ASSESSMENT OF THE EFFECT OF ENVIRONMENTAL TAXES ON ENVIRONMENTAL PROTECTION

[1]ASTRIDA MICEIKIENE, [2]VIDA CIULEVICIENE

Aleksandras Stulginskis University, Faculty of Economics and Management, Lithuania
E-mails: [1]Astrida.Miceikiene@asu.lt, [2]Vida.Ciuleviciene@asu.lt

Abstract - The article analyses the effect of environmental taxes on environmental protection. Studies dealing with environmental taxation have been increasing in scope recently. Nonetheless, studies related to the effect of environmental taxes on environmental protection, in particular, works comparing results of different countries are fairly uncommon. Following identification of the factors as part of this study, the study further deals with determination and assessment of the effect of environmental taxes on key quantitative indicators of environmental protection. The model for assessment of the effect of environmental taxes on environmental protection has been developed. Greenhouse gas emissions (GHG) as equivalent of carbon dioxide (CO_2) have been chosen as a dependent variable in assessment of environmental taxes. The following independent variables have been chosen on the basis of the scientific literature and available statistical information: average GDP per capita; investments into environmental protection; share of environmental tax revenue in total tax revenues; population density; annual GDP growth rate, and annual industrial production sales growth rate. To provide higher level of objectivity to the research results, the following European countries have been chosen for comparison to Lithuania: Germany, Norway, Finland, Sweden, Denmark, Ireland, Estonia, and Latvia. Quantitative analysis has been conducted using information for years 1999-2013 by the method of correlation and regression analysis using the following assessment indicators: adjusted coefficient of determination (R-squared), p-value, Durbin-Watson criterion, Anova p value, Regressions and Residuals, and Studentized R^2. The study has shown that environmental taxes are highly significant and have considerable influence on reduction of environmental pollution indicators both in Lithuania and in certain other European countries, as where the model has been applied as an effective model, economic growth and environmental taxes have been found to have the greatest effect on variation in GHG amount. Meanwhile, for other European countries, the greatest effect on environmental pollution indicators comes from the GDP per capita (Latvia, Estonia, and Norway), investments into environmental protection (Norway), and population density (Ireland, Denmark, Finland, Sweden). Lithuania's national pollution index follows the same trend as in Latvia and Estonia, while the national pollution index of other European countries shows the opposite trend than that of the Baltic States, indicating increase of the pollution level in the Baltic States.

Keywords: Environmental taxes, environmental protection, assessment of the effect.

I. INTRODUCTION

Climate change related agreement between the countries during Paris Climate Change Conference 2015 has maintained the balance, and its roadmap is aimed at limiting global warming to well below 2°C. According to Carole Dieschbourg, the Minister of Environment of Luxembourg, the agreement is the roadmap for a better, fairer and more sustainable world (Paris UN climate .., 2015).

A number of countries have already undertaken certain measures for mitigation of climate change and environmental pollution after environmental pollution reached the level that called for real attention back in the 60s of the last century. Environmental taxes regulating the interplay between the economy and environment comprise one of such measures. Revenues collected from these taxes are allocated to promotion of sustainable economy based on nature conservation, greener production. The importance of environmental taxes is defined as the ability of environmental taxes to function as intended and implement the goals of mitigation of environmental pollution by increasing the tax rates related to environmental protection. Researchers however seem to not have found a consensus towards this aspect. Castiglione et al. (2014) have emphasized that application of environmental taxes is in fact considered to be a controversial policy measure. On one hand, evidence on positive effect of environmental taxes has been presented, in particular in terms of pollution reduction, in economically developed countries. On the other hand, environmental taxes have been claimed to diminish the results of economic activity as a result of distorting effect on production and consumption. Although scientific literature provides rather comprehensive analysis of the effect of environmental taxation on national environmental protection and economy, the works are usually limited to mere comparison of revenues from environmental taxes to the indicators of environmental pollution, such as national CO_2 or GHG amount. However, relatively few discussions have been held on the method for assessment and identification of the effect of environmental taxes on the indicators of environmental pollution, factors to be analysed and the rationale behind them (Castiglione, et al., 2014a; Morley, 2012; Skjelvik, Bruvoll, Ibenholt, 2011; Im, Wonhyuk, 2010).

