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POLLUTION ABATEMENT AND CONTROL EXPENDITURE IN ROMANIA: A MULTILEVEL ANALYSIS

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Abstract

The transition process in Central and Eastern Europe was associated with growing environmental awareness. This paper analyses the determinants of Pollution Abatement and Control Expenditure (PACE) at plant level in the case of Romania using survey data and a Multilevel Regression Model (MRM). Our findings suggest that, although Romania has improved its environmental performance, formal and informal regulation are still only partially developed due to the difficulties of economic transition, and heterogeneity across regions remains considerable.

Key Words: Pollution Abatement and Control Expenditure, Transition Economy, Multilevel Regression Model (MRM)

JEL Classification: Q52, C29, C40

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Non-Technical Summary

Global environmental issues have acquired crucial importance in recent years. Pollution is responsible for decreased overall biodiversity, and the alteration of geographical landscapes and climatic patterns, with a negative impact on the global economy. This represents a momentous challenge for policy-makers. Romania, like other countries of Central and Eastern Europe (CEE), has been making several efforts to comply with the environmental legislation of the European Union (EU). Its heavy mineral and petrochemical industries being highly polluting, a new environmental law framework was adopted in 1995 in order to achieve the transition to an environmentally sustainable market economy. The new laws introduced a number of policy instruments, including environmental permits, charges, subsidies, legal liabilities and other economic incentives. Compliance has required firms to implement substantial changes at plant level. In particular, pollution abatement efforts have had an impact on both capital expenditure and operating costs.

Early in the transition process, Romania and the other CEE countries experienced a decline in industrial production and a consequent decrease in pollution levels. In subsequent stages, higher economic growth may lead to higher pollution, unless concerted action is taken to implement more effective environmental policies. Unfortunately, environmental efforts in Romania face the twin obstacles of severe budgetary constraints and a legacy of poor practice in investment and project management. In this context, innovative and effective financing strategies for environmental protection need to be developed or strengthened, and steps must be taken to ensure that scarce financial resources are allocated efficiently to address priority issues.

The aim of the present study is to shed some light on the factors affecting Pollution Abatement and Control Expenditure (PACE) in Romania. Its contribution is threefold: first, it analyses the case of a transition economy, in contrast to the existing literature which mostly focuses on developed economies; second, it uses a database at plant level; third, it adopts a suitable econometric method, i.e. the Multilevel Regression Model (MRM), to investigate the determinants of environmental behaviour at plant level.

Our results are generally consistent with the literature suggesting that plant characteristics, formal pressure through substantial regulatory actions and informal pressure through market incentives and community aspects may be important drivers of the level of plant PACE. However, unlike in the case of developed countries, we find that in Romania the potential for collective action in the environmental area is not significant. Whether the influence of stakeholders on PACE will strengthen as Romania completes its development process remains to be seen. Also, there is no evidence that environmental taxes work as incentives to adopt an environmental behaviour at plant level. As expected, the actions of regulators (command and control and liability instruments), market pressure and plant characteristics are the most important determinants of the level of PACE. Thus, the largest, most competitive and profitable private owned enterprises have made more efforts to reduce pollution. These findings enable us to gain a better understanding of the factors affecting the level of plant PACE in the case of transition economies in general and Romania in particular. Even partially developed formal and informal regulations appear to increase abatement efforts. An increase in income per capita also increases local pressure on intensive pollution plants. From a policy perspective, this evidence points to the need to redesign environmental taxes in order to achieve better outcomes. Further, measures to increase environmental awareness would also be useful in this respect.

1. Introduction

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The remainder of the paper is organised as follows. Section 2 briefly discusses the relevant literature on environmental performance. Section 3 reviews the theory of environmental regulation focusing on the Pigouvian and Coasian approaches. Section 4 outlines the econometric framework and presents the empirical findings. Section 5 offers some concluding remarks.

2. Literature Review

The basic economic processes are production and consumption: firms transform natural resources, through the production process, into commodities supplied to consumers. However, this conversion is never perfectly efficient: by-products (residuals) are produced. When such residuals have no economic value they can be thought of as waste, which may lead to pollution.

Thus, firms impose costs on other agents in the economy. This is a typical case of a negative externality. As prices do not take into account the negative effects on the environment, they do not reflect full production costs for the economy; to correct this form of market failure it is necessary to introduce environmental regulations, as otherwise there is no incentive for a polluting profit-maximising firm to internalise the externality (DiMaggio and Powell 1983). When formal regulation is weak or perceived to be insufficient, communities may informally regulate firms indirectly or directly through bargaining, petitioning and lobbying. Clearly, determining the "right" amount of pollution requires evaluating its negative effects - the willingness to pay to reduce pollution is an obvious measure. Environmental issues invariably involve a trade-off between using resources for conventional goods and services or for environmental protection instead - i.e. how much is a consumer willing to pay for a particular level of an environmental good?

Since the Brundtland Report was published in 1987 as a result of the work of the World Commission on Environment and Development, extensive research has been done by economists on how to improve environmental performance through pollution abatement, in some cases using capital expenditure as a proxy for environmental performance (Panayotou et al 1997, Ferraz and Seroa da Motta 2002, OECD 2001). Pollution abatement and control of residuals from production processes can be achieved either using end-of-pipe technology attached to a given production process, or by changing the process. Investment in the former does not affect the production process itself, and the amount of pollution generated; instead, it aims to treat pollution already generated. By contrast, investment in integrated technologies is synonymous with reducing the amount of potential pollutants at source, reducing the consumption of resources and energy, and recycling residues and used products.

