WHAT TYPES OF TAXES ARE IN FACT ENVIRONMENTAL TAXES ?[1]

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ABSTRACT

This paper empirically examines which type of taxes are in fact environmental taxes, by analyzing how governments actually use them. The theoretical literature proposes four alternative interpretations of environmental taxes: strictly or loosely Pigouvian, the double dividend and the Leviathan hypotheses, each leading to alternative testable hypotheses. We test them on a sample where the analysts' discretionary evaluations are minimal, the EU-27 countries that committed themselves to correcting a negative environmental externality, the greenhouse gas emissions, by 2020. The estimates lend support to the strict Pigouvian hypothesis, and to the broad Pigouvian as far as the Western European countries are concerned. The other interpretations appear less consistent with the data.

Keywords: Environmental taxes, environmental policy goals, Pigouvian taxation, double dividend hypothesis, Leviathan government, dynamic simultaneous equations model.

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1. *Introduction*

What type of taxes are, in fact, environmental taxes (henceafter, ET)? For what purposes governments actually use them, and how efficient are they in achieving such goals?

The theoretical literature proposes four alternative answers to these questions, i.e., four alternative ways to rationalize governments' resort to ET. The first is the classical Pigouvian interpretation, whereby ET are sufficient to internalize and correct negative environmental externalities, regardless of how their revenues are being spent (Baumol and Oates, 1988). Secondly, a looser version of this hypothesis, stemming mainly from the public policy literature, holds that the fundamental complexity of environmental policies requires that ET be jointly and coherently used with other environmental policy instruments, including revenues from ET, which should be reinvested in the pursuit of environmental goals. We label this interpretation "broadly Pigouvian" (Fouquet and Johanson, 2008; OECD, 2011). Thirdly, ET can be used to achieve a "double-dividend": beyond the correction of the environmental externality, ET improve the overall efficiency of the economy, by substituting other taxes with larger excess burdens, chiefly personal income taxes (Tullock, 1967; Fullerton and Metcalf, 1997; Bosquet, 2000; Schöb, 2003). A fourth and final interpretation views ET just like any other tax, with the notable exception that they are the least unpopular among all fiscal levies, because of the citizens' favorable outlook on the protection of the environment (EU Commission, 2014). Leviathan governments, aiming at maximizing tax revenues at the lowest political cost, exploit this feature and resort to ET relatively more, irrespective of their efficiency at achieving environmental goals (Kirchgassner and Schneider, 2003).

This paper empirically analyzes how governments actually use ET to verify which of these four alternative theoretical interpretations best represents the reality of environmental fiscal policy. To this end we consider the sample of the 27 EU countries that in 2009 have formally decided to commit themselves to attaining a specific environmental protection target: the reduction of Green House Gases (henceafter, GHG). Two features make this sample especially suitable for this analysis: first, GHG reduction is a clearly measurable objective[2]; second, the countries in the sample have chosen their reduction target themselves. Both features reduce to a strict minimum the analysts' discretion in the evaluation of the governments' use of ET[3], an attribute hard to find in the rest of the literature and which greatly eases the task of identifying which of the four theories best represents the way governments actually use ET.

Our empirical strategy consists in successively testing the empirical restrictions that theory associates to each of the four alternative interpretations of ET. To verify the strict Pigouvian hypothesis, we compare the intensity with which each country has resorted to ET with the degree of success in achieving the GHG reduction target; a positive correlation between the country's distance from the target[4] and its resort to ET confirms the hypothesis that ET are adopted to (and effective at) correcting the negative environmental externality. For the "broad Pigouvian" interpretation, that insists on the consistency in the use of taxing and spending instruments in environmental policy, we check the baseline requirement that countries that resort to ET more also spend more for the general protection of the environment. As for the double dividend hypothesis, we verify whether countries actually substitute ET to personal income taxation (or even to other revenue sources), to reduce the important distortionary effects of high marginal tax rates. Finally, the Leviathan hypothesis, which basically states that governments tax only to maximize revenues, disregarding

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[2] Article 2.1 of decision 406/2009 defines the GHG emissions as "…the emission of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6), […] expressed in terms of tons of carbon dioxide equivalent".

[3] Decision 406/2009 of the EU Parliament and Council of the EU commits the EU member countries collectively to reduce GHG to 70% of their 1990 levels by the year 2020. In addition to this EU wide target, the Decision sets also country-specific targets, to account for the economic and environmental starting point situations of each country, especially those of the former Eastern European nations. (Annexe II to Decision 4006/2009).

[4] Measured as the difference between the emission target, which is fixed, and the observed emissions. If the ET reduce them, the difference increases in value.

the environmental goals of ET, can be either tested in a residual way, i.e., as a rejection of the first three hypotheses, or directly, by verifying whether a correlation exists between ET and several expenditure programs with a high redistributive (and vote-buying) potential.

This type of analysis faces two fundamental, difficulties, which the literature has failed to address so far. The first is that the distance from the environmental target can be either negative or positive. As figure 1 shows, countries can either fall short of their target, and be therefore supposed to intensify their environmental policies; or they can go beyond their target and might in principle relax their fiscal efforts aimed at protecting the environment. The negative and positive values that the target variable may assume of course affect the interpretation of the estimated coefficients and complicates the analysis. We address this problem by distinguishing between countries with a positive difference with respect to the target, i.e., those that have already achieved or even done better than it, from those with a negative difference, i.e., those which have still to attain their target.

[Figure 1 about here]

The second problem is the choice of the proper fiscal indicator to measure the effect of ET on the GHG target. The theoretical literature is not univocal in this respect. Strict Pigouvian models (Baumol and Oates, 1988; Sandmo, 2010) advise using the ET rate as the policy choice variable; revenue-based measures of fiscal effort, such as the ratio of ET revenues over total tax revenues, seem instead more appropriate for the other three (Schöb, 2003). In addition, the ET's efficiency at correcting the externality – a point to be verified in the analysis – also affects the choice of either the rate-based or the revenue-based indicator of the government's effort at reducing the externality. If governments actually use ET in a Pigouvian way *and* these taxes are effective at reducing GHG emissions, we should observe in those countries higher than average ET rates but lower than average ET revenues, since the high tax rates reduced the externality and hence the revenue source. Yet, if ETs were inefficient at correcting the externality and governments still acted in a Pigouvian way, the revenue source would still exist, so that both rates and revenues should be higher than average. To sort out this potentially serious problem, we estimate the model using proxies for both ET rates and revenues. Indeed, the correlation coefficient between the two indicators is 0,17, low enough to legitimize using both of them as alternatives in our analysis.

