countries in modern conditions. Enhancing economic wealth, without taking into account the environment, does not lead to sustainable development. For this reason, all countries define appropriate instruments to achieve defined environmental objectives.

In the countries that are the subject of the analysis, environmental taxes occupy a significant place, as one of the instrument used in the realization of ecological goals. Environmental taxes, in addition to having a positive impact on the changing behavior of economic entities and households in the direction of environmentally sound behavior, also create additional monetary resources that the states collect. Despite neutral tax reform, the

growth trend of these revenues has created the basis for higher state allocations for environmental protection, which is confirmed by the results of the conducted panel analysis. Conducted panel data analysis showed that with an increase in revenues of 1%, the state spending on environmental protection increased by 0.99%.

This analysis has proven the initial hypothesis that the growth of collected funds from environmental taxes has an impact on the growth of state allocation in the field of environmental protection. This fact in this way gives to environmental taxes another positive characteristic, in addition to the possibility of achieving a blue dividend through a neutral tax environmental reform and the impact on the environmentally acceptable behavior of economic entities and households.

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## EKOLOŠKI POREZI I IZDACI ZA ZAŠTITU ŽIVOTNE SREDINE U IZABRANIM ZEMLJAMA: PANEL ANALIZA

*Apstrakt: Cilj ovog rada je da izvrši analizu veze između prihoda od ekoloških poreza i izdataka države za zaštitu životne sredine u 8 evropskih zemalja. Sprovođenjem panel analize podataka na definisanom uzorku došlo se do rezultata da između izdataka države u oblasti zaštite životne sredine i prihoda od ekoloških poreza postoji pozitivna veza. Dobijeni rezultati ukazuju da je ta veza jaka. Rast prihoda od ekoloških poreza za 1%, ima uticaj na rast isdataka u oblasti zaštite životne sredine za 0,99%. Da bi se razvoj učinio održivim, potrebno je da u posmatranim zemljama rast ovih izdataka bude brži od rasta prihoda od ekoloških poreza.*

*Ključne reči: ekološki porezi, izdaci za zaštitu životne sredine, panel data analiza.*