Research problem: which factors should be used for assessment of the effect of environmental taxes on environmental protection, and the degree of their effect?

Research object: environmental taxes.
Research aim: identification of the factors followed by determination and assessment of the effect of environmental taxes on environmental protection.

Research objectives:

- analysis of the previous research works followed by identification of the factors that have effect on reduction of environmental pollution and development of their research methodology;
- determination and assessment of the effect of environmental taxes on environmental protection.

A. Methodology for assessment of the effect of environmental taxes on environmental pollution indicators

Analysis of previous empirical studies for assessment of environmental tax effect on environmental pollution (Castiglione et al., 2014a; Abdullah, Morley, 2014; Kurtinaitytė–Venediktovienė, Pereira, Černiauskas, 2014; Tsakas, Katharaki, 2014; Kalinichenko, 2014; Castiglione et al., 2014b; Krass, Nedorezov, 2013; Mascu, 2013; Nagy, 2013; Morley, 2012; Piciu, Trica, 2012; Heine, Norregaard, Parry, 2012; Skjelvik, Bruvoll, Ibenholt, 2011; Opulskyte, 2011; Parry, 2011; Valles-Gimenez, Zarate-Marco, Trueba-Cortes, 2010; Im, Wonhyuk, 2010; Klingelhofer, 2010; Scasny, et al., 2009; Lazdina, 2008; Barker et al., 2007) has shown that although majority of the authors assess the effect of environmental taxes on environmental protection using the multidimensional regression model, their approach to selection of dependent and independent variables differs.

Morley (2012) has conducted empirical study for assessment of the effect of environmental taxes on environmental protection dealing with the issue of global warming by verifying the effect of environmental taxes on air pollution and energy consumption level in the EU. The analysis is based on an econometric model employing the factors used in conventional approach towards pollution and energy consumption proposed by Grossman and Krueger (1995). According to Morley (2012), GHG amount should be considered as a dependent variable. Im and Wonhyuk (2010) share the same approach as Morley (2012), namely, that environmental performance measured as GHG amount should be considered as a dependent variable. Environmental performance is essentially related to enhancement of environmental quality; therefore, pollution reduction has positive effect on environmental performance. In assessment of enhancement of the overall environmental quality, the authors place the main focus on air pollution factors and, as a result, use GHG amount as the environmental performance indicator which encompasses CO_2, sulphur oxide (SO_2) and nitrogen oxide. Meanwhile, Castiglione et al., (2014a) argue that environmental tax revenues should be used as a dependent variable, as they also reflect the environmental policy.

Hence, there are researchers who advocate for the use of environmental taxes as a dependent variable for identification of indicators that have the greatest effect on variation of these taxes, while other researchers argue that the environmental protection indicator should be used as a dependent variable, while environmental taxes should be an independent variable, claiming that this is the only way to determine how environmental taxes influence reduction of environmental pollution indicators. In our opinion, the effect of environmental taxes on environmental protection indicators should be assessed by taking an integrated approach. Morley (2012), Im and Wonhyuk (2010), Jackson (2009), aiming to assess the effect of environmental taxes on environmental protection, propose taking GHG amount, one of the key pollution indicators used worldwide, as a dependent variable. GHG amount covers CO_2, sulphur oxide (SO_2), methane (NH_4), nitrogen oxide (N_2O), etc. according to the base established by Kyoto Protocol.

In development of methodology, another factor – scope of investments into environmental protection – has been added to the list of factors analysed by the researchers. This factor as the key factor has been emphasized by Morley (2012). On one hand, the variable of investments into environmental protection would be expected to have a negative effect, as increasing investments would provide easier access to more advanced, energy intensive production technologies. On the other hand, with increasing emissions into the atmosphere, investments into environmental protection would need to be increased to a certain breaking point, at which the amount of pollutants starts declining.

