

Bostan, Ionel; Onofrei, Mihaela; Dascălu, Elena-Doina; Fîrţescu, Bogdan; Toderaşcu, Carmen

Article

Impact of Sustainable Environmental Expenditures Policy on Air Pollution Reduction, During European Integration Framework

Amfiteatru Economic Journal

Provided in Cooperation with:

The Bucharest University of Economic Studies

Suggested Citation: Bostan, Ionel; Onofrei, Mihaela; Dascălu, Elena-Doina; Fîrţescu, Bogdan; Toderaşcu, Carmen (2016) : Impact of Sustainable Environmental Expenditures Policy on Air Pollution Reduction, During European Integration Framework, Amfiteatru Economic Journal, ISSN 2247-9104, The Bucharest University of Economic Studies, Bucharest, Vol. 18, Iss. 42, pp. 286-302

This Version is available at:

<https://hdl.handle.net/10419/169002>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<http://creativecommons.org/licenses/by/4.0/>

IMPACT OF SUSTAINABLE ENVIRONMENTAL EXPENDITURES POLICY ON AIR POLLUTION REDUCTION, DURING EUROPEAN INTEGRATION FRAMEWORK

**Ionel Bostan^{1*}, Mihaela Onofrei², Elena-Doina Dascălu³, Bogdan Fîrtescu⁴
and Carmen Toderaşcu⁵**

¹⁾ *Stefan cel Mare University of Suceava and Romanian Court of Accounts
of Bucharest, Romania*

²⁾⁴⁾⁵⁾ *Alexandru Ioan Cuza University of Iasi, Romania*

³⁾ *Romanian Court of Accounts of Bucharest and Spiru Haret University
of Bucharest, Romania*

Please cite this article as:

Bostan, I., Onofrei, M., Dascălu, E.D., Fîrtescu, B. and Toderaşcu, C., 2016. Impact of Sustainable Environmental Expenditures Policy on Air Pollution Reduction, During European Integration Framework. *Amfiteatru Economic*, 18(42), pp. 286-302

Abstract

Pursuant to the growth of society, against the boosting of scientific and technological progress, also arises the negative effect of pollution acceleration. In this context, we relate to risks that imply the growth of pollution, especially against nuisance air pollution increase (CO, SO₂, NO etc.) with major implications on the growth of greenhouse effect, the melting of the ice fields, respectively the pollution of the soil with nitrates from fertilizers intensively used in agriculture. Our study is up-to-date, as pursuant to the ONU Conference from Paris (France 2015, Conference on Climate Changes), they reached an agreement and the adopted text admits the menace of climate modifications is far more important than previously acknowledged and engages the participants to reduce their pollutant emissions. The researchers' current concerns focus on studying the effects of the redistribution of financial resources obtained by practising the 'green' fiscal policy on dependent variables. Observing them, we integrate the respective variables into complex models analysed by multiple regression (both standard and robust) and the fixed effects panel on 20 European countries which also reflect the different effects on the environmental policy and the expenses it incurred. The main purpose of the analysis we aim to accomplish is the impact of the policy for environment expenditure tenable within the European framework on against nuisance air pollution attenuation. The statistical analysis aims at identifying these effects by means of regression equations (OLS), robust regression (M method), fixed and random effects, using panel data from 18 EU countries, as well as Switzerland and Turkey due to their position in relation to the community block; we will analyse the period between 1995-2013. Further to the application of multiple regression statistical methods (OLS and

*Corresponding author, **Ionel Bostan** – ionel_bostan@yahoo.com

robust M), our results show that *teimi*gdp expenses played a major role in the reduction of carbon monoxide. These are the total investments made in the mining sector; when these expenses were raised by 1% of the GDP value, there was a decrease of 11 628.3 thousand tons Cot at the level of the European countries analysed, according to the result of the OLS analysis, based on the robust M estimation.

Keywords: environment expenditure, European framework, air quality, environmental policy, pollution reduction, green tax

JEL Classification: H23, Q58, Q530

Introduction

A current problem, highly debated and publicized within the European framework, is that of the natural capital degradation pursuant to the development of the technological systems and of the scientific innovations within various domains. Due to the development of human society, against the boosting of scientific and technological progress, also arises the negative („perverse”) effect of pollution acceleration, therewith determining the sight of new risks (created by every person by their daily activity), the current society transforming itself in a hybrid world (Beck,2002) stated, an interdependence between nature and culture. At this point we have in view the risks that favour the rise of the level of pollution in the context of a higher volume of noxes (CO, SO₂, NO_x etc.) which, among other things, resulted in an extremely increased greenhouse effect, melting of glaciers, and soil pollution by nitrates used in agricultural fields. Therefore, in our opinion, the present approach is in the pipeline, as pursuant to the ONU Conference from Paris (France 2015, Conference on Climate Changes), they reached an agreement and the adopted text admits the menace of climate modifications is far more important than previously acknowledged and engages the participants to reduce their pollutant emissions. This impels all countries to a commitment concerning carbon emissions, and previously, key-groups such as G77 – a group of emergent countries, but also countries like China and India announced they shall actively support the adopted motions.

The main purpose of the analysis we aim to accomplish is the impact of the policy for environment expenditure tenable within the European framework on nuisance air pollution attenuation. The statistical analysis targets the identification of these effects through regression equations (OLS), robust regression (method M), random and fixed effects, using panel data from 20 European countries, for the period between 1995 and 2013. The states included in the analysis are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden (EU member), respectively Switzerland and Turkey – due their geographic and economic position, as partners of EU. We consider that the environmental policy within the European framework against the economic sustainability is highly connected and conditioned by the economic and financial politics, having a huge impact on competitiveness increase, but equally connected with the community environmental programmes. Concurrently, the environmental programmes once elaborated and implemented into the economic system, aims at assuring a continuous development, improvement of national and community environmental policies, respectively the enhancement of these activities for pollution reduction.