Some research has analysed specific external factors that drive companies to improve their environmental performance, such as regulatory regime or government support (Delmas, 2003; Chan & Wong, 2006; Rivera, 2004; Rivera & de Leon, 2004; Rivera et al, 2006; Shin, 2005,), pressure from local wealthy stakeholders, civil society, and foreign customers in Europe and Japan (Neumayer & Perkins 2004) and industry pressure (Guler et al. 2002, Corbett & Kirsch, 2004; Viadiu et al., 2006). Other research has focused on the role of internal organisational factors such as "organisational structure and culture." Only a few studies have begun integrating key organisational characteristics with institutional theory. This approach can yield new insights into understanding differences between firms' strategies. (Seroa da Motta, 2006; Gunningham, 1995; Hoffman 2001).

Some other studies have analysed the implications of corruption and political instability for firm investment in abatement technology. Their prediction is that greater corruptibility increases the level of abatement technology investment. The strategic incentive to under-invest in pollution control technology declines when policymakers become more corruptible. Similarly, political instability is predicted to increase abatement technology investment (Fredriksson and al., 2008). Fredriksson and al. (2005) analyse the relationship between environmental lobbies and environmental policy in rich and developing countries, and find that lobbying leads to more stringent environmental policies.

Chávez and Stranlund (2009) show that setting a uniform tax equal to the expected marginal damage is not generally efficient under incomplete information about firms' abatement costs and damages from pollution. The efficient emissions tax rates will vary across firms if a regulator can use observable firm-level characteristics to gain some information about how the firms' marginal abatement costs vary.

A few more recent studies concerning the relationship between enforcement mechanism and firm's compliance behaviour highlight the fact that an increase in enforcement efforts may provide better environmental results (Shimshack and Ward, 2008). Even in an industry where compliance is generally high, an increase in enforcement through fines can cause a significant reduction in discharges. Enforcement not only induces non-compliant plants to become compliant, it also makes many typically over-compliant plants reduce discharges even further below the permitted levels.

Almost all these empirical studies focus on the developed countries. Additional challenges are faced by the developing economies, including the CEE countries such as Romania, which underwent a transition process. Under central planning, the well-known bias towards heavy industry combined with a lack of incentives to economise on inputs created considerable waste and pollution. Thus, in the transition countries production technologies are substantially less efficient than in the developed economies, and therefore emissions per unit of output are higher. In addition to the environmental problems inherited from the period of central planning, transition economies have experienced various other difficulties, including financial and economic hardship. The adjustment to market equilibrium is a gradual process, during which many variables such as provision of public goods, willingness to pay, technology and capital markets etc. are in disequilibrium. This creates both constraints and opportunities that may not be available to more “settled” economies.

From an econometric viewpoint, the Multilevel Regression Model (MRM) is the most appropriate for our sample which contains hierarchical data structured in three levels (plant, county and region). We choose this approach because it allows to combine these levels into a single analytical framewok. This is important as theory suggests that different levels are interrelated.

3. Environmental regulation: the theoretical framework

The impact of environmental regulation on the economy should be examined both theoretically and empirically. Economists thought of the problem of environmental degradation as one in which the economic agents impose external costs on society as a whole in the form of pollution. The obvious solution was seen as the introduction of a tax on the polluting activity internalising social costs. Thus, the study of the degradation of the environment introduces the concept of externality, which is one of the main arguments for neoclassical interventionism. External effects have been analysed in the light of the divergent views of Pigou and Coase respectively.

Pigou (1920) introduced the concept of external economy as a form of service or disservice to others which is not paid or compensated, focusing on the divergence between private and social marginal products. The presence of externalities legitimised the intervention of the state, whose goal was to restore the equality between marginal products, guaranteeing the maximisation of social income. The solution lies in taxing the activity causing the disservice. Since the pioneering study of Pigou (1920) it has been recognised that a regulatory authority can internalise external costs resulting from production (emissions) by introducing an environmental tax based on the marginal damage resulting from the activity (Pigouvian tax).

Coase (1960) called into question the assertion that the presence of externalities legitimates corrective government intervention, in order to restore an optimal situation in terms of allocation of resources. His criticism is based on demonstrating the existence of a spontaneously negotiated solution. This argument is the heart of his well known “Coase Theorem”. This shows that decentralised bargaining between sender and receiver of the harmful effect for the amount of compensatory payment for the nuisance can produce a situation corresponding to an optimal final allocation.

The Coasian criticism is fundamental to the neo-liberal offensive against neoclassical interventionism. Essentially, Coase establishes the existence of a solution to pollution problems by spontaneous negotiation between the concerned agents. This direct solution breaks with the Pigouvian approach in two ways: the recognition of the reciprocal nature of the harmful effects and the introduction into economic analysis of the legal concept of property rights. However, as the hypothesis of zero transaction costs is unrealistic, the Coasian solution has been marginalised in the field of environmental economics.

In brief, in the Pigouvian approach it is the polluter which is responsible for the externality and the policy prescription consists in a pollution tax. By contrast, in the Coasian approach the externality is assumed to be reciprocal (i.e., both polluter and polluted cause it), and this implies that legal rules and institutions should change to internalise it.

Our aim is to establish whether formal (governmental) environmental regulation is more effective than informal ones (negotiation, community pressure) in reducing pollution in the case of Romania.