According to various researchers, the key factor in assessment of the effect of environmental taxes on environmental protection is the share of environmental tax revenues in the total tax revenues, even though efficiency of environmental taxes is considered to be negative due to exemptions that apply to energy intensive industries (Im, Wonhyuk, 2010). Morley (2012) argues that efficiency of these taxes reduces as a result of exemptions proposed for certain industries with the ultimate goal of maintaining international competitiveness.

Population growth is another important factor. Population growth nationwide leads to increasing consumption, with the resulting increase in environmental pollution. Every resident is a consumer, which means that growth in the number of consumers nationwide is accompanied by increase in electricity consumption, waste, heat consumption, all of that leading to higher pollution. It is therefore important to assess the effect of variation in population density on environmental protection (Im and Wonhyuk, 2010). GDP is indicative of the national economic growth at a certain moment. Nonetheless, the level of pollution varies depending on the growth rate characteristic of each country. OECD employs the concept of decoupling for assessment of national results of activity in environmental protection. It is important to distinguish between absolute and relative decoupling. Absolute decoupling refers to the situation characterised by stable or declining variables of environmental protection in the context of growth of the national economy. Relative decoupling refers to pollution index rising at a rate lower than the GDP growth rate (Jackson, 2009). It would therefore be reasonable to analyse the GDP per capita and economic growth by controlling their effect, as it may affect environmental performance considerably.

Previous studies have provided evidence on economic growth having direct influence on CO_2 emission. It is still important to acknowledge that economic growth promotes the processes of industrialization and urbanization, which lead to increasing CO_2 level, with even greater negative impact on environmental pollution. This is the result of increasing production and consumption promoted by growing economy, and higher level of pollution is the consequence of such processes. It is therefore important to complement the model with annual industrial production sales growth rate reflecting production intensity.

Table 1 summarizes the variables proposed by the researchers to be included into the model for assessment of the effect of environmental taxes on environmental pollution.

TABLE I
VARIABLES FOR ASSESSMENT OF FACTORS OF REDUCTION OF ENVIRONMENTAL POLLUTION

Variable	Description	Unit of measure	Authors
Dependent variable			
Pollution index	GHG amount	thous. tons as CO_2 equivalent	Morley (2012); Abdullah, Morley (2014)
Independent variables			
GDP	GDP per capita	EUR	Im and. Wonhyuk (2010); Morley (2012); Castiglione, et al., (2014a); Castiglione, et al., (2014b); Valles-Gimenez, Zarate-Marco, Trueba Cortes (2010); Abdullah, Morley (2014); Soderholm, Christiernsson (2008)
Investments	Investments into environmental protection	EUR	Castiglione, et al., (2014a); Castiglione, et al., (2014b); Kaufmann (2014); Soderholm, Christiernsson (2008)
Environmental taxes	Share of environmental taxes in overall taxes	%	Im, Wonhyuk (2010); B. Morley (2012); P. Soderholm, A. Christiernsson (2008)
Population	Population density in the country	People per sq. km	Morley (2012); Valles-Gimenez, Zarate-Marco, Trueba-Cortes (2010)
Economic growth	Annual GDP growth rate	%	Im, Wonhyuk (2010); Abdullah, Morley (2014)
Production	Annual industrial production sales growth rate	%	Im , Wonhyuk (2010)

Source: created by authors‘ on the basis of (Im, Wonhyuk, 2010; Skjelvik, Bruvoll, Ibenholt, 2011; Castiglione, et al., 2014a, Morley, 2012) data

Correlation and regression analysis methods have been used for assessment of the effect of environmental taxes on environmental protection. Regression model including the factors, which according to foreign researchers' and the article authors' opinion are the most indicative of the variations in indicators of environmental tax revenues and environmental indicators, has been developed. Dependence between GHG and the following variables is analysed: GDP per capita, investments into environmental protection, share of environmental tax revenues in total tax revenues, population, annual GDP growth, annual variation in production. The following regression equation has been developed for assessment of the effect of environmental taxes on environmental indicators:

$$y_{it} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \varepsilon$$

where y_{it} – GHG amount, thous. tons as CO_2 equivalent; $ß_0$– constant; x_1 – GDP per capita, EUR; x_2 – investments into environmental protection, EUR; x_3 – share of environmental tax revenues in total tax revenue, %; x_4 – population density, people per sq. km, x_5 – annual GDP growth rate, %; x_6 - annual variation in sale of industrial production, %; ε_{it} – regression residual.