A final goal of our analysis is shedding light on the politico-institutional transmission mechanisms between the resort to environmental fiscal means and the attainment of environmental goals – an issue understudied so far[5] (Kirchgassner and Schneider, 2003; Cadoret and Padovano, 2016). By that we can ascertain in which institutional environment ET function better and hence which factors make ET more or less effective in reaching the environmental goals. To this end, we first estimate the model with the economic and environmental controls usually considered in the literature; we then consider a series of political and institutional variables that may condition the "stringency" with which ETs are directed to correct environmental negative externalities, such as the ideology of government, the type of institutional framework in which it operates, the degree of government centralization, the presence of lobbies, etc. Naturally, countries dispose of other policy instruments, different from ET, which can be adopted to achieve environmental goals, like regulation, the creation of market and so on. We control for them by using proxies of the stringency of environmental regulations, provided by the OECD; by a linear trend, to account for the progressive extension of environmental regulation (Botta and Kuzlok, 2014); and by the countries fixed effects, which account for the countries' idiosyncratic features of environmental policies (Farmer, 2012).

[5] A great deal of attention has been devoted to the relevance of electoral processes as the median voter vs. the lobbying ones in the pursuit of environmental policies (Congleton, 1992; Farzin and Bond 2006; Fredrikkson, 1997; Aidt, 1998; Conconi, 2003; Riddel, 2003). Other papers have focused on the relationship between government ideology and environmental policies (Horbach, 1992; Neumayer, 2004, 2003; Potrafke, 2010; Chang and Berdiev, 2011; Biressieloglu and Karaibrahimoglu, 2012). Finally, some political economy models have examined the quality of institutions in the achievement of environmental goals (Fredriksson and Svensson, 2003; Fredriksson et al., 2004; Welsch, 2004; Morse, 2006; Lopez and Mitra, 2000).

The rest of the paper is organized as follows. Section 2 illustrates the empirical strategy, the dataset and the specification of the model. The results of the estimates about the strict Pigouvian hypothesis are presented and discussed in section 3. In section 4 we examine the determinants of the expenditures for environmental protection, to verify the "broad Pigouvian" interpretation. Section 5 examines the evidence related to the double dividend hypothesis, while section 6 discusses the direct and indirect evidence supporting the Leviathan interpretation. Section 7 summarizes the conclusions of the analysis.

2. *Empirics*

2.1. Empirical testing strategy. Bringing the four theoretical hypotheses to the data first implies the choice of the dependent variables, which will be regressed, as discussed in section 2.2., on the main variables of interest related to each hypothesis plus three sets of controls: 1) the economic variables **X**; 3) the energy characteristics and environmental policy variables **W**; 4) the politico-institutional variables **Z**.

Our empirical strategy proceeds in four steps. First, to test the strict Pigouvian interpretation we select the difference between the country's GHG emissions target and the observed emissions, named GHG_DIFF, as the endogenous variable. It measures the distance separating the country from the target assigned by Decision 406/2009 – Annexe II.[6] Hence, when necessary, this variable is separated in two groups, one including the countries that are doing better than their target (usually, the Eastern European ones) and have thus a positive difference; the other with the countries that are underscoring their specific target (the Western Europeans) and show a negative difference. The specification of the empirical model is as follows:

$$GHG\_DIFF_{it} = \alpha_1 GHG\_DIFF_{it-1} + \beta_{1R}\mathbf{ET\_REV_{it}} + \beta_{1T}\mathbf{ET\_RATE_{it}} + \gamma_1 \mathbf{X}_{it} + \delta_1 \mathbf{W}_{it} + \theta_1 \mathbf{Z}_{it} + \varphi_i + \epsilon_{it} \qquad (1)$$

[6] For consistency with the Decision, both the target and the observed values of GHG are specified as an index with respect to the base year of 1990. See the text of Decision 406/2009 for the precise specification of this index.

where i identifies the country and t the year and φ are the country fixed effects. Since the attainment of the GHG target is progressive over time, the equation includes the lagged dependent variable; it is estimated dynamically via Arellano-Bond GMM estimator with robust standard errors, taking into account the potential endogeneity problem with ET.

Among the explanatory variables, the strict Pigouvian hypothesis calls for examining two complementary measures of ET. The first one represents the revenue of environmental taxes (labeled ET_REV). The second one is a proxy for the effective marginal tax rate of environmental taxation (labeled ET_RATE). As such we use the variation of the implicit energy tax rate calculated over two successive calendar years[7]. ET_REV is instead the share of all environmental tax revenues in total tax revenues[8]. As mentioned in the introduction, if ET_RATE are used as Pigouvian taxes and they prove effective at reducing GHG emissions, we should observe a negative correlation between ET_RATE and GHG emissions, which should reduce the tax base for the ETs. If instead ET_RATE are inefficient at correcting the externality, even in the case when governments acted in a Pigouvian way, the externality would still remain and the revenue source with it. In this case we should observe *both* high ET rates and revenues. We hence estimate the model using both ET_RATE and ET_REV as proxies for the country's environmental fiscal effort. We hold that the strict Pigouvian hypothesis is confirmed if A) in countries with a positive difference between the GHG target and the observed emissions, there is a *positive* correlation between GHG_DIFF and ET_RATE; that because higher tax rates

[7] The implicit energy tax rate is measured as the ratio of energy tax revenues to final energy consumption. Energy tax revenues are calculated in constant price euros (deflated with the implicit GDP deflator, prices of year 2010) and final energy consumption is assesed in tons of oil equivalent. Eurostat is the source for these data.

[8] According to Eurostat, our data source, "…an environmental tax is a tax whose base is a physical unit (or a proxy of a physical unit) of something that has a proven, specific negative impact on the environment". Hence environmental taxes fall within the following economic sectors: energy, transport, pollution, resources. Eurostat data are compatible with the concepts used in the system of national accounts. Throughout the paper, we stick to this definition and to this source of official data.

further reduce the emissions and thus *increase* the *positive* difference between the target and the observed value of GHG; furthermore GHG_DIFF and ET_REV should be not significantly correlated; B) in countries where instead there is a negative difference between the GHG target and the observed emissions, again a *positive* correlation is found between GHG_DIFF and ET_RAT, because higher tax rates reduce the emissions and therefore *reduce* the *negative* difference between the target and the observed value of GHG; once more a not significant correlation should exist between GHG_DIFF and ET_REV.

Among the economic variables of vector **X** we begin by examining the complex relationship between income-related variables and pollution. A first theoretical linkage is the well-known "environmental Kutznets curve" (Dinda, 2004), which posits a positive relationship between economic development and environmental degradation at low levels of per capita income, which then turns negative when citizens-taxpayers' support for environmental protection begins to improve environmental quality, including the reduction of GHG emissions. More recently, in the context of neoclassical growth models, Ordas Criado et al. (2011) show that along the pollution optimal path, the growth rate of output per capita has a negative impact on the growth rate of emissions per capita (scale effect) which is negatively relative to the initial level of pollution (defensive effect). In the extended version of their model, the impact of the initial level of output per capita is not a priori define. We insert in equation (1) both indicators of per capita economic growth (G_GDPPC) and of per capita income levels (GDPPC) in logarithm, and let the sign be determined by the empirical analysis.