4. Econometric Analysis

4.1 Econometric method

In the statistics literature MRM is alternatively referred to as multilevel analysis, hierarchical models, random coefficients models, and variance components analysis. The common element of all these methods is that the dependent variable is analysed as a function of predictors measured at the lowest level and of those measured at higher levels. The rationale for using the multilevel model is based on the assumption that the variation in the dependent variable is a function of both lower-level and higher-level factors - not only of individual-level attributes, but also of extra-individual factors. Besides, the relationship between lower- and higher-level factors and the dependent variable is not assumed to be fixed or constant across space or time. Therefore, the regression coefficients in micro-level models are not fixed, and they can vary across these factors.

Conceptually, the model is often viewed as a hierarchical system of regression equations. The simplest multilevel model that can be formulated considers only two levels of analysis[5]. The analysis focuses on level-1 (individuals), whilst level-2 (group) provides the context for the level-1 units. For instance, in our case, level-1 units are the plants who are nested in different counties (level-2 units). The dependent variable (note: in Y_{ij} , i refers to

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5 For more details concerning MRM, see Greene (2002).

level-1 units and j refers to level-2 units) is measured for level-1 units, since this is the primary level of analysis. The explanatory variables are X_{ij} for level-1 and Z_j for level-2. By assumption, there are J groups and in each group there are N_i individuals.

Thus, there is a separate regression equation for each group.

$$Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + \varepsilon_{ij} \quad \text{with} \quad (j = 1,2, \ldots\ldots J;\ i = 1,2,\ldots\ldots N) \qquad (1)$$

where :

β_0 is the regression intercept;

β_1 is the regression slope for the explanatory variable X;

ε_{ij} is the residual term.

To model group variation (this time for the level-2 units) in regression parameters additional equations are required, with the level-1 regression parameters as their dependent variables. The regression includes at least a constant, one level-2 explanatory variable and a disturbance.

Thus, a typical level-2 model consists of the following equations:

$$\beta_{0j} = \mu_{00} + \mu_{01} Z_j + u_{0j} \quad \text{with } (j = 1,2,\ldots N) \qquad (2)$$

$$\beta_{ij} = \mu_{10} + \mu_{11} Z_j + u_{1j} \quad \text{with } (j = 1,2,\ldots N) \qquad (3)$$

After substituting equations (2) and (3) into equation (1), one obtains:

$$Y_{ij} = \mu_{00} + \mu_{01} Z_j + \mu_{10} X_{ij} + \mu_{11} X_{ij} Z_j + u_{1j} X_{ij} + u_{0j} + \varepsilon_{ij} \qquad (4)$$

where: μ_{00} is the intercept; μ_{01} μ_{10} are the effect of the level-2 variable Z_j on level-1 X_{ij} ; μ_{11} is the cross-level interaction between the level-1 and level-2 variables. The last three terms in equation [4] are the disturbance terms.

If there are P variables X at level-1 (lowest level) and Q variables Z at level-2 (highest level) the equations (1→4) become:

$$Y_{ij} = \beta_{0j} + \sum_{p=1}^{P} \beta_{pj} X_{ij}^{p} + \varepsilon_{ij} \qquad (1a)$$

$$\beta_{0j} = \mu_{00} + \sum_{q=1}^{Q} u_{oq} Z_j^{q} + u_{0j} \qquad (2a)$$

$$\beta_{pj} = \mu_{p0} + \sum_{q=1}^{Q} \mu_{pq} Z_j^{q} + u_{pj} \qquad (3a)$$

$$Y_{ij} = \mu_{00} + \sum_{p=1}^{P} \mu_{p0} X_{ij}^{p} + \sum_{q=1}^{Q} \mu_{0q} Z_{j}^{q} + \sum_{q=1}^{Q} \sum_{p=1}^{P} \mu_{pq} Z_{j}^{q} X_{ij}^{p} + \sum_{p=1}^{P} u_{pj} X_{ij}^{p} + u_{0j} + \varepsilon_{ij} \qquad (4a)$$

where:

$\boldsymbol{\mu}$ are the regression coefficients (fixed parts of the model – they do not change across groups);

$\boldsymbol{u}$ are the residuals at the group level;

$\boldsymbol{\varepsilon}$ are the residuals at the individual level. The residuals $\boldsymbol{u}$ and $\boldsymbol{\varepsilon}$ are the random or stochastic part of the model.

The multilevel model can be extended to more than two levels of analysis. The parameters at the highest level are always assumed to be fixed. A multilevel model extended to a greater number of levels produces structures that are even more complex and implies more complex disturbance term. Recent advances in computational power and software packages allows the analysis of at least three-level models, and even nine levels, but the interpretation of complex multi-level models is very difficult. That is why more than two levels should not be included unless one has a clear rationale for doing so and strong priors about the nature of the effects.

The standard techniques for combining data of different levels often break down, while multilevel methods allows to take into consideration their relationships and at the same time avoid the pitfalls associated with the traditional methods of dummy variable models and standard interactive approaches (see Jones and Steenbergen (2002) for more details concerning the multilevel methods).

4.2 Model specification

The econometric model used here considers four determinants of pollution expenditure: plant characteristics, market incentives, communities' characteristics and regulation intensity. In our analysis we focus on the regulatory variables in order to explain pollution abatement through the control expenditure at plant level. The dependent variable is plant environmental pollution expenditure (PACE) defined as:

$$PACE = f(PLANT, MARKET, COMMUNITY, REGULATORY) \qquad (5)$$

Plant - Plant characteristics,

Market – Market incentives,

Community - Community characteristics, *Regulatory* - Regulatory intensity.