The original input of this essay consists in the study of effects redistribution of the financial resources attained by environment taxes, allocating them by environment expenditure, on dependent variables studied separately in speciality literature and which we integrated in complex patterns, analysed both by multiple regression (standard and robust) and by fix and random effects applied to panel data on 20 European countries, that also reflect the various effects of environment policy (expenditure).

Our wish to give scientific consistency to the present approach, on the one hand and to make the final results robust/ solid, on the other hand determined us to use this complex statistical analysis. Our aim is to account for the effects mentioned above via regression equations (OLS), robust regression (M), fixed and random effects.

1. Literature review

EU environment policy altered and developed during the last years by introducing the Environmental Tax Reforms (ETR) on the member states legislation. Environment expenditure and taxes thus become instruments of environment protection that promote pollution reduction, based on the economic principle „the pollutant is the payer” (Bostan *et al.*, 2009). Authors such (Bosquet, 2000; Do Valle *et al.*, 2012) argue that the environmental taxes (also called “green taxes”) and the ETR mostly contribute by applying taxes on CO₂ (carbon taxes) for diminishing global warming.

The directions of environment policy within the member states of OECD were approached by many authors such as (Lafferty *et al.* (2003), Knill *et al.* (2010), respectively Holzinger *et al.* (2011). Ruffing (2010) highlight the importance of the economic leverages used on the level of environment policy, observing that the environment policy directions always follow the direct environment regulations (environment standards, emission standards, design standards, product standards, etc.) and the economic instruments (environment taxes and expenditure, as integrant parts of the environment policy) meant to stimulate the public financial support as an encouragement of the practices in accord with the environment and of the environment financing investments. Debates concerning the environment policy and certain innovations (such as such as payments for ecosystem services – PES) are approached by authors like Johnstone *et al.* (2010), Everett *et al.* (2010), Ambec *et al.* (2011), Ohori (2011), respectively Dunn (2011). Recent studies belonging to authors like Haibara (2009), Do Valle *et al.* (2012) highlight that, in reality, the environment taxes, as part of the environment policy, only represent redistribution (by environment expenditure and subventions) in the sense that these are allocated to producers for „technology renewal”. For example, in Sweden, the taxes on GHG and other gases emissions return to companies depending on the energy they furnish. Roads construction in many countries among which is Romania is directly or indirectly financed by taxes and/or excises on power fuels, and the resources attained by taxing water are used for infrastructure efficiency.

Studies that empirically approach the interdependence between environment policy (environment taxes) and pollution (expressed by GHG and other emissions) are also found at Kotnik (2014), López *et al.* (2011), López and Palacios (2014), Miller and Vella (2013), that measure the impact of taxation on GHG reduction. Other studies such as the study belonging to Clinch *et al.* (2006), argue that the tax on energy leads to the improvement of the air quality by reducing CO₂, SO₂ and NO_x emissions. Morley (2012) investigates the impact of the environment taxes on air pollution, as an adjective process of the energy

consumption in EU and Norway between 1995 and 2006. Results of the study reveal the diminished effects on pollution, but also the limited effect on using the energetic resources. Miller and Vella (2013) examine the long term relation between climatic factors, based on panel data on 35 countries, between 1975 and 2012. The empiric study indicates the existence of a long term relation between the variables included in regression and the importance of the nuclear energy in limiting gas emissions (GHG). The purpose of the study accomplished by Rafaj *et al.* (2014) is to identify the major impact factors on the evolution of SO₂, CO₂ and NO_x emissions in Europe, between 1960 and 2010. The author identifies major differences emerging between Eastern and Western Europe countries, especially concerning the decrease of sulphur dioxide SO₂.

2. The database

The data are obtained from Eurostat (n.d.). The initial database is unbalanced and contains 335 up to 646 statistical observations, regarding the variables, referring to period 1995-2013. In order to achieve a better data visualisation, we have decided to eliminate the observations that are not available (NA's), a brief description of the database, used as base for statistical calculations, being presented at Annex no. 1. The latest database is unbalanced and contains 259 statistical observations.

The independent variable codification is presented as follows:

- epegovgdp – Environmental protection expenditure for General government, Percentage of gross domestic product (GDP)
- tcelegdp – Total environmental current expenditure for Electricity, gas, steam and air conditioning supply; water collection, treatment and supply, Percentage of gross domestic product (GDP)
- tcgovgdp – Total environmental current expenditure for General government, Percentage of gross domestic product (GDP)
- tcemangdp – Total environmental current expenditure for Manufacturing, Percentage of gross domestic product (GDP)
- tcemiqgdp – Total environmental current expenditure for Mining and quarrying, Percentage of gross domestic product (GDP)
- tceppsgdp – Total environmental current expenditure for Private and public specialised and secondary producers of environmental protection services (mainly E37, E38.1, E38.2 and E39), Percentage of gross domestic product (GDP)
- teielegdp – Total environmental investments for Electricity, gas, steam and air conditioning supply; water collection, treatment and supply, Percentage of gross domestic product (GDP)
- teigovgdp – Total environmental investments for General government, Percentage of gross domestic product (GDP)
- teimangdp – Total environmental investments for Manufacturing, Percentage of gross domestic product (GDP)
- teimiqgdp – Total environmental investments for Mining and quarrying, Percentage of gross domestic product (GDP)

• teipps – Total environmental investments for Private and public specialised and secondary producers of environmental protection services (mainly E37, E38.1, E38.2 and E39), Percentage of gross domestic product (GDP).