Information for 13-year period (2000-2013) drawn from Eurostat database has been used for correlation and regression analysis. To obtain more comprehensive and objective research findings, the following 8 countries have been selected for comparison to Lithuania:

- Germany (selection rationale: one of the countries that has implemented the environmental tax reform in the most effective way; very strong economy, year 2013 GDP – EUR 2,809 billion);
- Norway, Finland, Sweden (selection rationale: characterised by highly effective implementation of the environmental tax reforms);
- Ireland (selection rationale: similarity to Lithuania);
- Latvia, Estonia (selection rationale: neighbouring Baltic countries often compared to each other);
- Denmark (selection rationale: highly developed taxation system and one of the leaders in terms of the number of environmental taxes).

Statistics application SPSS has been used for determination of correlation and regression relations between the variables. Model validation criteria used for validation of the developed model are presented in Table 2.

TABLE II
MODEL VALIDATION CRITERIA APPLIED

Criteria	Description	Validation value
Adjusted coefficient of determination R^2	One of the key criteria in model assessment. Coefficient of determination shows the percentage of behaviour Y that explains behaviour X_1, X_2, X_n. Given that the developed multidimensional regression model involves more than one variable, adjusted R^2, reflecting the situation more accurately is used.	Values of the coefficient of determination are within the range [0,1]. Higher value (closer to 1) indicated higher efficiency and quality of the model
p-value	Indicates statistical significance of the data. Also referred to as T (Student) test.	p<0.05
Durbin-Watson	Used for identification of correlation between residuals, i.e. autocorrelation.	Autocorrelation is absent where the value is within the rane [1,5;2,5]
ANOVA p-value	The obtained value indicates presence of any repressors related to the dependent variable.	ANOVA p<0.05
Regression and Residual	Indicate the number of correct and wrong forecasts. Where regressions exceed the number of residuals, the model is deemed to be efficient, as correct forecasts outnumber the wrong ones.	Regressions > Residuals
Studentized R^2	Indicates the dependence of Y on studentized residuals. Where Y is closer to 0 among the studentized residuals, the distribution is considered to be normal, and to the contrary, if closer to 1.	Closer to 0

Source: created by authors‘

II. RESEARCH RESULTS

Following the validation of model criteria, analysis of correlation between the dependent variable and independent variables has been performed. Regression model has been validated for each individual country, and the obtained coefficient estimates and standardized beta coefficients have enabled making the conclusions on model validity for each country and interpreting the obtained results by identifying whether or not the environmental taxes have effect on reduction of environmental pollution indicators.

For assessment of the effect of environmental taxes on environmental protection in Lithuania, the analysis has focused on identifying whether or not environmental taxes have any effect on reduction of environmental pollution. The results obtained Lithuania have been compared to similar indicators of the foreign countries.

The average share of GHG emissions per capita and trend in GHG per capita from 2000 to 2013 have been identified (Figure 1)