Plant characteristics included in the analysis are the competitiveness of the firm, ownership, size, location, the technology used and external financing. Competitiveness and profitability are important factors as they represent the willingness and ability of the firm to abate pollution. Other relevant variables are solvency, liquidity and the debt ratio which are indices of financial stability and can provide more information about the ability of plants to invest in pollution abatement technology.

Regarding ownership, we consider three categories, namely enterprises with state capital (state-owned enterprises), with private capital (privately owned enterprises) and with mixed capital. We also distinguish between domestic and foreign enterprises.

Plant size is proxied by turnover and is a measure of the ability of the firm to invest in order to abate pollution. The geographical location can be urban or rural. Eight regions are considered. The technology used in the production process allows to distinguish between intensive pollution sectors (dirty sectors) and the non-pollutant sectors (clean sectors).

It is also important to take into account other economic factors and market characteristics of the environment where plants develop their activities. Thus, income per capita at purchasing power parity at national and regional level is included as a measure of the standard of living. People from regions with high income tend to be better educated, more informed about environmental issues and more active in abating pollution.

Government's pressure or formal regulation is included in the form of environmental taxes and penalties, environmental subsidies and legislation on air and water pollution abatement at regional level. As for community pressure or informal regulation, we consider non-governmental organisations (NGO) at regional and county level which can exert important pressure on plants to abate pollution and use cleaner technologies.

Table 1 provides a list of variable definitions and a summary of theoretical priors for their effects on pollution abatement.

Table 1 Variable Definitions and Expected Signs

Variables	Definitions	Sign
Plant characteristic variables		
$Profit_{it}$	Disposable profit of plant *i* in year *t* as a measure of competitiveness and profitability;	+
$Product_{it}$	Plant productivity of plant *i* in year *t* as a measure of economic performance;	+
$Debt_{it}$	Debt ratio of plant *i* in year *t* – a measure of a company's financial leverage;	-
$Turnover_{it}$	Turnover of plant *i* in year *t* ; plant activity size defined as turnover;	+
Svb_{it}	Solvency of plant *i* in year *t* as a measure of financial performance	+
Lqt_{it}	Liquidity of plant *i* in year *t* as a measure of financial performance;	+
CS_{it}	Ownership of the plant *i* in year *t*. The dummy variable takes value 1 if the plant is a state-owned enterprise and 0 otherwise;	+/-
CP_{it}	Ownership of the plant *i* in year *t*. The dummy variable takes value 1 if the plant is a privately owned enterprise and 0 otherwise;	+/-
CM_{it}	Ownership of the plant *i* in year *t*. The dummy variable takes value 1 if the plant has mixed capital and 0 otherwise;	+/-
$Frgn_{it}$	Foreign plants. The dummy variable takes value 1 for foreign enterprises and 0 for domestic enterprises;	+/-
Loc_{it}	Geographical location of the plant *i* in year *t* according to the degree of urbanization. The dummy variable takes value 1 if the plant is located in an urban area and 0 if is located in rural area;	+/-
Efn_{it}	Foreign financing aid of plant *i* in year *t*.	+/-
Market incentive variables		
Iso_{it}	ISO 14001 certification, indicating environmental management adoption by the plant *i* The dummy variable takes value 1 if the plant is certified ISO and 0 otherwise;	+

$Mark_{it}$	Listing on Bucharest Stock Exchange (BSE) of plant *i* in year *t*, proxy for the firm's visibility. The dummy variable takes value 1 if the plant is listed at BSE and 0 otherwise;	+
PCI_{kt}	Per capita income for each region *k* in the year *t* , a proxy for local informal regulatory pressure, education and citizen activism	+
CRP_t	Corruption index of the country in year *t*	-
Community characteristics variables		
$UnEmp_{jt}$	Unemployment rate of county *j* in year *t* as a proxy for population welfare ;	-
RSH_{kt}	Population with university studies of region *k* in year *t* as a proxy for population skills.	+
Regulatory intensity variables		
$PollSect_{it}$	Pollution industry sectors as a proxy for intensity of regulation and environmental policy instruments. Dummy variable which takes value 1 if the production of the plant *i* in year *t* is dirty and 0 otherwise;	+
$EnvNGO_{jt}$	Number of environmental non-governmental organisations of county *j* in year *t*;	+
$Locpres_{it}$	The existence of the local pressure on the plant *i* in year *t*. Dummy variable which takes value 1 if the plant i in year t was subject to a local pressure and 0 otherwise;	+
$EnvGuard_{kt}$	Environmental penalties in region *k* in the year *t*, proxy for the formal regulatory pressure to adopt an environmental behaviour- liability environmental policy instruments;	+
$EnvTx_{it}$	Environmental taxes of plant *i* in year *t* , proxy for the economic incentives to adopt an environmental behaviour – economic environmental policy instruments;	+
$EnvSub_{it}$	Environmental subsidies of plant *i* in year *t*, policy instruments to promote plant environmental behaviour- economic environmental policy instruments;	+
$Acom_t$	Communitary aquis ; Dummy variable which takes value 1 if the country adopted the aquis in year *t* and 0 otherwise;	+