Vector **W** includes controls for energy and environmental policies. We control for the energy intensity in production (variable ENERGY_INT), specified as the kilogram of oil equivalent per 1000 euros worth of products. The expected sign on this covariate is always negative, since in countries with a positive difference higher values of ENERGY_INT increase GHG emissions thus reducing the value of GHG_DIFF; in countries with a negative difference, more pollution increases the negative GHG_DIFF, resulting again in an inverse correlation. Moreover, we have a battery of controls for the non-fiscal environmental policies that each country implements. The first is NM_EPS, the OECD index of stringency of nonmarket environmental policies, which excludes fiscal instruments (already accounted for by ET) but includes most of the other policies based on regulation. It measures the efficiency with which a country is implementing such policies. The second is the linear TREND, which captures the increasing diffusion of environmental regulations over time in our sample (Botta and Kozluk, 2014).

Variables in vector **Z** characterize the transmission mechanism from environmental taxation to the attainment of the environmental goals. They describe either the preferences of the political agents that take environmental policy decisions concerning the use of ET, or the political and institutional framework where these decisions are actually taken. Hence, holding constant the covariates in vectors **W** and **X**, the variables in **Z** tell us why, for a given use of environmental taxation, some countries are more efficient than others at reaching their GHG reduction target. Starting from the proxies for political preferences, we consider the variable LEFT, a dummy equal to 1 if the country's incumbent government is supported by left-wing parties (green parties included). As left-wing governments allegedly place a larger weight on environmental protection, they should pursue the goal of reaching the GHG reduction goal more actively, especially in the Western European countries, characterized by a positive difference. To check for left-wing coalitions' ability to make their environmental ideology be transformed into legislation, we interact LEFT with the Herfindahl index of concentration of the government majority (variable LEFT*HERF). Herfindahl index is included in the [0, 1] interval, with 1 indicating single party governments.[9] Another preference indicator is MAN_VA, the share of

[9] As for the eastern European countries with a negative difference, left wing governments could either continue to pursue the environmental protection policies, which would result in a positive coefficient on LEFT*HERF; or they could ease off their GHG reduction efforts in favor of other "leftist" ideological goals (such as reduction of unemployment). In such a case the expected coefficient on LEFT*HERF should be either negative or not statistically significant.

value added from the manufacturing industry on total GDP. This variable proxies the diffusion of lobbies from the manufacturing sector, which oppose the pursuit of environmental goals that increase production costs. The expected sign on this variable should be negative, because more emissions should move the observed GHG away from their target. In one specification we have also considered the diffusion of lobbies from the agricultural sector (AGR_VA), with the same theoretical presuppositions and expected signs. Furthermore, we examine four proxies for the institutional constraints under which environmental policy decisions are taken. The first is PARL, a dummy from the Database of Political Institutions, equal to 1 if the country has a parliamentary system and 0 if it has a presidential or semi-presidential one. The idea, from the political economy literature (Persson and Tabellini, 2003), is that parliamentary countries tax more than presidential ones; this tendency might influence the resort to environmental taxation as well. We have interacted this variable too with the index of parliamentary concentration, to verify whether the effects of parliamentary systems on environmental policy choices are stronger when parliaments are more homogeneous (variable PARL*HERF). The second is the country's decentralization of expenditure decisions (variable DECENTR), specified as the share of total expenditures of the general government made by subcentral government levels. This variable checks the efficiency with which the central government can direct the country's policy of reduction of GHG emissions, including the resort to environmental taxation. Because considerable geographical spillovers characterize this policy target, countries with more centralized policy decision making processes should perform better in the attainment of the GHG target. Finally, we control for two measures of government policy efficiency. The first is the "control of corruption" index (variable CC), a World Bank indicator that reflects the perceptions about the extent to which public power is exercised for private gain, including the "capture" of the state by elites and private interests. The second is the government effectiveness indicator (GOV_EFF), another highly aggregated World Bank indicator that compounds the perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The expected sign depends on the government's commitment to reduce the GHG emissions.

Table 1 summarizes the expected signs of the coefficients for each explanatory variable, illustrating both the impact on the observed GHG emissions and on the final GHG_DIFF variable. This table is specific to the tests of the strict Pigouvian hypothesis, as equation (1) implies.

[Table 1 about here]

The second step of the analysis is the test of the broad Pigouvian hypothesis. To this end we estimate the same model adopted for the strict Pigouvian but using the countries' expenditures for environmental protection ENV_PROT, as a percentage of GDP, as the dependent variable. Environmental protection expenditures are the most comprehensive aggregate of government outlays for environmental purposes for which Eurostat (and the OECD) collect information. The broad Pigouvian interpretation imposes consistency between environmental policy instruments: hence a greater resort to ET should be reflected in higher expenditures for environmental protection (Fouquet and Johanson, 2008). Equation (2) is therefore specified with ET_REV as the main explanatory variable of interest, and it is also estimated via Arellano-Bond:

$$ENV\_PROT_{it} = \alpha_2 ENV\_PROT_{it-1} + \beta_2 \mathbf{ET\_REV}_{it} + \gamma_2 \mathbf{X}_{it} + \delta_2 \mathbf{W}_{it} + \theta_2 \mathbf{Z}_{\boldsymbol{it}} + \varphi_i + \eta_{it} \tag{2}$$

With respect to equation (1), we consider variables that could shift the budget constraint for environmental protection expenditures, the dependent variable. To this end, in vector X we include the country's revenues requirements via the debt-to-GDP ratio (labeled DEBT), which should be negatively correlated with overall government expenditures, including those of the environmental type[10]. Furthermore, we have considered the non-environmental taxes (variable OTHER_TAX), measured as the difference between total tax revenues and environmental tax revenues, both normalized by GDP[11]. Here instead the expected sign is positive.

The third step of the analysis focuses on the double dividend hypothesis. As it is standard in the literature, we verify the double dividend hypothesis by introducing a proxy for marginal tax pressure, especially on personal income, in the equation that explains the government resort to ET. To this end we resort to the variable MARTAX, the top legislated marginal tax rate on personal income, from OECD. To this end equation (3) is a tax setting equation for ET

$$\mathbf{ET\_REV}_{it} = \alpha_3 \mathbf{ET\_REV}_{it-1} + \mu_1 MARTAX_{it} + \mu_2 OTHER\_TAX_{it} + \beta_1 \mathbf{X}_{1it} + \gamma_1 \mathbf{W}_{1it} + \delta_1 \mathbf{Z}_{\mathbf{1}\boldsymbol{it}} + \varphi_{1i} + \varpi_{1it} \quad (3)$$

A negative correlation between MARTAX and the ET_REV is evidence of substitution of ET for personal income taxes to reduce marginal excess burdens. As variables of control we add the energy dependency (ENERGY_DEP) [12]; it shows to which extent an economy relies on imports to meet its energy requirements. As such, ENERGY_DEP is a measure of the country's competitiveness, since it takes into account the weight of the imported energy on the actual costs of domestic products; hence it should be correlated with the country's propensity to introduce ET.