Due to existence of correlation between some independent variables, we have removed them from the regression model, along with the variables with high levels of VIF's (Variance Inflation Factor). The results after this procedure are shown in table no. 1.

Table no. 1 The Variance Inflation Factor after removing some dependent variables with high levels of correlation

epgovgdp	tcelegdp	tcegovgdp	tcemangdp	tcemiogdp	tceppsgdp	teielegdp	teigovgdp	teimangdp	teimiogdp	teipps
4.31	1.523	6.498	1.441	1.968	2.228	1.664	3.300	1.346	1.689	2.156

The statistical model is presented in next section.

3. The Model and the Results

The statistical model (for panel data) is shown in Equation no. 1

$$Dv_t^m = c + \sum_{i=1}^n \alpha_i EnvExp_{it} + \chi + \mu \quad (1)$$

Where:

Dv_t – dependent variables (Cot – CO carbon monoxide emissions in thousand tonnes; NOXt – nitrogen oxide emissions, in thousand tonnes; PMm - PM10 Emissions, micrograms per cubic meter; SO2t–Sulfur / also Sulphur dioxide) emissions, in thousand tonnes);

EnvExp – Environmental expenditures (total investments and current expenditure for business sector total and public sector) as percentage of GDP;

i – counter by categories in expenditures;

t – Time period (1995-2013);

n – number of independent variables;

m – number of dependent variable (1-4);

α – Coefficients (estimated parameters);

c – constant;

χ – individual effects;

ui – Idiosyncratic errors.

Codification of variables used in the model is shown above (see Chapter 2), and the results of statistical modelling are presented below in sections 3.1-3.3.

3.1 The Results of the Multiple Linear Regression (OLS method)

The results of the Breusch-Pagan tests (Annex no. 2) indicates the presence of heteroskedasticity, which have effects on the reported results (the coefficients are unbiased and consistent, but inefficient, the reported errors being biased). For more accurate results in the presence of heteroscedasticity, we consider that the use of standard robust errors is more appropriate in reporting (see also Zeileis, 2006), HC3, as suggested by Long and Ervin (2000) who are actually the most employed in economic literature.

In order to present a synthetic research results, for showing the influence of the independent variables (represented by Environmental Expenditure in the global context of European Environmental Policy) on dependent variables (air pollution), we have shown during the paper only the variables with coefficients that fulfil simultaneous two conditions (the full summary of regression equations can be found in the appendices):

- have the expected sign (negative values, sign minus),
- are statistically representative (at least 10% level).

The results of OLS regression with robust standard errors HC3 type are shown in table no. 2, as follows:

Table no. 2. The results of OLS regression

	Cot (1)	NOxt (2)	PMm (3)	S02t (4)
epegovgdp	-2,858.264*** p = 0.00001	-13.092** p = 0.035	-1,545.687*** p = 0.00000	-1,562.384*** p = 0.000
tceelegdp	959.300 p = 0.161	1.581 p = 0.696	220.717 p = 0.397	-482.605*** p = 0.009
tceppsgdp	310.098 p = 0.144	-3.220* p = 0.069	105.389 p = 0.221	69.366 p = 0.372
teielegdp	-3,395.353*** p = 0.00001	14.575** p = 0.017	-1,556.968*** p = 0.00000	-754.094*** p = 0.007
teimangdp	-3,694.941*** p = 0.00000	1.201 p = 0.872	-1,317.190*** p = 0.00001	-591.582* p = 0.088
teimiaggdp	-11,628.230*** p = 0.001	102.511*** p = 0.003	-6,118.512*** p = 0.00001	-3,220.532*** p = 0.003
Constant	700.847*** p = 0.0005	33.416*** p = 0.000	347.848*** p = 0.0001	581.963*** p = 0.0001

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Note: OLS regression - the dependent variables are: Cot - CO carbon monoxide emissions in thousand tonnes; NOxt - nitrogen oxide emissions, in thousand tonnes; PMm - PM10 Emissions, micrograms per cubic meter; S02t - Sulfur (also Sulphur dioxide) emissions, in thousand tonnes; only coefficients for independent variables that are statistically significant and have minus sign are presented.

The result of the robust linear regression which is less sensitive to the presence of outliers is shown next section.

3.2 The results of the robust linear model (M estimation method)

The Bonferroni tests reveal the presence of some outliers (see Annex no. 3), so we use in further analyse the robust regression, which is less sensitive to extreme values. We consider that is not necessary to eliminate from the database these values, because we consider not being errors in data collection, and being part of the same population. A description of the method is available at Fox and Weisberg (2010).

The results of robust regression are shown in Annex no. 5. We present in table no. 3, only the coefficients that fulfil the above explained conditions:

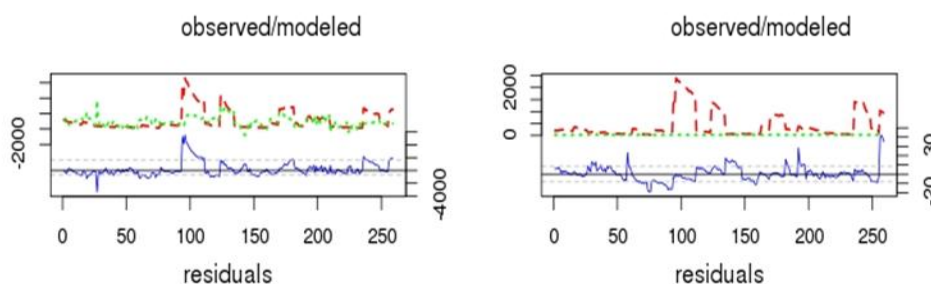
Table no. 3. The results of robust regression