Thus, the econometric specification used is the following:

$$\log(PACE_{it}) = \beta_0 + \beta_1 \log(\text{Profit}_{it}) + \beta_2 \log(\text{Product}_{it}) + \beta_3 \log(Debt_{it}) + \beta_4 \log(Turnover_{it}) +$$
$$+ \beta_5 \log(Svb_{it}) + \beta_6 Lqt_{it} + \beta_7 CS_{it} + \beta_8 CP_{it} + \beta_9 CM_{it} + \beta_{10} Frgn_{it} + \beta_{11} Loc_{it} + \beta_{12} Efn_{it} + \beta_{12} Iso_{it} +$$
$$+ \beta_{13} \log(Mark_{it}) + \beta_{14} \log(PCI_{kt}) + \beta_{15} \log(CRP_{t}) + \beta_{16} \log(UnEmp_{jt}) + \beta_{17} PolSect_{it} + \quad (6)$$
$$+ \beta_{18} \log(EnvNGO_{jt}) + \beta_{19} Locpres_{it} + \beta_{20} \log(EnvGuard_{kt}) + \beta_{21} \log(EnvTx_{it}) + \beta_{22} \log(EnvSub_{it}) +$$
$$+ \beta_{23} Acom_{t} + u_{it}$$

where: PACE_{it} = pollution abatement expenditure incurred by plant ***i*** in year ***t*** and $\boldsymbol{u_{it}}$ is the error term. Some details about our sample and the data sources are provided below.

4.3 Data

The analysis has been carried out for Romania in the period 2002 – 2005. The data are taken from the yearly survey of plant pollution abatement effort conducted by the Romanian National Institute of Statistic which inquires about capital expenditures and operating cost associated with pollution abatement efforts. Data in the survey are tabulated by industry.

The data are in the form of a panel providing environmental and financial information at establishment level (on pollution abatement and control expenditure, environmental taxes and subsidies) and community characteristics and regulation intensity data at county level for the period 2002-2005. The sample contains plants covering almost all industrial sectors. We selected only the plants with continuous activity over the sample period (1422 plants).

The establishment characteristics (economic and financial information) are taken from plant financial reports. Also, we identified the firms that were traded on the capital market and listed on the Bucharest Stock Exchange, and those certified ISO 14001, using information from the Romanian Accreditation Association. The community characteristics were obtained from the Romanian National Institute of Statistics, except for the number of environmental ONG which comes from the Ministry of Environment. Using the information from Environmental Guard we constructed a proxy variable for regulation intensity (environmental penalties levied).

4.4 Empirical results and policy implications

First, we run a regression for total environmental expenditure, and then we model the pollution abatement effort separately for air and water. Subsequently, we also analyse pollution abatement at the regional level, so as to highlight the different determinants for each region.

4.4.1 Abatement pollution effort

The econometric results from the model are reported in Table 2.

Table 2: Econometric results of determinants of abatement pollution effort

Variables	OLS	OLS	OLS	MRM
	(1)	(2)	(3)	(4)
	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$
$Product_{it}$	0.087	0.092	0.090	0.075
	(5.19)***	(5.51)***	(5.36)***	(4.58)***
Svb_{it}	0.032	-0.040	0.052	0.024
	(0.66)	(0.82)	(1.08)	(0.50)
Lqt_{it}	0.150	0.122	0.125	0.103
	(4.57)***	(3.70)***	(3.63)***	(3.02)***
$Turnover_{it}$	0.837	0.843	0.851	0.795
	(48.03)***	(48.06)***	(48.19)***	(4.51)***
$Profit_{it}$	0.042	0.046	0.144	0.138
	(3.04)***	(3.34)***	(3.20)***	(2.79)***
$Frgn_{it}$	0.437	0.412	0.387	0.375
	(5.15)***	(4.85)***	(4.57)***	(4.03)***
ISO_{it}	0.455	0.492	0.510	0.492
	(5.23)***	(5.65)***	(5.85)***	(5.52)***
$Mark_{it}$	0.858	0.831	0.826	0.800
	(22.87)***	(22.12)***	(22.02)***	(20.52)***
$PollSect_{it}$	0.199	0.196	0.192	0.182
	(6.64)***	(6.54)***	(6.44)***	(5.32)***
$EnvSub_{it}$	0.295	0.294	0.294	0.293
	(10.45)***	(10.41)***	(10.45)***	(10.58)***
Efn_{t}	0.393	0.390	0.382	0.320
	(6.91)***	(6.86)***	(6.75)***	(6.12)***
$Debt_{it}$	-0.328	-0.327	-0.325	-0.324
	(6.36)***	(6.35)***	(6.33)***	(6.00)***
CS_{it}	-0.628	-0.587	-0.617	-0.362
	(5.99)***	(5.60)***	(5.90)***	(6.38)***
CM_{it}	0.347	0.338	0.329	0.210
	(4.91)***	(4.77)***	(4.66)***	(2.70)***
CP_{it}	0.324	0.328	0.336	0.377
	(4.09)***	(4.14)***	(4.25)***	(4.31)***
$EnvTX_{it}$	0.151	0.158	0.151	0.425
	(15.85)***	(16.42)***	(15.58)***	(4.50)***
$UnEmp_{jt}$	-	-0.145	-0.076	-0.014
		(1.63)	(0.73)	(1.34)
Loc_{it}	-	0.168	-0.064	-0.073
		(1.67)*	(1.14)	(0.13)
$EnvNGO_{jt}$	-	0.066	-0.050	0.072
		(1.49)	(1.05)	(1.29)
$LocPres_{it}$	-	-0.061	0.203	0.126
		(1.39)	(0.11)	(1.03)
PCI_{kt}	-	-	1.481	5.277

			(7.71)***	(5.53)***
$Acom_t$	-	-	0.085	0.020
			(2.53)**	(1.61)*
$EnvGUARD_{kt}$	-	-	0.035	0.255
			(2.59)***	(6.51)***
CRP_t	-	-	-0.126	-0.069
			(2.11)**	(1.20)*
Constant	-3.044	-3.669	1.518	20.071
	(20.29)***	(20.56)***	(2.01)**	(5.39)***
Observations	5688	5688	5688	5688
R-squared	0.30	0.31	0.31	-
Log restricted-likelihood	-	-	-	-34871.95
Sd_reg	-	-	-	0.8762831
IC_reg	-	-	-	0.33
Sd_jud	-	-	-	0.7484896
IC_jud	-	-	-	0.26
Sd_residual	-	-	-	1.260319
LR test vs. OLS chi2	-	-	-	807.22
Prob>chi2				(0.00)
Absolute value of t statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

Note: the regressions (1→3) are performed using the ordinary least squares (OLS) and 4 is performed with multilevel regression (MRM).