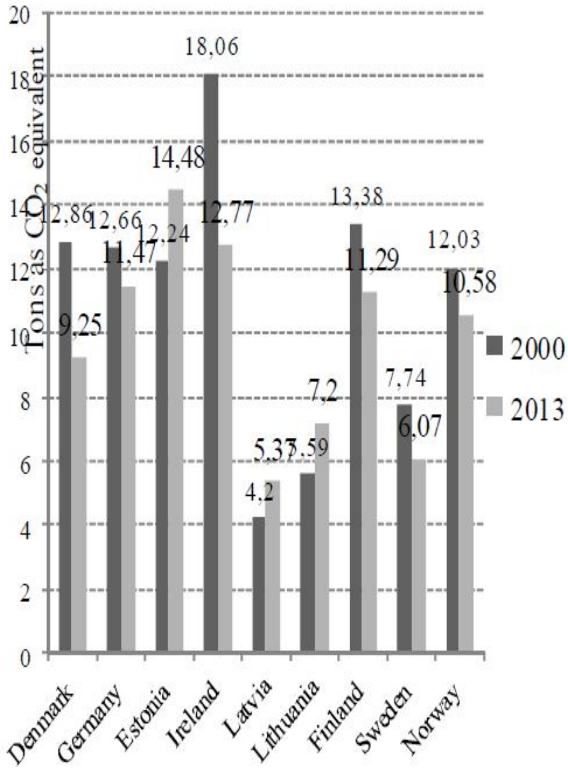

Fig.1. GHG amount per capita in the European countries

Information presented in Figure 1 indicates that the average GHG amount per capita in almost all European countries analysed reduced in 2013 as compared to 2000, while the opposite trend has been observed in Lithuania, Latvia, and Estonia, i.e. the average GHG amount per capita increased by respectively 29.8, 27.9 and 18.3 %. In 2000, the largest share of GHG amount was registered in Ireland; however, the indicator was reduced by as many as 29.3 % by 2013. In 2013, the largest amount of GHG per capita was registered in Estonia, while the lowest indicator throughout the analysed period of 2000 – 2013 was measured in Lithuania, Latvia, and Sweden.
Application of the developed regression model for each country analysed has suggested that the model is fairly illustrative of the situation in almost all countries, with the exception of Norway and Lithuania (Table 3). Adjusted coefficient of determination R^2 in Norway in Lithuania is respectively 0.413 (p>0.05) and 0.187 (p>0.05), meanwhile in other countries R^2 has been fluctuation between 0.611 (p<0.05) in Latvia and 0.951 (p<0.05) in Germany. This means that the values of independent variables (X_{it}) in Lithuania explain only 18.7 % variation in GHG amount, while for Sweden, they explain as many as 96.8 %.

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TABLE III
CRITERIA FOR ASSESSMENT OF THE EFFECT OF ENVIRONMENTAL TAXES ON ENVIRONMENTAL PROTECTION, SOURCE: OWN ELABORATION

Suitability criteria	Lithuania	Latvia	Estonia	Ireland	Denmark	Germany	Finland	Sweden	Norway
Adjusted R^2	0.187	0.611	0.628	0.874	0.759	0.951	0.637	0.968	0.413
p-value	0.306	0.036	0.032	0.000	0.008	0.000	0.029	0.000	0.126
Durbin-Watson criterion	0.748	2.359	2.123	1.760	2.499	2.885	2.109	2.495	2.495
ANOVA p-value	0.306	0.036	0.032	0.000	0.008	0.000	0.029	0.000	0.126
Regressors	23	3	21	243	499	31000	447	262	9
Residual	18	0.8	5	20	74	846	115	4	4
Studentized R^2	0.216	0.161	0.207	0.054	0.120	0.064	0.184	0.007	0.372

Source: authors‘ calculation

ANOVA p-values have suggested that the model data are statistically significant for Latvia, Estonia, Ireland, Denmark, Germany, Finland, Sweden, and less significant for Norway and Lithuania (Table 3). Durbin-Watson criterion for majority of the countries falls within interval [1.5; 2.5], indicating absence of any autocorrelation effect. In all countries' models, the number of regressions is higher than that of the residuals; therefore; correct forecasts comprise the larger share. Nevertheless, the highest number of errors remains for Lithuania and Norway, as the studentized R^2 are equal to 0.216 and 0.372 respectively.

In general, it may be suggested that the model provides the most appropriate and high-quality representation of the situation in Sweden and Germany, while the situation in Norway and Lithuania is underrepresented.

The result of correlation analysis has suggested that in Lithuania, the strongest and statistically significant ($p<0.05$) correlation relationship is observed between the GHG amount and the share of environmental tax revenue in total tax revenues, and GDP per capita. Weak negative relationship (-0.497) has been observed between the environmental taxes and GHG amount, indicating that with increase of the revenues from environmental taxes, the GHG amount shows the downward trend. Meanwhile, GDP per capita has a weak positive relationship with the GHG amount (0.435) – growth of the national GDP is accompanied by growth in production and consumption, resulting in increase in GHG amount and pollution. Similar situation has been demonstrated by economic growth, namely, weak positive correlation relationship indicates that the GHG amount has an upward trend in the context of economic growth.