	C0t (1)	NOXt (2)	PMm (3)	SO2t (4)
epegovgdp	-2,024.927*** p = 0.002	-11.073 p = 0.178	-844.159*** p = 0.00005	-862.067*** p = 0.00000
teielegdp	-2,336.260*** p = 0.0002	18.682*** p = 0.005	-878.507*** p = 0.00003	-331.893 p = 0.121
teimangdp	-2,743.950*** p = 0.00002	8.780 p = 0.233	-935.639*** p = 0.00001	-276.980 p = 0.124
teimiaggdp	-6,925.038* p = 0.060	83.592*** p = 0.003	-3,934.846*** p = 0.0002	-3,511.520*** p = 0.001
Constant	465.323*** p = 0.009	29.378*** p = 0.000	137.721** p = 0.030	162.108*** p = 0.0004

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Note: OLS regression - the dependent variables are: C0t - CO carbon monoxide emissions in thousand tonnes; NOXt - nitrogen oxide emissions, in thousand tonnes; PMm - PM10 Emissions, micrograms per cubic meter; SO2t - Sulphur (also Sulphur dioxide) emissions, in thousand tonnes; only coefficients for independent variables that are statistically significant and have minus sign are presented.

The graphical representation of the models (figure no.1) for dependent variables (C0t, NOXt, PMm si SO2t) shows initial values (gap line), fitted values (dotted line) and residuals (continuous line). The order of the graphics corresponds to regression analyse order - in graphic matrix (the graph from line 1, column 1 corresponds to the C0t model).



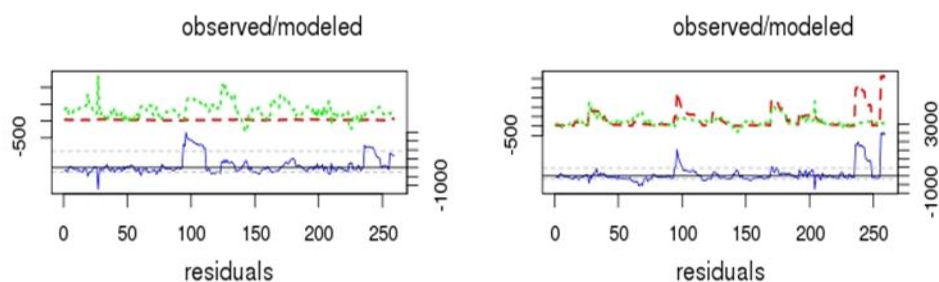


Figure no. 1. Graphical representation of statistical models

The results of Panel Data Fixed/Random Effects Models are presented in the following section.

3.3 The results of Panel Data Fixed/Random Effects Models

For panel data, we consider the Id variable being represented by Country and time variable by Year. The results of Panel Data Fixed/Random Effects Models are shown in Annex no. 4 and Annex no. 5.

The results for the variables that fulfil the imposed conditions in fixed effects models are presented in table no. 4.

Table no. 4. The Results for Panel Data Fixed Effects

Fixed effects panel clustered robust errors				
	C0t fixed (1)	NOXt fixed (2)	PMm fixed (3)	S02tfixed (4)
epegovgdp	-150.979	-0.458	-140.266**	-288.338**
	p = 0.639	p = 0.867	p = 0.045	p = 0.045
tceelegdp	142.464	-4.273	-0.424	-255.071*
	p = 0.624	p = 0.394	p = 0.995	p = 0.079
tceppsgdp	-209.354	-8.352***	-90.341*	-218.617**
	p = 0.207	p = 0.003	p = 0.088	p = 0.048
Notes:				
	***Significant at the 1 percent level.			
	**Significant at the 5 percent level.			
	*Significant at the 10 percent level.			
Note 1: Panel data fixed time effects - only coefficients for independent variables that are statistically significant and have minus sign are presented;				
Note 2: the model shows fixed-effects(the error structure is assumed to be hetero-skedastic autocorrelated upto some lag and possibly correlate between the groups).				

The results for the variables that fulfil the imposed conditions in random effects models are presented in the table no. 5.

Table no. 5. The Results for Panel Data Random Effects

Random effects panel clustered robust errors				
	C0t random (1)	NOXt random (2)	PMm random (3)	SO2t random (4)
epegovgdp	-160.229 p = 0.626	-0.930 p = 0.732	-143.718** p = 0.045	-305.238** p = 0.039
tceelegdp	151.046 p = 0.608	-4.179 p = 0.402	1.162 p = 0.985	-259.676* p = 0.070
tceppsgdp	-195.835 p = 0.219	-8.299*** p = 0.003	-88.441* p = 0.091	-217.469** p = 0.047
Constant	814.328*** p = 0.006	39.780*** p = 0.000	379.476*** p = 0.00005	413.188** p = 0.012
Notes:				
***Significant at the 1 percent level.				
**Significant at the 5 percent level.				
*Significant at the 10 percent level.				
Note 1: Panel data random effects – only coefficients for independent variables that are statistically significant and have minus sign are presented.				
Note 2: the model shows fixed-effects(the error structure is assumed to be hetero-skedastic, autocorrelated upto some lag and possibly correlated between the groups).				

The results of F test for individual effects and Lagrange Multiplier Test (Annex no. 6) justifies the panel group of data, providing significant results than OLS regression. The Hausman tests (Annex no. 7) suggests that fixed effects analysis is to prefer instead of random effects. We decided to show the both results, in concordance to statistical literature (Baltagi, 2008), that suggests in the estimation of the both models (fixed and random) to also use the information criteria in order to choose between FE and RE models.