We also include the variable OTHER_TAX, holding constant the proxies for double dividend strategies in taxation. This variable controls for Leviathan-style

[10] The debt-to-GDP ratio is measured as the general government consolidated gross debt. We have also considered the country's deficit-to-GDP ratio, measured as the country's net lending (+) or net borrowing (-), at the general government level. The results were quite similar to those obtained using the DEBT variable.

[11] The normalization by GDP avoids the possibility that the variables ENV_TAX and OTHER_TAX sum to 1.

[12] The indicator is calculated as net imports divided by the sum of gross inland energy consumption plus bunkers. The (crude) oil price is specified as the average spot price Brent, Dubai and West Texas Intermediate, equally weighed, in US$ per barrel at 2010 prices. See for instance Chang et al. (2009) and Marques et al. (2010).

behaviors in the government's fiscal policy, which typically substitutes alternative fiscal instruments regardless of their end use in order to minimize the loss of popularity.

Finally, the Leviathan hypothesis can be verified in two different ways: either "*a contrario*", whereby a lack of evidence for the three other interpretations lends support to the Leviathan one, as the only remaining alternative; or in a "direct" manner, which exploits the implication that ET revenues should finance, and thus be positively correlated with, the more redistributive expenditure items, i.e., the most apt to secure a power base to the government (Hettich and Winer, 1999). To this end, we have estimated equation (2) for the two expenditure items most prone to redistribution and to buying a power base, namely, general services and social protection (Hettich and Winer, 1999). The idea of this test is that a well-meaning, Pigouvian-style government should spread the ET revenues across all expenditure items. This dispersion should result in a lack of statistical significance of the coefficient relating ET_REV to each expenditure item. Conversely, if ET revenues are spent in a Leviathan style, they should result positively correlated with these highly redistributive expenditure items.

2.3. Sample. The sample encompasses 26 of the EU-27 countries that, through Decision 406/2009, have a) committed themselves to collectively reduce GHG to 70% of their 1990 levels by the year 2020; and b) agreed to a series of country-specific targets, to account for the economic and environmental starting points of each country, especially those of the former Eastern European nations (Benjamin et al. 2015). These countries are Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.[13] The time interval covers the period 1995-

[13] The dropped country is Malta; because of its small insular territory it has an environmental profile too different from the rest of the sample with respect to GHG emission. Its inclusion does not, however, qualitatively alter the results.

2012, for which Eurostat provides coherent data for the dependent variables. Tables 3 to 6 presents the results that are pertinent to the objective of our analysis. We test all the control variables described in 2.2 and keep the significant ones.

Table A.1 in the appendix reassumes the characteristics of the variables and their data sources, while table 2 provides the descriptive statistics.

[Table 2 about here]

3. *Testing for the strict Pigouvian hypotheses*

The estimates of equation (1) about the strict Pigouvian hypothesis are reported in tables 3a, 3b and 3c. In particular, table 3a shows the estimation results for the whole sample of 26 countries, whereas table 3b reports the estimates for countries with a positive GHG_DIFF values (i.e., those that have already gone beyond the target, mainly the Eastern European ones); table 3c the results for the countries with a negative value of GHG_DIFF (i.e., those that have still to attain the target, mainly the western Europeans countries).

[Table 3a, 3b and 3c about here]

If we consider the whole sample, the estimates reported in table 3a appear consistent with the strict Pigouvian hypothesis in the cases where ET are effective at reducing the GHG emissions. Model 1 shows that ET_REV is not statistically significant, whereas ET_RATE has the expected positive sign. This pattern confirms that high marginal rates on ET actually reduce the environmental externality represented by the GHG emissions, and the tax base for ET with it. Table 3b provides the results for countries with a positive GHG_DIFF, while table 3c reports those for countries with a negative GHG_DIFF. In the short run, model 5 of table 3b and model 2 of table 3c show that the impact of ET is quantitatively similar (around 0,04) in both Eastern European countries, which have already achieved their targets, and in the Western European ones, which still have to attain it. This means that if European countries increase their marginal tax rate by one euro, the GHG emission will decrease by 0,04 points of the index compared to the base value of 1990; and consequently it will increase the distance from the target by 0,04 index points. In any event, this result shows that for both groups of countries an increase of the ET_RATE does reduce the GHG emissions, as the strict Pigouvian hypothesis predicts. In the long run, the multiplier effect is equal to 0,06 index points for the eastern European countries and to 0,08 index points for the Western European ones. Coming to the economic controls, as predicted by Ordas Criado et al. (2011), we observe the scale effect for the Eastern European countries; an increase of the growth rate of GDP per capita determines an increase of GHG emission equal to 0,14 points of the index and, consequently, a decrease of the distance from the target in the short run. In the long run, the effect is equal to 0,21 points of index for the Eastern European countries, while it is not significant for the Western European ones. Moreover, an increase of GDP per capita raises GHG emissions in both the short and the long term in both groups. In particular, for the Eastern European countries, an 1% increase of GDP per capita induces a short term decrease of 0,37 index points of the distance of the observed emissions from the target; for the long term, the decrease amounts to 0,52 index points. Once the confidence intervals are taken into account, these two estimates are not quantitatively very different. Among the energy/environmental variables of vector **W**, the estimates also confirm the expected negative relationship between energy intensity of production and the dependent variable. Among the variables of the political vector **Z**, only decentralization seems to have an impact, and only in the overall sample, possibly because this variable has a much greater between variance than the within one; this seems to suggest that GHG reduction policies are characterized by considerable geographical spillovers, which requires that they be implemented by the central government to be efficient, but this result is not confirm when we split the sample. In countries with a positive distance, evidence is found of lobbying by the manufacturing and agricultural sector to stay closer to the target by increasing the emissions. Most other institutional variables within this vector (such as PARL) never turn out significant, probably because they have no variance within, and only a minor variance between, due to the similarities among the countries' institutional systems; this may explain the lack of statistical significance of these regressors.