TABLE IV
CORRELATION MATRIX OF GHG AMOUNT AND INDEPENDENT VARIABLES, SOURCE: OWN ELABORATION

Independent varia-bles	Assessment criteria	GHG amount								
		Lithuania	Latvia	Estonia	Ireland	Denmark	Germany	Finland	Sweden	Norway
x_1	R	0.435	0.730	0.736	0.089	-0.764	-0.901	-0.474	-0.787	-0.367
	p-value	0.050	0.002	0.007	0.381	0.001	0.000	0.043	0.000	0.099
x_2	R	0.183	0.683	0.317	-	0.607	0.890	0.122	-0.491	-0.528
	p-value	0.265	0.004	0.135	-	0.011	0.000	0.338	0.037	0.027
x_3	R	-0.497	-0.067	0.365	-0.645	0.845	0.733	0.313	0.288	0.525
	p-value	0.035	0.410	0.100	0.000	0.000	0.001	0.138	0.159	0.027
x_4	R	0.129	-0.566	-0.552	-0.788	-0.901	0.844	-0.613	-0.927	-0.482
	p-value	0.330	0.018	0.020	0.000	0.000	0.000	0.010	0.000	0.410
x_5	R	0.373	-0.014	0.253	0.584	0.357	0.217	0.520	0.496	0.618
	p-value	0.094	0.482	0.191	0.014	0.105	0.229	0.028	0.036	0.009
x_6	R	0.104	0.186	0.385	0.554	0.191	0.216	0.462	0.529	0.229
	p-value	0.361	0.263	0.087	0.020	0.257	0.230	0.048	0.026	0.215

Source: created by authors‘

The model has demonstrated that GHG and share of the revenues from environmental taxes in total tax revenues have a statistically significant relationship in Ireland, Denmark, Germany, and Norway. Strong positive correlation relationship observed in Denmark and Germany indicates that with the GHG amount increasing in these countries, the share of environmental taxes in the overall tax revenues also shows a rising tendency. Although in Ireland and Norway, GHG and environmental tax revenues have medium strong correlation relationship, in Ireland the relationship is negative (-0.645), while in Norway – positive (0.525). In Latvia and Estonia, GDP per capita has the strongest and statistically most significant relationship, while environmental taxes do not have any statistically significant correlation relationship. Change in population shows strong correlation relationship in Ireland, Denmark, Germany and Sweden. In contrast to other countries, change in population has strong positive correlation relationship in Germany. This means that with the population density variation in Germany, its GHG amount follows similar trend, while in other European countries, population density and GHG amount tend to change in different directions.

Investments into environmental protection and GHG have a statistically significant and strong positive correlation relationship in Germany only (0.890). This indicates that investments into environmental protection and GHG amount have the similar trend, i.e. with increase of the GHG amount, more investments are allocated to new, greener equipment, and, to the contrary, with decline of the GHG amount, the need for investment declines as well.

Analysis of coefficients of the polynomial regression (Table 5) has revealed that in Lithuania, economic growth and the share of environmental taxes in total tax revenues have the greatest effect on variation in GHG amount. With increase of the Lithuanian GDP growth by 1 percentage point, the GHG amount would increase by 243 thousand tons as CO_2 equivalent. Meanwhile, increase of environmental tax revenue in total tax revenues by 1 percentage point, the GHG amount would decrease by 438 thousand tons as CO_2 equivalent. Such factors as variation in population density, investments into environmental protection, and annual variation in industrial production do not have any significant effect on variation in the GHG amount in Lithuania.