4. Results and discussion

In relation to the analysis we conducted, we ascertain that both the regression analysis for pool data and for panel data, highlights the diminished effects of the nuisance air pollution, pursuant to the usage of instruments specific to environment policy, rather the redistribution of the financial resources as expenditure made both in the public and private sector, while actually expressing the fulfilment of their main economic vocation, that of reducing pollution. Effects are to be found differently, depending on the country (q.v. Annex no. 8), and the biggest decrease is to be found in the Czech Republic for carbon monoxide CO, according to the results of the fixed effects. The attained results are in accordance with Rafaj *et al.* (2014) as regards the differences emerging between Eastern and Western Europe countries, especially in reducing sulphur dioxide SO₂.

We ascertain, as table no. 6 suggests, the types of expenditure with impact on all the dependent variables, revealed by the statistic results (negative value in pattern and statistically representative) in all regression equations is *epegovgdp* – environmental protection expenditure by general government, expressed as percentage of Gross Domestic

Product. We ascertain that this type of expenditure has effects of reduction on all noxae (COt, NOxt, PMm, SO2t). We therefore ascertain that the Government interventions, both on the legislative and financial aspect, are very important. The conclusion is in accordance with the study of Horbach *et al.*(2012), who states that both the regulations and the governmental intervention are important in the decision making of the private companies to reduce gas emissions (CO2, SO2 or NOx) or phonic pollution.

Table no. 6. The influence of Environmental protection Expenditure on Nuisance Air Pollution Reduction

Variabila	COt				NOxt				PMm				SO2t			
	lm	rlm	fix	rnd	lm	rlm	fix	rnd	lm	rlm	fix	rnd	lm	rlm	fix	rnd
epegovgdp	x	x			x			x	x	x	x		x	x	x	x
tcelegdp													x		x	x
teielegdp	x	x							x	x			x			
teimangdp	x	x							x	x			x			
teimiaggdp	x	x							x	x			x	x		
tceppsgdp							x	x			x	x			x	x

The information presented here is significant for assessing the importance of the governments' legislative and financial intervention, as claimed by Horbach *et al.* (2012). They proved that regulations and governmental intervention are essential in the decision of private companies to reduced gas emissions (CO2, SO2 or Nox) or phonic pollution; similarly, due to the results we reached, we may consider that we thus contribute to increasing the awareness of the parties interested in the matter with respect to the problems outlined above.

Conclusion

As can be seen from the present study, our results are in agreement with those obtained by other authors (Morley, 2012; Rafaj *et al.*, 2014). In essence, our results of the multiple regression (OLS and robust M), highlighting that the biggest impact on carbon monoxide reduction is the one given by *teimiaggdp* expenditure – Total environmental investments by Mining and quarrying sector as Percentage of Gross Domestic Product (GDP). This actually suggests that when raising these costs by 1% of the GDP value, it emerges a reduction at the level of analysed European countries of 11628,3 thousands tones COt, according to the results of OLS analysis, respectively 6925 thousands tones COt, according to the result of robust M analysis.

The robustness of the results obtained is fully confirmed, a situation that may be explained by an adequate use of the three methods mentioned above, and the algorithm used is adaptable/ can be generalise (on a semiautomatic manner) to other sets of statistic data. In the case of fixed effects, the expenditure with the biggest impact seem to be *epegovgdp*, these having the maximum effect on COt reduction (on an increment of 1% to this type of expenditure in GDP, it emerges a decrease of 305.2 thousands tones).

The limits of our study, as in the case of other econometric research, are closely related to missing or lack of complete data for some countries and, also, to the short period of time (the reports are annual).Consequently, we propose for the future studies, we wish to fathom this analysis, while also considering the possibility of adding certain instrumental variables

(for controlling possible appearance of endogeneity phenomenon), respectively, attempting to quantify the level of sustainability of the economic and financial leverages (other than environmental expenditure).

References

- Ambec, S., Cohen, M., Elgie S. and Lanoie, P. 2013. The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? *Review of Environmental Economics and Policy*, 7(1), pp.2-22.
- Baltagi, B.H., 2008. *Econometric analysis of panel data*. New York: John Wiley & Sons Ltd.
- Beck, U., 2002. *The Terrorist Threat World Risk Society Revisited, Theory, Culture & Society*. s.l:s.n.
- Bosquet, B., 2000. Environmental Tax Reform: Does It Work? A Survey of the Empirical Evidence. *Ecological Economics*, 34(1), pp. 19-32.
- Bostan, I., Burciu, A. and Condrea P., 2009. Involvement of legal responsibility for severe acts of pollution and noncompliance. *Environ Eng Manage J*, 8(3), pp. 469-473.
- Clinch, J.P., Dunne, L. and Dresner, S., 2006. Environmental and Wider Implications of Political Impediments to Environmental Tax Reform. *Energy Policy*, 34(8), pp. 960-970.
- Do Valle, P.O., Pintassilgo, P., Matias, A. and Andre, F., 2012. Tourist Attitudes Towards an Accommodation Tax Earmarked for Environmental Protection: A Survey in the Algarve. *Tourism Management*, 33(2), pp. 1408-1416.
- Dunn, H., 2011. *Payments for Ecosystem Services*. [online] Available at: <<http://www.defra.gov.uk/publications/2011/10/13/ecosystem-payment-pb13658/>> [Accessed 2 August 2015].
- Eurostat, n.d. Eurostat. Your key to European statistics. [online] Available at: <<http://ec.europa.eu/eurostat/data/database>> [Accessed 15 July 2015].
- Everett, T., Ishwaran, M., Ansaloni, G.P. and Rubin, A., 2010. *Economic Growth and the Environment*. [online] Available at: <<http://www.defra.gov.uk/publications/files/pb13390-economic-growth-100305.pdf>> [Accessed 4 August 2015].
- Fox, J. and Weisberg, S., 2010. *Robust Regression in R An Appendix to An R Companion to Applied Regression*. [online] Available at: <<https://socserv.socsci.mcmaster.ca/jfox/Books/Companion/appendix/Appendix-Robust-Regression.pdf>> [Accessed 12 June 2015].
- Haibara, T., 2009. Environmental Funds, Public Abatement, and Welfare. *Environmental and Resource Economics*, 44(2), pp. 167-177.
- Horbach, J., Rammer, C. and Rennings, K., 2012. Determinants of eco-innovations by type of environmental impact – The role of regulatory push/pull, technology push and market pull. *Ecological Economics*, 78(iss. June), pp. 112-122.
- Johnstone, N., Haščic, I. and Kalamova, M., 2010. Environmental Policy Characteristics and Technological Innovation. *Economia Politica*, 27(2), pp. 275-299.
- Kotnik, Z., Klun, M. and Damjan Škulj, D., 2014. The Effect of Taxation on Greenhouse Gas Emissions. *Transylvanian Review of Administrative Sciences*, No. 43 E, pp. 168-185.