4. *Testing the "broad Pigouvian" hypothesis*

The combination of a negative coefficient on ET_RATE and a lack of statistical significance on ET_REV is a necessary, but not sufficient evidence to conclude in support of the strict Pigouvian hypothesis. We cannot yet rule out the possibility that ET are used for other environmental concerns, not necessarily the reduction of GHG. If this were so, the results would be consistent also with the broad Pigouvian hypothesis, which posits that the complexity of environmental policy goals requires that all environmental policy instruments be directed to the attainment of environmental goals. In other words, the support for the strict Pigouvian hypothesis cannot exclude the broad Pigouvian interpretation because the restricted nature of the dependent variable used (GHG_DIFF), too limited to represent the whole environmental policy of the country. Equation (2) features the countries' expenditures for environmental protection in percentage of GDP as the dependent variable (ENV_PROT). Environmental protection expenditures are the most comprehensive aggregate of government outlays for environmental purposes for which Eurostat (and the OECD) collect information. Data limitations about the dependent variable unfortunately constrain the sample to 25 countries, as there is no information for Finland, and the time series starts in 2002, instead of 1995. Moreover, since the broad Pigouvian hypothesis posits that environmental tax revenues be spent for environmental concerns, we concentrate the analysis on ET_REV and check whether they remain not statistically significant. Equation (2) is again estimated via an Arellano-Bond dynamic panel estimator. Table 4 illustrates the results.

[Table 4 about here]

Colum 1 of table 4 points out that for the whole sample ET appear to be specifically aimed for environmental concerns. Yet a comparison of the results of column 2 and column 3 of table 4 show that a negative correlation between ET revenues and environmental protection expenditures prevails in the Eastern European countries (column 2), and it overwhelms the positive one of the Western European ones (column 3; the positive one is about ¼ of the negative in absolute value). The negative coefficient reveals that, within the Eastern European countries, more environmental tax revenues are correlated with lower expenditures for environmental protection; hence these countries tend to spend the ET revenues for purposes different from environmental protection. The opposite occurs in Western European countries, which appear much more consistent in their environmental policies, to the point that also the broad Pigouvian interpretation seems able to explain their policy choices. The dynamic structure of the estimating procedure ensures that this result does not depend on the time difference between the moments when revenues are collected and when they are spent. Among the political variables of vector ***Z***, no variable ever reaches statistical significance, and are therefore not reported in the estimates.

5. *Testing the double dividend hypothesis*

The double dividend hypothesis refers to a substitution of ET for other taxes characterized by larger and more distortive excess burdens. As the excess burden of taxation increases with the square of the marginal tax rate, the literature concurs in pointing out the personal income taxes as the natural candidate for substitution (OECD, 2011; Sandmo, 2010). This hypothesis gained some prominence in the European policy debate at the turn of the century, when the Red-Green coalition government in Germany placed it with great emphasis in its political platform. Indeed, such debate occurred during the sample period of our analysis.

[Table 5 about here]

In the estimates of equation (3) – always via GMM Arellano-Bond - two covariates play a crucial role: OTHER_TAX and MARTAX. A negative sign on the former reveal a generic substitution of ET with other taxes, which may be due to any swap between fiscal instruments on the active part of the budget; a negative sign on MARTAX instead reveals an attempt to lower high-excess burden taxes with environmental ones, hence, a proper attempt to attain a double dividend. The estimates show that, when we consider ET_REV (table 5), there is evidence of a generic exchange of ET with other taxes (covariate OTHER_TAX), especially among the countries that have already attained their target. The rate of substitution is however limited, approximately 1/6, implying a rise of the overall fiscal pressure. Countries that must still reduce GHG emissions seem slightly less prone to substitute ET. Yet the evidence of a proper double dividend strategy in this substitution is quite limited, if any, since the coefficient on MARTAX is negative and barely significant (10% level) only among the Western European countries. These results are obtained controlling for the countries revenue requirements, proxied by the variable DEBT, which is never significant.

6. *Direct tests of the Leviathan hypothesis*

The evidence in favor of the strict Pigouvian hypothesis appears for both group of countries Western and Eastern Europeans, as they resort to ET in order to reduce GHG emissions. Hence the indirect, *a contrario* test of the Leviathan hypothesis does not receive support from the data. To this end, we have estimated equation (2) for general services expenditures and social protection expenditures, the most redistributive ones among the expenditure categories provided by Eurostat. Table 6a and 6b reports the results of the estimates of equation (2) for these two dependent variables.

[Table 6a and 6b about here]

For the sake of brevity, we report the results only for the variables of interest and for the explanatory variables that turned out significant. The estimated coefficient on the ET_REV regressor is barely significant only when we consider the all sample but it is never so when we distinguish Eastern and Western countries in the case of general services – basically, public goods – and social protection the most redistributive expenditure.

All in all, the data seem not to support the interpretation that governments use ET is a Leviathan style.

7. *Conclusions*

In the sample under examination, the empirical analysis of this paper lends support to the interpretation that European governments use ET is a Pigouvian way. The positive correlation between ET rates and distance from the target, together with the lack of statistical significance on measures of environmental tax revenues, suggests that high Pigouvian tax rates reduce the environmental externality represented by GHG emissions and therefore shrink the tax base for these taxes. Both countries that have already attained their GHG emissions targets and those that still have to meet it are characterized by similar levels of correlation between ET rates and reduction of GHG emissions; this suggests that environmental policies tend to become embedded in the fiscal system even after certain policy goals are reached.

The analysis also finds that other alternative interpretations receive little or no empirical support. There is some, although not quite compelling, evidence that governments of Western European countries use ET to finance expenditures for the protection of the environment, as a broad interpretation of the Pigouvian tax theory recommends; those of Eastern Europe tend to do the opposite. "Double dividend" types of environmental policies have been largely discussed recently and also in the period and countries considered in our sample, but there is no empirical trace that governments actually implement them in any significant way. The evidence in favor of Leviathan style behaviors is rather inconsistent.

Testing the way governments use ET is a difficult task, especially in terms of finding a proper empirical strategy; ours has the non-negligible advantage of minimizing the discretionary intervention of the analyst in evaluating the countries' commitment in achieving environmental goals, since we focus on a clearly measurable environmental goal, the reduction of GHG emission, which the EU-27 countries themselves have formally decided to attain. Hence, and with no claim of having provided conclusive and/or general evidence, our interpretation of the overall results of the analysis is that environmental taxation is mainly conducted in a Pigouvian way.