TABLE V
MODELS FOR ASSESSMENT OF THE EFFECT OF ENVIRONMENTAL TAXES ON ENVIRONMENTAL PROTECTION, SOURCE: OWN ELABORATION

Country	Models
Lithuania	$y_{it} = 23.381 + 0.142x_1 + 0.00x_2 - 0.438x_3 + 0.006x_4 + 0.243x_5 - 0.088x_6$
Latvia	$y_{it} = -7.785 + 0.318x_1 + 0.011x_2 + 0.235x_3 + 0.406x_4 - 0.206x_5 - 0.045x_6$
Estonia	$y_{it} = -59.686 + 0.839x_1 - 0.005x_2 - 0.311x_3 + 2.330x_4 - 0.055x_5 - 0.096x_6$
Ireland	$y_{it} = 119.669 + 0.557x_1 - 2.614x_3 - 0.839x_4 - 0.289x_5 + 0.332x_6$
Denmark	$y_{it} = -514.115 + 0.803x_1 - 0.084x_2 + 2.065x_3 - 3.852x_4 + 0.102x_5 - 0.800x_6$
Germany	$y_{it} = -7206.13 + 13.983x_1 + 0.118x_2 + 23.951x_3 + 32.074x_4 + 7.751x_5 - 1.368x_6$
Finland	$y_{it} = 739.922 + 2.364x_1 + 0.148x_2 + 10.396x_3 - 47.682x_4 + 0.784x_5 - 0.822x_6$
Sweden	$y_{it} = 208.552 + 0.305x_1 + 0.021x_2 + 3997x_3 - 7.899x_4 + 0.579x_5 - 0.066x_6$
Norway	$y_{it} = 60.618 + 156x_1 + 0.000x_2 + 1.740x_3 - 1.789x_4 + 0.434x_5 - 0.110x_6$

Source: created by authors‘

In Latvia and Estonia, GDP per capita and production have the greatest effect on the GHG amount, while in Ireland, Denmark and Finland, GHG amount is influenced the most by population density. In Finland and Norway, environmental taxes also have considerable and statistically significant ($p<0.05$) effect. Meanwhile, in Germany, GHG amount is influenced the most by investments into environmental protection rather than by environmental taxes. In Germany and Norway, variation in GDP per capita and population density also have strong effect on variation in GHG amount.

The pollution index designed using standardized values for each individual country demonstrates how variation of GHG amount is influenced by GDP per capita, investments into environmental protection, share of environmental tax revenue in total tax revenue, population density, economic growth and annual variation in industrial production (Table 6).

TABLE VI
STANDARDIZED ORDERED ARRAY VALUES, SOURCE: OWN ELABORATION

	Denmark	Germany	Estonia	Ireland	Latvia	Lithuania	Finland	Sweden	Norway
2000	0.8163	1.2339	-0.6526	0.2005	-2.4959	-0.3823	0.304	0.9280	0.1691
2001	0.8723	1.1308	-1.0246	1.1448	-0.5533	-1.0329	0.2784	0.7608	0.3891
2002	0.9541	1.0832	-0.8608	0.8588	-0.7365	-0.8681	0.5192	1.1613	0.8966
2003	0.6831	1.0422	-0.5699	0.9724	-0.7431	-0.6357	1.7220	1.0815	0.4396
2004	0.8373	0.8679	-0.6368	0.4972	-0.6066	-0.7615	1.4386	1.0162	0.8684
2005	0.7002	0.0560	-0.4468	0.6652	0.1412	0.0948	-0.5726	0.4512	0.4653
2006	0.6162	0.4444	0.2608	0.9055	0.5840	1.0082	0.3542	0.4024	1.0066
2007	0.4896	0.1247	1.2545	0.7632	1.1152	1.7905	0.3829	0.0216	1.2790
2008	-0.1280	-0.2349	0.7187	0.0211	1.2017	0.6493	0.6143	-0.5322	-0.7004
2009	-0.4721	-1.3051	-1.9102	-0.7746	-0.4927	-1.9301	-1.3342	-1.2417	-2.5042
2010	-0.5457	-0.8472	1.1123	-0.8565	0.7955	-0.1513	0.0869	-0.1118	-0.4748
2011	-1.4867	-0.9642	1.2363	-1.4432	0.5581	0.039	-0.4890	-0.6630	-0.3661
2012	-1.8573	-1.0907	0.5077	-1.2620	0.6721	0.6922	-1.6129	-1.6881	-0.6866
2013	-1.4793	-1.5410	1.0114	-1.6924	0.5603	0.7230	-1.4183	-1.5863	-0.7814

Source: created by authors‘

Based on the standardized values presented in Table 6, different variation tendencies have been observed for the pollution index. In Denmark, Germany, Ireland, Sweden and Norway, the values are high at the start of the analysed period, and low at the end. Opposite situation has been observed in the Baltic States – Estonia, Latvia, and Lithuania. In these countries, the standardized values are low at the start of period, but tend to increase by the end of period. The situation in Finland is different both from the Baltic States and from other European countries, as the variation tendency is the closest to the one of Sweden. In 2009, the values for all countries declined considerably dropping below the average. This was influenced by the global financial crisis, leading to decline in production and consumption, company bankruptcies, all of this resulting in lower pollution index.