- Knill, C., Debus, M. and Heichel, S., 2010. Do parties matter in internationalised policy areas? The impact of political parties on environmental policy outputs in 18 OECD countries, 1970-2000. *European Journal of Political Research*, iss. 49, pp. 301-330.
- Lafferty, W. and Eivind Hovden, E., 2003. Environmental policy integration: towards an analytical framework. *Environmental Politics*, 12(3), pp. 1-10.
- López R., Galinato, G. and Islam, A., 2011. Fiscal spending and the environment: theory and empirics. *Journal of Environmental Economics and Management*, iss. 62, pp. 80-198.
- López, R. and Palacios, A., 2014. Why has Europe Become Environmentally Cleaner? Decomposing the Roles of Fiscal. *Trade and Environmental Policies. Environmental and Resource Economics*, 58(1), pp. 91-108.
- Long, J.S. and Ervin, L.H., 2000. Using Heteroscedasticity Consistent Standard Errors in the Linear Regression Model. *The American Statistician*, iss. 54, pp. 217-224.
- Miller, S.J. and Vela, M.A., 2013. *Are Environmentally Related Taxes Effective?*, *Inter-American Development Bank*. [online] Available at: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2367708> [Accessed 21 September 2015].
- Morley, B., 2012. Empirical evidence on the effectiveness of environmental taxes. *Applied Economics Letters*, 19(18), pp. 1817-1820.
- Ohori, S., 2011. Environmental policy instruments and foreign ownership. *Environmental Economics and Policy Studies*, 13(1), pp. 65-78.
- Holzinger, K., Knill, C. and Sommerer, T., 2011. Is there convergence of national environmental policies? An analysis of policy outputs in 24 OECD countries. *Environmental Politics*, 20(1), pp. 20-35.
- Rafaj, P., Amann, M., Siri, J. and Wuester, H., 2014. Changes in European greenhouse gas and air pollutant emissions 1960–2010: decomposition of determining factors. *Climatic Change*, 124(3), pp. 477-504.
- Ruffing, K.G., 2010. The Role of the Organization for Economic Cooperation and Development. *Environmental Policy Making Review of Environmental Economics and Policy*, 4(2), pp. 199-210.
- Zeileis, A., 2006. Object-oriented Computation of Sandwich Estimators. *Journal of Statistical Software*, 16(9), pp. 1-16.

Annex no. 1

Summary statistics for data – NA's values removed

Statistic	N	Mean	St. Dev.	Min	Median	Max
Year	259	2,005.467	4.512	1,995	2,006	2,013
C0t	259	1,111.981	1,298.260	18.000	508.500	6,595.100
PMm	259	34.361	9.141	15.400	33.900	72.700
NOxt	259	425.734	548.215	19.200	209.600	2,390.900
SO2t	259	366.562	532.420	7.500	94.000	2,665.000
epeelegdp	259	0.178	0.171	0.010	0.110	0.760
epegovgdp	259	0.517	0.299	0.010	0.500	1.680
epeindgdp	259	0.557	0.297	0.080	0.500	1.530
epemangdp	259	0.349	0.156	0.040	0.340	0.970
epemiqgdp	259	0.030	0.044	0.000	0.010	0.260
epeppsgdp	259	0.726	0.617	0.020	0.600	3.570
tcelegdp	259	0.090	0.101	0.000	0.050	0.630
tcegovgdp	259	0.280	0.209	0.000	0.250	1.420
tceindgdp	259	0.348	0.198	0.020	0.310	1.110
tcemangdp	259	0.238	0.124	0.020	0.220	0.860
tcemiqgdp	259	0.020	0.031	0.000	0.010	0.200
tcpeppsgdp	259	0.565	0.521	0.000	0.430	2.990
teielegdp	259	0.089	0.099	0.000	0.050	0.550
teigovgdp	259	0.175	0.148	0.000	0.130	0.960
teiindgdp	259	0.210	0.147	0.010	0.150	0.840
teimangdp	259	0.111	0.077	0.010	0.090	0.460
teimiqgdp	259	0.009	0.018	0.000	0.000	0.140
teippepgdp	259	0.160	0.137	0.000	0.130	0.870

Annex no. 2

Results of Studentized Breusch-Pagan Test

```

studentized Breusch-Pagan test
data: lm3-C0t
BP = 33.257, df = 11, p-value = 0.0004779
studentized Breusch-Pagan test
data: lm4-SO2t
BP = 31.062, df = 11, p-value = 0.001077
studentized Breusch-Pagan test
data: lm5-PMm
BP = 61.239, df = 11, p-value = 5.454e-09
studentized Breusch-Pagan test
data: lm6-NOxt
BP = 33.813, df = 11, p-value = 0.0003881