Sd_reg = Standard deviation at the region level (3);

Sd_jud = Standard deviation at the county level (2);

Sd_residual = Standard deviation at the plant level (1);

IC_reg = Intraclass_ correlation (region – fiscal) = $\frac{Sd\_reg^2}{Sd\_reg^2 + Sd\_residual^2}$

IC_jud = Intraclass_ correlation (county – fiscal) = $\frac{Sd\_jud^2}{Sd\_jud^2 + Sd\_residual^2}$

If the interclass correlation (IC) approaches 0 then the grouping by counties (or regions) is not of any use (one might as well run a simple regression). If IC approaches 1 then there is no variance to explain at the individual level, every unit being the same.

We focus in particular on the results obtained through the multilevel method (column 4). It can be seen that the signs of the statistically significant variables are in general as expected. The large and successful firms with capital availability are more likely to adopt an environmental behaviour and invest in environmental protection. The competitiveness variables have a positive and significant effect. Thus, if the plants are more competitive (i.e., profitable) they abate pollution more aggressively, presumably because they can afford to invest more to improve their environmental performance. Plants with good solvency and liquidity and not too indebted can invest more in cleaner technologies. Plant productivity is a measure of competitiveness. Size also matters As already mentioned, this is proxied by turnover. From our results it is clear that the largest plants are more aggressive in abating pollution.

Plant ownership also plays an important role. We find a negative correlation between state-owned plants and abatement efforts and a positive one in the case of privately owned or mixed capital enterprises. Most enterprises in our sample have private or mixed capital, the state owned plants representing only 5 % of the total. After 1989, Romania privatised many state owned enterprises. This wave of privatisation has increased the competitiveness and efficiency of plants and thus has improved their environmental performance. Our results show clearly that private enterprises (domestic or foreign) make more significant abatement efforts. Concerning the relationship between geographical location and abatement efforts, our results show that clean technologies are more common in the urban areas, whilst more pollution is found in the rural ones. Financial or foreign aid is also positively correlated with abatement effort.

Market pressure from consumers, investors and competing firms, estimated by the adoption of ISO 14001 and by the listing on the Bucharest Stock Exchange, has a significant positive impact. Good visibility of a plant and the adoption of environmental management standards are two important determinants of abatement efforts and indicate that the management of these plants are more responsive to environmental regulations.

There is a positive relationship between regional per capita income and abatement effort. Our sample includes eight regions as specified in table A_1 in the appendix. Regions with a higher income are more environmentally aware and invest more in pollution abatement. The corruption index is instead negatively correlated with abatement effort.

Community groups, proxied by unemployment and the number of environmental non-governmental organisations, have no statistically significant impact on PACE. EnvNGOs do not appear to have an important role either. In general, in the transition economies the concern for the environment is not a top priority for the community, which is confronted with economical and financial problems.

Concerning the government pressure on plants we used three proxies for formal regulatory pressure, namely environmental penalties, taxes and subsidies. Public authorities which are concerned with regulatory enforcement and monitoring are critical factors influencing plants' decisions to take an environmental approach and undertake environmental investment. Environmental penalties and subsidies are found to have a statistically significant positive impact, whilst environmental taxes are also statistically significant but have a low impact. These results show that, although formal regulations are still only partially developed, they have measurably beneficial effects on abatement efforts in the case of Romania.

4.4.2. Water and Air Pollution Abatement Effort

Environmental standards are typically drafted by research institutes or ministries. A system of environmental authorisations has been created consisting of environmental agreements and environmental permits. All environmental permits specify that enterprises are responsible for monitoring emissions. The authorities (environmental protection agencies) have the right to amend, suspend and revoke environmental authorisations but they prefer to be more collaborative to obtain compliance. If an enterprise is unable to meet the discharge levels specified in its permits, a plan is developed containing the steps that must be undertaken within a specified time. There are penalties for exceeding permitted emission, but these are not linked to pollution quantities and are not an effective deterrent.

Water resources in Romania are managed according to the principals of integrated water management. Therefore, policies to promote sustainability try specifically to incorporate linkages between water quality and water quantity. These are potentially important, because excessive usage can lower underground and surface water levels and increase concentration of contaminants.

Water charges exist in Romania, both for direct consumption or use and for discharges. Their aim is to encourage the sustainable use of this resource and to generate revenues to finance water supply and sewage treatment and disposal. They were introduced at the beginning of 1991 and rates are indexed quarterly. There are separate national prices for each category and user of raw water, with the industry sector paying more than agriculture, and agriculture paying more than households.

Penalties are levied on twenty substances divided into two general categories. The first contains substances such as chlorine, sulphates, nitrates, detergents for which allowable levels are established to meet concentrations standards. The second group contains substances such as mercury, pesticides, radioactive residues for which no discharges are permitted.