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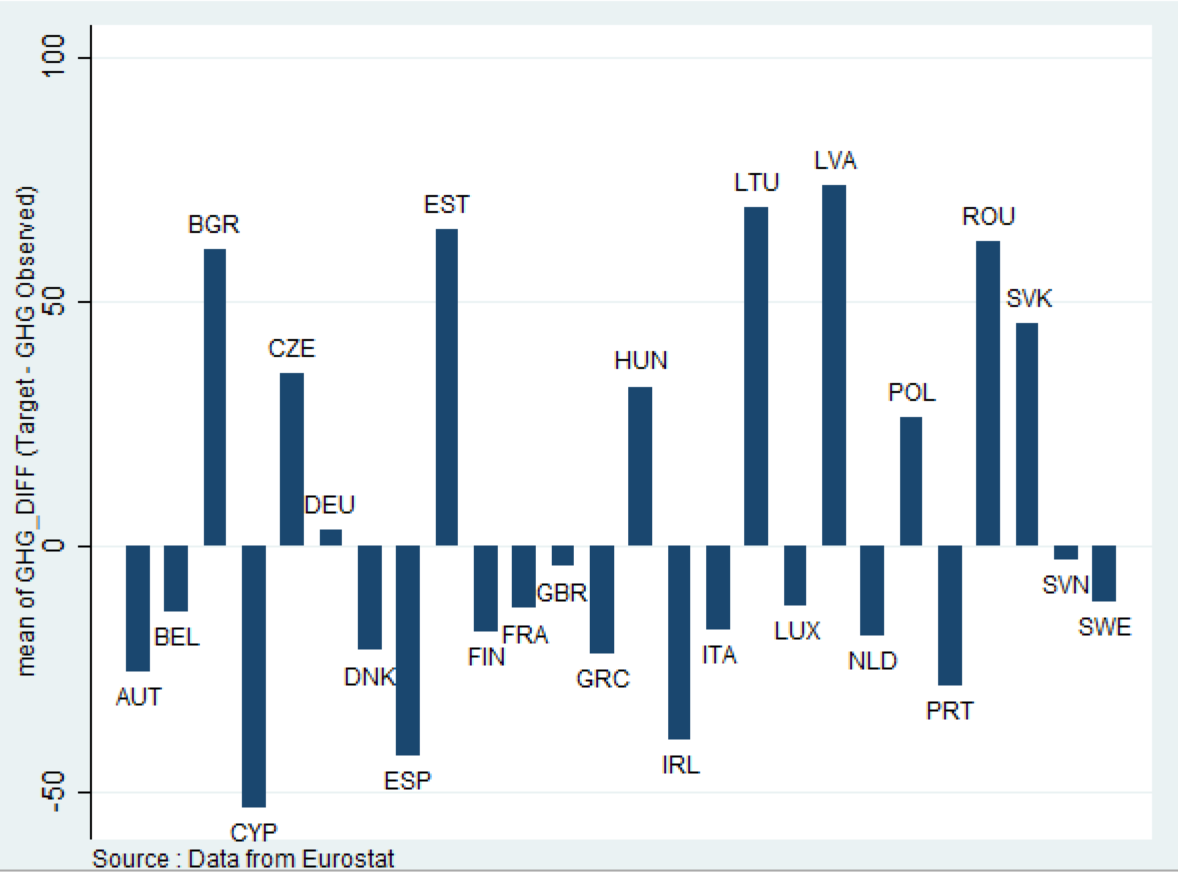
Figure 1. Distance from country specific targets for GHG emissions set by Decision n. 406/2009 (observed GHG emissions mean over the period 1995-2012)



AUT: Austria, BEL: Belgium, BGR: Bulgaria, CYP: Cyprus, CZE: Czech Republic, DNK : Denmark, EST : Estonia, FIN : Finland, FRA: France, DEU: Germany, GRC: Greece, HUN: Hungary, IRL: Ireland, ITA: Italy, LVA: Latvia, LTU : Lithuania, LUX: Luxembourg, NLD : Netherlands, POL : Poland, PRT :Portugal, ROU: Romania, SVK: Slovakia, SVN:Slovenia, ESP:Spain, SWE:Sweden, GBR:United Kingdom

Table 1. Impact of an increase of some explanatory and control variables on GHG_DIFF and on the observed GHG emissions consistent with strict Pigouvian hypothesis

	Countries with GHG_DIFF>0		Countries with GHG_DIFF<0	
	GHG_DIFF	GHG emissions	GHG DIFF	GHG emissions
ET_REV	No effect	No effect	No effect	No effect
ET_RATE	+	-	+	-
G_GDPPC	-	+	-	+
GDPPC	?	?	?	?
ENERGY_INT	-	+	-	+
LEFTxHERF	?	?	+	-
PARxLEFT	?	?	+	-
GOV_EFF	?	?	?	?
CC	?	?	?	?
MAN_VA	-	+	-	+
AGR_VA	-	+	-	+
DECENTR	-	+	-	+

Table 2. Descriptive statistics

	all observations, NT= 468				observations with GHG_target >0, NT=191				observations with GHG_target <0, NT=277			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
ET_REV	7.43	1.70	2.70	13.42	7.30	1.50	2.70	12.41	7.52	1.82	4.40	13.42
ET_RATE	160.38	77.73	13.76	441.18	109.63	57.99	13.76	414.23	195.38	69.98	38.26	441.18
GHG_DIFF	5.05	38.23	-72.66	78.89	44.95	23.34	0.36	78.89	-22.47	15.34	-72.66	-0.24
ENV_PROT	0.72	0.34	-0.30	1.80	0.69	0.34	-0.30	1.80	0.74	0.34	0.20	1.70
GS_DEP	6.85	2.38	3.10	17.60	5.83	2.32	3.10	17.60	7.57	2.16	3.40	14.30
SP_DEP	16.17	4.22	7.3	25.6	14.20	3.55	8.0	24.7	17.56	4.11	7.3	25.6
NM_EPS	2.54	1.16	0.63	5.50	2.34	1.16	0.63	5.25	2.61	1.15	0.75	5.50
OTHER_TAX	34.93	6.14	23.56	49.44	31.22	4.47	23.83	45.86	37.48	5.84	23.56	49.44
MAR_TAX	41.22	11.65	10.00	65.00	33.09	11.96	10.00	60.20	46.82	7.36	30.00	65.00
G_GDPPC	2.43	3.87	-14.55	13.32	3.64	4.75	-14.55	13.32	1.60	2.85	-8.80	9.47
GDPPC	0.02	0.01	0.00	0.07	0.01	0.01	0.00	0.06	0.03	0.01	0.01	0.07
DEBT	51.87	31.00	3.66	171.35	35.94	24.70	3.66	138.94	62.85	30.15	6.10	171.35
ENERGY_DEP	53.74	29.02	-49.80	102.50	44.74	19.98	-3.00	99.50	59.94	32.48	-49.80	102.50
ENERGY_INT	291.15	226.95	82.46	1810.43	475.00	257.74	86.38	1810.43	164.38	43.53	82.46	313.71
LEFT*HERF	0.27	0.38	0.00	1.00	0.24	0.35	0.00	1.00	0.29	0.39	0.00	1.00
PAR*HERF	0.53	0.33	0.00	1.00	0.39	0.32	0.00	1.00	0.62	0.31	0.00	1.00
GOV_EFF	1.18	0.68	-0.62	2.36	0.67	0.57	-0.62	2.05	1.54	0.50	0.21	2.36
CC	1.09	0.87	-0.82	2.59	0.43	0.68	-0.82	2.39	1.55	0.67	-0.25	2.59
MAN_VA	18.04	5.11	5.10	29.70	20.20	3.87	10.00	26.90	16.55	5.32	5.10	29.70
AGR_VA	3.69	3.12	0.30	24.90	5.35	3.99	0.60	24.90	2.54	1.50	0.30	9.90
DECENTR	35.98	13.74	0.26	74.50	36.50	12.38	6.03	74.50	35.62	14.62	0.26	71.78