```

Annex no. 3

Outliers

```

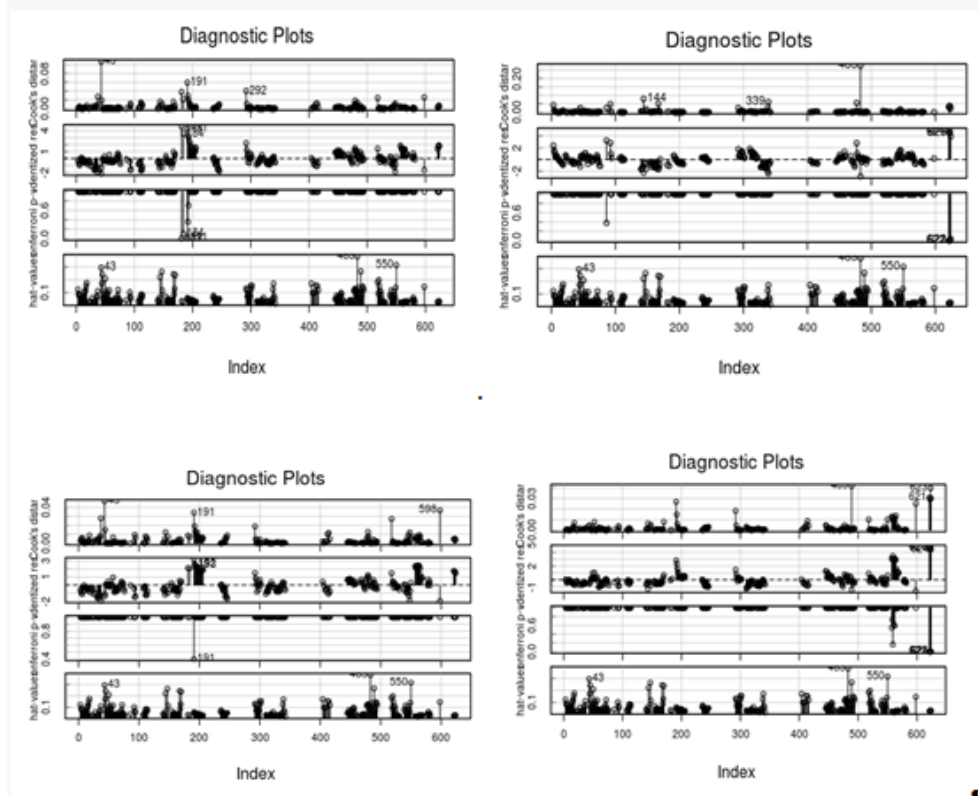
rstudent unadjusted p-value Bonferonni p
181 4.586664 7.2567e-06 0.0018795
191 4.289270 2.5998e-05 0.0067334
rstudent unadjusted p-value Bonferonni p
622 5.007545 1.0683e-06 0.00027669
621 4.580021 7.4718e-06 0.00193520
623 4.542463 8.8085e-06 0.00228140
624 3.887723 1.3101e-04 0.03393200

```

No Studentized residuals with Bonferonni $p < 0.05$

Largest |rstudent|:

	rstudent	unadjusted p-value	Bonferonni p
191	3.204245	0.0015378	0.39828
	rstudent	unadjusted p-value	Bonferonni p
623	4.784478	2.9959e-06	0.00077594
621	4.724679	3.9262e-06	0.00101690
624	4.436177	1.3955e-05	0.00361430
622	4.420284	1.4938e-05	0.00386900



Annex no. 4

Panel Data Fixed Effects Results

	Cot fixed (1)	NOXt fixed (2)	PMm fixed (3)	S02t fixed (4)
epgovgdp	-150.979 p = 0.639	-0.458 p = 0.867	-140.266** p = 0.045	-288.338** p = 0.045
tcelegdp	142.464 p = 0.624	-4.273 p = 0.394	-0.424 p = 0.995	-255.071* p = 0.079
tcegovgdp	464.135 p = 0.530	-7.084 p = 0.234	236.416 p = 0.141	181.713 p = 0.479
tcemangdp	1,123.069 p = 0.139	-0.208 p = 0.952	181.728 p = 0.284	223.557 p = 0.247
tcemiqgdp	703.395 p = 0.559	1.963 p = 0.807	-4.917 p = 0.987	1,265.946 p = 0.236

tceppsgdp	-209.354	-8.352***	-90.341*	-218.617**
	p = 0.207	p = 0.003	p = 0.088	p = 0.048
teielegdp	-256.757	5.207	-25.190	68.913
	p = 0.493	p = 0.150	p = 0.796	p = 0.582
teigovgdp	623.703	3.667	214.811	455.085*
	p = 0.363	p = 0.501	p = 0.127	p = 0.087
teimangdp	259.447	7.293	140.567	347.767*
	p = 0.466	p = 0.236	p = 0.123	p = 0.079
teimiogdp	-5,038.397	17.729	-495.382	-46.850
	p = 0.212	p = 0.391	p = 0.664	p = 0.970
teippsgdp	432.215	1.981	156.422	224.693
	p = 0.286	p = 0.499	p = 0.194	p = 0.255