Next, we estimate separate regressions for water and air pollution abatement effort. The variables are generally the same as in the previous regression, but there are a few additional ones specific to water and air respectively. Thus, the econometric specifications are the following:

- *for water pollution abatement*

$$\begin{aligned}\log(PACEw_{it}) &= \beta_0 + \beta_1 \log(\mathrm{Pr}ofit_{it}) + \beta_2 \log(\mathrm{Pr}oduct_{it}) + \beta_3 \log(Debt_{it}) + \beta_4 \log(Turnover_{it}) + \\ &+ \beta_5 \log(Svb_{it}) + \beta_6 Lqt_{it} + \beta_7 CS_{it} + \beta_8 CP_{it} + \beta_9 CM_{it} + \beta_{10} Frgn_{it} + \beta_{11} Loc_{it} + \beta_{12} Efnw_{it} + \beta_{12} Iso_{it} + \\ &+ \beta_{13} \log(Mark_{it}) + \beta_{14} \log(PCI_{kt}) + \beta_{15} \log(CRP_t) + \beta_{16} \log(UnEmp_{jt}) + \beta_{17} PolSect_{it} + \\ &+ \beta_{18} \log(EnvNGO_{jt}) + \beta_{19} Locpres_{it} + \beta_{20} \log(EnvGuard_{kt}) + \beta_{21} \log(EnvTxw_{it}) + \beta_{22} \log(EnvSubw_{it}) + \\ &+ \beta_{23} LWw_t + u_{it}\end{aligned} \quad (7)$$

where : PACEw$_{it}$ = water pollution abatement expenditure incurred by plant i in year t; EnvTxw$_{it}$ = environmental taxes incurred by plant i in year t for water pollution abatement; EnvSubw$_{it}$ = environmental subsidies received by plant i in year t for water pollution abatement; Efnw$_{it}$ = foreign financing aid received by plant i in year t for water pollution abatement; LWw$_t$ = number of laws adopted concerning water pollution in year t and u$_{it}$ – error term.

- *for air pollution abatement*

$$\begin{aligned}\log(PACEa_{it}) &= \beta_0 + \beta_1 \log(\mathrm{Pr}ofit_{it}) + \beta_2 \log(\mathrm{Pr}oduct_{it}) + \beta_3 \log(Debt_{it}) + \beta_4 \log(Turnover_{it}) + \\ &+ \beta_5 \log(Svb_{it}) + \beta_6 Lqt_{it} + \beta_7 CS_{it} + \beta_8 CP_{it} + \beta_9 CM_{it} + \beta_{10} Frgn_{it} + \beta_{11} Loc_{it} + \beta_{12} Efna_{it} + \beta_{12} Iso_{it} + \\ &+ \beta_{13} \log(Mark_{it}) + \beta_{14} \log(PCI_{kt}) + \beta_{15} \log(CRP_t) + \beta_{16} \log(UnEmp_{jt}) + \beta_{17} PolSect_{it} + \\ &+ \beta_{18} \log(EnvNGO_{jt}) + \beta_{19} Locpres_{it} + \beta_{20} \log(EnvGuard_{kt}) + \beta_{21} \log(EnvTxa_{it}) + \beta_{22} \log(EnvSuba_{it}) + \\ &+ \beta_{23} LWa_t + u_{it}\end{aligned} \quad (8)$$

where : PACEa$_{it}$ = air pollution abatement expenditure incurred by plant *i* in year *t* for air ; EnvTxa$_{it}$ = environmental taxes incurred by plant *i* in year *t* for air pollution abatement; EnvSuba$_{it}$ = environmental subsidies received by plant *i* in year *t* for air pollution abatement; Efna$_{it}$ = foreign financing aid received by plant *i* in year *t* for air pollution abatement; LWa$_t$ = number of laws adopted concerning air pollution in year t and u$_{it}$ – error term.

The econometric results are reported in Table 3.

Table 3: Econometric results for air and water pollution abatement effort

	AIR ABATEMENT EFFORT (MRM)		WATER ABATEMENT EFFORT (MRM)	
Variables	**Coefficient**	**z**	**Coefficient**	**z**
$Product_{it}$	0.078	(-4.69)***	0.081	(-4.85)***
Svb_{it}	0.016	(-0.32)	0.009	(-0.19)
Lqt_{it}	0.108	(-3.13)***	0.095	(-2.73)***
$Turnover_{it}$	0.772	(41.37)***	0.811	(43.04)***
$Profit_{it}$	0.037	(2.92)***	0.041	(2.95)***
$Frgn_{it}$	0.331	(-3.51)***	0.349	(-3.64)***
ISO_{it}	0.489	(5.42)***	0.556	(6.12)***
$Mark_{it}$	0.858	(19.27)***	0.936	(20.66)***
$Debt_{it}$	-0.336	(-6.15)***	-0.335	(-6.06)***
CS_{it}	-0.762	(6.29)***	-0.908	(7.37)***
CM_{it}	0.172	(2.18)**	0.246	(3.07)***
CP_{it}	0.363	(-4.10)***	0.346	(-3.82)***
$EnvTXw_{it}$	-	-	0.004	(-0.26)
$PollSectw_{it}$	-	-	0.148	(4.50)***
$EnvSubw_{it}$	-	-	0.292	(7.29)***
$Efnw_{it}$	-	-	0.341	(4.56)***
LWw_{t}	-	-	0.211	(3.27)***
$EnvTXa_{it}$	0.285	(16.26)***	-	-
$PollSecta_{it}$	0.215	(5.46)***	-	-
$EnvSuba_{it}$	0.244	(5.70)***	-	-
$Efna_{it}$	0.370	(3.92)***	-	-
LWa_{t}	0.322	(6.72)***	-	-
PCI_{kt}	3.542	(-3.46)***	4.358	(-4.22)***
$UnEmp_{jt}$	-0.611	(-1.21)	-0.819	(1.61)*
$EnvNGO_{jt}$	0.007	(-0.61)	0.089	(-1.16)
$EnvGUARD_{kt}$	0.301	(6.61)***	0.345	(7.54)***
Constant	2.687	(-0.61)	5.426	(-1.22)
R-squared	0.67	-	0.78	-
Observations	5688	-	5688	-
Log restricted-likelihood	-32175.62	-	-30117.35	-
Sd_reg	0.8925334	-	0.9125631	-
IS_reg	0.33	-	0.30	-
Sd_jud	0.6253471	-	0.7285243	-
IS_jud	0.16	-	0.21	-
Sd_residual	1.413562	-	1.394265	-
LR test vs. OLS chi2	906.13	-	786.34	-
Prob>chi2	(0.00)	-	(0.00)	-
Absolute value of t statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