Table 3a. Dependent variable GHG_DIFF (all countries)

	Model 1	Model 2	Model 3	Model 4	Model5
GHG_DIFF_{t-1}	0.375***	0.503***	0.475***	0.478***	0.452***
	(3.95)	(7.25)	(6.55)	(6.98)	(6.36)
ET_REV_{t}	-0.228				
	(-0.88)				
ET_RATE_{t}	0.0356**	0.0626***	0.0641***	0.0659***	0.0616***
	(3.25)	(4.85)	(4.48)	(4.54)	(4.11)
G_GDPPC_{t}	0.0365	-0.118*	-0.105*	-0.0892+	-0.110*
	(0.33)	(-2.23)	(-2.06)	(-1.78)	(-2.13)
$logGDPPC_{t}$	-70.45***	-42.93***	-46.91***	-46.47***	-48.58***
	(-5.39)	(-5.73)	(-5.48)	(-5.80)	(-5.85)
$logENERGY\_INT_{t}$	-68.96***	-46.66***	-51.18***	-52.21***	-52.29***
	(-5.48)	(-5.85)	(-5.24)	(-5.21)	(-5.44)
NM_EPS_{t}	0.129				
	(0.40)				
TREND	0.409**	0.221+	0.207	0.162	0.230
	(2.78)	(1.75)	(1.28)	(1.02)	(1.43)
$LEFT_{t}xHERF_{t}$		0.619			
		(0.97)			
$PAR_{t}xHERF_{t}$		-2.583			
		(-1.30)			
GOV_EFF_{t}			-0.639		
			(-0.48)		
CC_{t}			0.378		
			(0.30)		
MAN_VA_{t}				-0.151	
				(-0.64)	
AGR_VA_{t}				0.158	
				(0.76)	
$DECENTR_{t}$					-0.133+
					(-1.69)
N	304	416	416	416	416
AR(1) p-value	0.000	0.000	0.001	0.000	0.001
AR(2) p-value	0.28	0.17	0.17	0.17	0.17

GHG_DIFF = target emissions - observed GHG emissions, t statistics in parentheses,

+ p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond with robust standrard errors

Table 3b. Dependent variable GHG_DIFF (countries with GHG_DIFF>0)

	Model 1	Model 2	Model 3	Model 4	Model5
GHG_DIFF_{t-1}	0.341***	0.314***	0.349***	0.287**	0.336**
	(4.65)	(3.91)	(3.31)	(3.25)	(3.20)
ET_REV_t	-0.426				
	(-1.48)				
ET_RATE_t	0.0373*	0.0437**	0.0473*	0.0443*	0.0476*
	(1.97)	(2.63)	(2.50)	(2.49)	(2.40)
G_GDPPC_t	-0.232**	-0.159***	-0.141***	-0.0902*	-0.144***
	(-3.14)	(-3.50)	(-3.62)	(-1.97)	(-3.48)
$logGDPPC_t$	-38.40***	-34.12***	-33.52***	-37.65***	-35.15***
	(-5.30)	(-5.58)	(-5.22)	(-7.21)	(-5.14)
$logENERGY\_INT_t$	-36.53***	-34.63***	-32.47***	-31.59***	-33.33***
	(-4.81)	(-5.34)	(-4.03)	(-4.13)	(-4.07)
NM_EPS_t	-0.129				
	(-0.29)				
TREND	0.509**	0.382***	0.428***	0.543***	0.446***
	(2.75)	(3.61)	(4.41)	(4.72)	(3.70)
$LEFT_t xHERF_t$		-0.452			
		(-0.65)			
$PAR_t xHERF_t$		0.988			
		(0.62)			
GOV_EFF_t			-1.437		
			(-1.08)		
CC_t			0.316		
			(0.32)		
MAN_VA_t				-0.271+	
				(-1.66)	
AGR_VA_t				-0.247*	
				(-2.01)	
$DECENTR_t$					-0.0247
					(-0.50)
N	89	172	172	172	172
AR(1) p-value	0.02	0.01	0.01	0.01	0.02
AR(2) p-value	0.28	0.07	0.06	0.08	0.05

GHG_DIFF = target emissions - observed GHG emissions, t statistics in parentheses,

+ p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond with robust standrard errors

Table 3c. Dependent variable GHG_DIFF (countries with GHG_DIFF<0)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
GHG_DIFF_{t-1}	0.282**	0.397***	0.427***	0.403***	0.386***	0.384***
	(2.94)	(4.56)	(4.70)	(4.03)	(4.41)	(4.40)
ET_REV_t	0.376					
	(0.71)					
ET_RATE_t	0.0158	0.0480**	0.0498***	0.0479***	0.0510**	0.0450**
	(1.50)	(3.20)	(3.31)	(3.31)	(2.93)	(3.11)
G_GDPPC_t	0.211+	0.145	0.122	0.140	0.103	0.144
	(1.94)	(1.45)	(1.23)	(1.24)	(1.01)	(1.46)
$logGDPPC_t$	-91.43***	-77.56***	-73.61***	-76.55***	-74.80***	-77.65***
	(-7.42)	(-6.96)	(-6.12)	(-5.74)	(-6.20)	(-7.15)
$logENERGY\_INT_t$	-89.88***	-82.09***	-76.57***	-82.06***	-83.86***	-82.07***
	(-6.06)	(-6.43)	(-5.32)	(-5.94)	(-6.35)	(-6.50)
NM_EPS_t	-0.475					
	(-1.45)					
TREND	0.666***	0.277	0.290+	0.249	0.317	0.300+
	(4.68)	(1.62)	(1.92)	(1.22)	(1.28)	(1.77)
$LEFT_t xHERF_t$			-0.497			
			(-0.55)			
$PAR_t xHERF_t$			-0.324			
			(-0.13)			
GOV_EFF_t				0.163		
				(0.06)		
CC_t				-0.890		
				(-0.43)		
MAN_VA_t					0.0252	
					(0.07)	
AGR_VA_t					0.878	
					(0.87)	
$DECENTR_t$						-0.121
						(-0.94)
N	215	244	244	244	244	244
AR(1) p-value	0.004	0.001	0.001	0.001	0.001	0.001
AR(2) p-value	0.22	0.28	0.28	0.29	0.29	0.28