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Annex no. 5

Panel Data Random Effects Results

	COt fixed (1)	NOXt (2)	PMm (3)	SO2t (4)
-----	-----	-----	-----	-----
epegovgdp	-160.229	-0.930	-143.718**	-305.238**
	p = 0.626	p = 0.732	p = 0.045	p = 0.039
tcelegdp	151.046	-4.179	1.162	-259.676*
	p = 0.608	p = 0.402	p = 0.985	p = 0.070
tcegovgdp	478.716	-6.226	242.573	198.393
	p = 0.519	p = 0.289	p = 0.135	p = 0.436
tcemangdp	1,140.286	-0.184	186.293	216.123
	p = 0.149	p = 0.957	p = 0.292	p = 0.267
tcemiogdp	755.777	3.015	1.943	1,306.882
	p = 0.548	p = 0.705	p = 0.995	p = 0.229
tceppsgdp	-195.835	-8.299***	-88.441*	-217.469**
	p = 0.219	p = 0.003	p = 0.091	p = 0.047
teielegdp	-291.979	5.062	-31.966	60.714
	p = 0.440	p = 0.158	p = 0.745	p = 0.621
teigovgdp	619.523	3.925	216.233	467.758*
	p = 0.370	p = 0.476	p = 0.131	p = 0.083
teimangdp	222.449	7.102	134.940	331.953*
	p = 0.527	p = 0.246	p = 0.140	p = 0.090
teimiogdp	-5,184.045	18.049	-523.780	-90.867
	p = 0.204	p = 0.378	p = 0.647	p = 0.941
teippsgdp	442.424	2.292	157.540	226.477
	p = 0.304	p = 0.453	p = 0.206	p = 0.263
Constant	814.328***	39.780***	379.476***	413.188**
	p = 0.006	p = 0.000	p = 0.00005	p = 0.012
=====	=====	=====	=====	=====
Notes:	***Significant at the 1 percent level.			
	**Significant at the 5 percent level.			
	*Significant at the 10 percent level.			

Annex no. 6

F test for individual effects and Lagrange Multiplier Test Results

F test for individual effects

data: C0t
F = 12.156, df1 = 23, df2 = 224, p-value < 2.2e-16
alternative hypothesis: significant effects
F test for individual effects

data: NOxt
F = 257770, df1 = 23, df2 = 224, p-value < 2.2e-16
alternative hypothesis: significant effects
F test for individual effects

data: PMm
F = 318.11, df1 = 23, df2 = 224, p-value < 2.2e-16
alternative hypothesis: significant effects
F test for individual effects

data: S02t
F = 104.27, df1 = 23, df2 = 224, p-value < 2.2e-16
alternative hypothesis: significant effects
Lagrange Multiplier Test - (Breusch-Pagan)

data: C0t
chisq = 23795, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects

data: NOxt
chisq = 22582, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects

data: PMm
chisq = 11576, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects

data: S02t
chisq = 23478, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects

Annex no. 7

Hausman Test Results

Hausman TestsCotdata: F chisq = 207.9915, df = 11, p-value < 2.2e-16
alternative hypothesis: one model is inconsistentS02t
data: F chisq = 229.8915, df = 11, p-value < 2.2e-16
alternative hypothesis: one model is inconsistent

PMm
data: F chisq = 207.3915, df = 11, p-value < 2.2e-16
alternative hypothesis: one model is inconsistent

NOxt
data: F chisq = 291.9315, df = 11, p-value < 2.2e-16
alternative hypothesis: one model is inconsistent

Annex no. 8

Fixed effects (constants for each country)

>fixed effects (CO _t)					
Austria	Belgium	Bulgaria	Croatia	Cyprus	CzechRepublic
Estonia	Finland				
654.10079	273.55545	-190.41926	100.28268	-323.34870	77.76335
-58.93281	151.22075				
France	Germany	Hungary	Italy	Latvia	Lithuania
Netherlands	Poland				
5003.15353	3957.43075	13.14333	2417.53327	45.26722	-245.26124
21.29165	2300.71608				
Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
Switzerland	Turkey				
208.04089	1239.45346	-123.58462	-379.13140	2057.61960	447.14427
-51.39586	2129.05443				
>fixed effects (NO _{x,t})					
Austria	Belgium	Bulgaria	Croatia	Cyprus	CzechRepublic
Estonia	Finland				
49.76607	39.09723	47.74479	34.13269	53.60477	35.42228
31.08924	20.96869				
France	Germany	Hungary	Italy	Latvia	Lithuania
Netherlands	Poland				
36.94669	34.47460	38.75770	48.76758	46.48407	30.54358
40.23570	41.41053				
Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
Switzerland	Turkey				
40.37418	50.15048	33.73351	34.33196	40.38610	27.47324
29.03007	72.82620				
>fixed effects (PM ₁₀)					
Austria	Belgium	Bulgaria	Croatia	Cyprus	CzechRepublic
Estonia	Finland				
266.04393	217.28087	30.54498	19.00307	-45.72764	199.00947
14.76043	131.61556				
France	Germany	Hungary	Italy	Latvia	Lithuania
Netherlands	Poland				
1380.37254	1916.57710	106.07243	1064.08511	17.96683	-30.13310
174.41126	800.79552				
Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
Switzerland	Turkey				
158.94672	266.28731	11.91094	-45.67012	1248.51149	268.67637
45.37022	927.48408				
>fixed effects (SO _{2,t})					
Austria	Belgium	Bulgaria	Croatia	Cyprus	CzechRepublic
Estonia	Finland				
354.03165	208.94352	465.66398	-13.96907	63.53050	111.47898
138.59767	63.31590				
France	Germany	Hungary	Italy	Latvia	Lithuania
Netherlands	Poland				
659.42210	847.75839	97.94353	485.35337	49.15121	-23.15801
152.35093	1015.68538				
Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
Switzerland	Turkey				
186.50437	505.20062	59.53876	-58.56552	1717.33411	54.96056
46.85867	2615.58795				