The graph demonstrates the upward trend of environmental pollution index in the Baltic States in the period 2000-2013 (Figure 2).

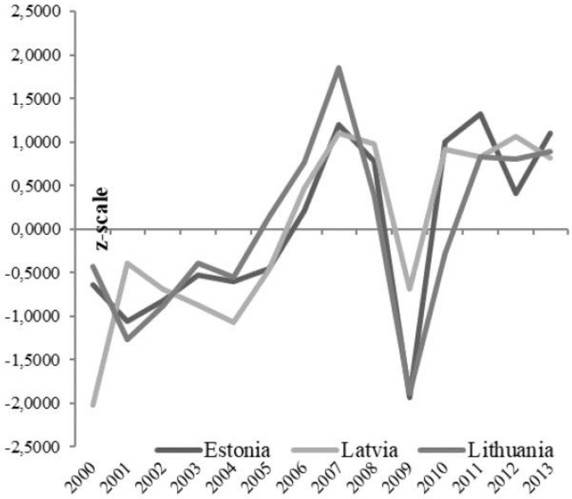

Fig. 2. Variation of environmental pollution index of the Baltic States in 2000 – 2013

As available from Figure 2, environmental pollution index showed an upward trend in 2000–2013 in the Baltic States. Decline of this index may be observed clearly in 2009, as the index involves GDP per capita having considerable influence on reduction of environmental pollution in almost all European countries. Opposite – downward – trend of the environmental pollution index has been observed in other European countries.

Thus, correlation analysis has determined that in Lithuania, the share of environmental tax revenue in total tax revenues and GDP per capita have weak, yet statistically significant relationship with the GHG amount. Meanwhile, strong correlation relationship between environmental taxes and GHG amount has been determined in Denmark and Germany, while in Ireland and Norway the same type of relationship is of medium strength only. Nonetheless, in these European countries, GDP per capita, population and investments into environmental protection have statistically significant relationship with GHG amount. Assessment of the coefficient of multiple regression models has determined that economic growth and environmental taxes have the greatest effect on GHG amount in Lithuania. Meanwhile, in other European countries, GDP per capita (Latvia, Estonia, and Norway), investments into environmental protection (Norway) and population (Ireland, Denmark, Finland, Sweden) have the greatest influence. The developed environmental pollution index suggests that the Lithuanian pollution index has the same trend as in Estonia and Latvia, meanwhile in other European countries, the pollution index shows opposite trend to that of the Baltic States.

CONCLUSIONS

Scientific literature dealing with environmental taxes places insufficient emphasis on discussions, analysis and assessment of the factors of environmental taxation, improvement of environmental protection in the country, and effect of these taxes on environmental protection.

The developed model for assessment of the effect of environmental taxes on environmental protection allows assessing the effect of environmental tax revenues on the indicators of environmental pollution.

Assessment of the effect of environmental taxes in Lithuania and comparison of the situation to other countries has led to the following observations:

Lithuanian environmental taxes are highly significant and have considerable influence on reduction of environmental pollution indicator values, as with the model interpreted as an effective method, GHG amount variation has been found to be influenced the greatest by economic growth and environmental taxes. Meanwhile in other European countries, environmental pollution indicators have been found to be influenced the greatest by GDP per capita (Latvia, Estonia, and Norway), investments into environmental protection (Norway) and population density (Ireland, Denmark, Finland, Sweden).

Lithuanian pollution index has similar variation trend as in Latvia and Estonia, meanwhile in other European countries, the pollution index shows opposite trend to that of the Baltic States, indicating the increasing level of pollution in the Baltic States.

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