GHG_DIFF = target emissions - observed GHG emissions, t statistics in parentheses, + p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond with robust standrard errors

Table 4. Dependent variable ENV_PROT

	All	GHG_DIFF > 0	GHG_DIFF < 0
ENV_PROT_{t-1}	0.303***	0.391***	0.428***
	(4.19)	(5.14)	(15.48)
$DEBT_t$	-0.000311	-0.000678	-0.00157***
	(-0.63)	(-0.70)	(-3.49)
ET_REV_t	-0.0117**	-0.0443***	0.0123**
	(-3.17)	(-14.09)	(2.68)
$OTHER\_TAX_t$	0.0109*	0.000730	0.000259
	(2.35)	(0.08)	(0.07)
G_GDPPC_t	-0.00626***	-0.00456***	-0.00947***
	(-3.72)	(-6.26)	(-4.99)
N	383	160	223
AR(1) p-value	0.01	0.03	0.03
AR(2) p-value	0.14	0.10	0.55

t statistics in parentheses, + p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Method : GMM - Arrellano-Bond two steps

Table 5. Dependent variable: ET_REV

	All	GHG_DIFF >0	GHG_DIFF <0
ET_REV_{t-1}	0.642***	0.553***	0.604***
	(13.02)	(7.81)	(8.93)
$OTHER\_TAX_t$	-0.136***	-0.188***	-0.133***
	(-4.50)	(-4.18)	(-3.51)
$MARTAX_t$	-0.0120+	-0.00910	-0.0163+
	(-1.92)	(-0.96)	(-1.74)
$logGDPPC_t$	-1.997***	-1.565	-1.757*
	(-3.47)	(-1.35)	(-2.50)
$DEBT_t$	0.00220	0.00745	0.00150
	(0.73)	(1.50)	(0.42)
$logENERGY\_DEP_t$	0.168	0.808***	-0.322
	(0.88)	(3.63)	(-1.24)
NM_EPS_t	0.0240	-0.140*	-0.00604
	(0.76)	(-2.27)	(-0.12)
N	282	88	194
AR(1) p-value	0.003	0.82	0.04
AR(2) p-value	0.34	0.49	0.95

t statistics in parentheses, + p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond with robust standrard errors

Table 6a. Dependent variable Total expenditures of the Public Administrations for general services (% of GDP)

	All	GHG_DIFF >0	GHG_DIFF <0
GS_DEP$_t$	0.526***	0.279***	0.897***
	(18.55)	(5.10)	(22.10)
ET_REV$_t$	0.0724*	0.0390	-0.0929
	(2.02)	(0.80)	(-1.04)
OTHER_TAX$_t$	0.212***	0.297***	-0.0650**
	(9.47)	(7.80)	(-2.87)
G_GDPPC$_t$	-0.0309***	-0.0186+	-0.0436***
	(-5.43)	(-1.95)	(-8.53)
N	383	160	223
AR(1) p-value	0,15	0,17	0
AR(2) p-value	0,07	0,44	0,35

t statistics in parentheses, + p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond two steps

Table 6b. Dependent variable Total expenditures of the Public Administrations for social protection (% of GDP)

	All	GHG_DIFF >0	GHG_DIFF <0
GS_DEP$_t$	0.526***	0.279***	0.897***
	(18.55)	(5.10)	(22.10)
ET_REV$_t$	0.0724*	0.0390	-0.0929
	(2.02)	(0.80)	(-1.04)
OTHER_TAX$_t$	0.212***	0.297***	-0.0650**
	(9.47)	(7.80)	(-2.87)
G_GDPPC$_t$	-0.0309***	-0.0186+	-0.0436***
	(-5.43)	(-1.95)	(-8.53)
N	383	160	223
AR(1) p-value	0,15	0,17	0
AR(2) p-value	0,07	0,44	0,35

t statistics in parentheses, + p<0.10, * p<0.05, ** p<0.01, , *** p<0.001.

Method : GMM - Arrellano-Bond two steps

Table A1.List of variables: Definition and sources

Name	Description	Source
ET_REV	Total environmental taxes, Percentage of total revenues from taxes and social contributions	Eurostat
ET_RATE	Variation of the implicit energy taxe rate (ratio between energy tax revenues (€ 2010) and final energy consumption (tonnes of oil equivalent))	Eurostat
TARGET	Target 2020, i.e. the level of GHG (base year 1990) actually assigned to the country by the European Commission (decision 406/2009 – Annexe II)	European Commission
GHG_DIFF	Target – GHG observed	
ENV_PROT	Total expenditures of the Public Administrations for environmental protection as a percentage of GDP	Eurostat
GS_DEP	Total expenditures of the Public Administrations for General Service as % of GDP	Eurostat
SC_DEP	Total expenditures of the Public Administrations for Social Protection as % of GDP	Eurostat
NM_EPS	Composite indicator of Non Market Environmental Policy Stringency	OECD
OTHER_TAX	Difference between total revenues from taxes and social contributions/GDP and total revenues from environmental taxes/GDP	Eurostat
MARTAX	Top legislated marginal tax rate on personal income.	
G_GDPPC	Growth rate of GDP per capita (Gross Domestic Product is expressed in millions of euro at 2005 constant prices and Population in millions)	Eurostat
GDPPC	GDP per capita (Gross Domestic Product is expressed in millions of euro at 2005 constant prices and Population in millions)	Eurostat
DEBT	General government consolidated gross debt :- Excessive deficit procedure (based on ESA 2010) (UDGG) (% of GDP)	AMECO - European Commission
ENERGY_DEP	Energy dependence (%) all product . Net imports of all types of energy divided by the sum of gross inland energy consumption plus bunkers	Eurostat
ENERGY_INT	Energy intensity (kg of oil equivalent per 1 000 EUR)	Eurostat
LEFT	Leftist governments (binary 0,1)	DPI*
PAR	Parliamentary versus Presidential System (binary, 0,1)	DPI
HERF	Herfindahl Index Government - the sum of the squared seat shares of all parties in the government	DPI
GOV_EFF	Perceptions about the quality of public services, civil service, independence from political pressures, quality of policy formulation and implementation and the credibility of government's commitment	World Bank
CC	Control of Corruption - Reflects perceptions of the extent to which public power is exercised for private gain	World Bank
MAN_VA	Manufacturing, value added expressed as % of GDP	World Bank
AGR_VA	Agriculture, value added expressed as % of GDP	World Bank
DECENTR	Central government expenditure/ General government expenditure, both expressed as % of GDP	Eurostat

*DPI = Database of Political Institutions, Development Research Group - The World Bank