One can see that the determinants of air and water pollution abatement effort are approximately the same and have the same signs as before. Environmental taxes seem to be more important for the former, indicating that formal regulation plays a bigger role in the case of air pollution abatement effort, while for the latter environmental taxes becomes insignificant. For both the effects of informal regulation are weak.

4.4.3 Abatement effort at the regional level

Next, we estimate equation (6) at the regional level, still carrying out multilevel analysis (MRM). The variable added is RSH, which is a proxy for human resource quality. The results are displayed in Table 4.

Table 4. Econometric results of the abatement pollution effort at the regional level (eight regions) by multilevel regression

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$	$PACE_{it}$
$Product_{it}$	0.122	0.179	0.140	0.130	0.071	0.096	0.021	0.053
	(2.86)***	(4.54)***	(3.31)***	(2.15)**	(1.67)*	(2.52)**	(0.51)	(1.28)
Svb_{it}	-0.098	-0.008	0.036	-0.038	-0.064	-0.037	-0.143	0.163
	(0.81)	(0.07)	(0.34)	(0.26)	(0.56)	(0.32)	(1.19)	(1.30)
Lqt_{it}	0.142	0.034	0.136	0.045	0.025	0.146	0.015	0.188
	(1.65)*	(0.42)	(1.71)*	(0.41)	(0.30)	(1.88)*	(0.18)	(2.02)**
$Turnover_{it}$	0.755	0.672	0.578	0.551	0.390	0.611	0.706	0.573
	(16.74)***	(15.00)***	(14.36)***	(10.30)***	(9.69)***	(14.62)***	(14.45)***	(11.52)***
$Profit_{it}$	0.043	0.097	0.074	0.114	0.046	0.074	0.022	0.112
	(1.25)	(2.92)***	(2.14)**	(2.37)**	(1.31)	(2.28)**	(0.64)	(0.34)
$Frgn_{it}$	0.214	0.443	0.010	0.486	0.111	0.610	0.407	0.121
	(0.77)	(2.07)**	(0.05)	(1.75)*	(0.49)	(3.41)***	(2.13)**	(0.59)
ISO_{it}	0.046	0.214	0.185	0.228	0.507	0.434	-0.058	0.203
	(0.20)	(0.90)	(0.99)	(1.01)	(2.06)**	(1.86)*	(0.24)	(1.11)
$Mark_{it}$	0.552	0.345	0.461	0.690	0.643	0.465	0.654	0.384
	(6.59)***	(3.70)***	(5.63)***	(6.42)***	(5.50)***	(5.54)***	(6.74)***	(3.84)***
$PollSect_{it}$	0.004	0.153	0.029	0.009	0.104	0.150	0.042	0.044
	(0.06)	(2.16)**	(0.42)	(0.09)	(1.39)	(2.34)**	(0.59)	(0.54)
$EnvSub_{it}$	-0.035	0.217	0.042	0.124	0.026	0.076	0.066	0.081
	(0.52)	(2.48)**	(0.50)	(1.51)	(0.36)	(0.91)	(0.96)	(1.54)
Efn_{it}	0.041	0.097	0.153	0.210	0.001	0.195	0.125	0.015
	(0.43)	(0.62)	(0.42)	(0.97)	(0.78.)	(1.66)*	(0.85)	(0.15)
$EnvTX_{it}$	0.012	-0.022	0.147	0.015	0.123	0.031	0.026	0.057
	(0.51)	(0.97)	(6.24)***	(0.45)	(4.45)***	(2.32)**	(1.71)*	(2.13)**
$Debt_{it}$	-0.343	0.050	-0.305	-0.072	-0.253	-0.295	-0.145	-0.482
	(2.46)**	(0.48)	(2.93)***	(0.38)	(1.84)*	(2.62)***	(1.05)	(3.62)***
CS_{it}	-1.028	-0.272	-0.677	-0.020	0.408	-0.121	-0.367	-0.253
	(3.15)***	(1.11)	(2.84)***	(0.07)	(1.48)	(0.50)	(1.59)	(0.91)

CM_{it}	0.316	0.348	0.192	-0.082	-0.383	0.057	0.293	0.416
	(1.49)	(1.78)*	(1.15)	(0.32)	(2.38)**	(0.34)	(1.73)*	(2.59)***
CP_{it}	0.061	0.332	0.063	0.688	0.438	0.561	0.292	0.157
	(0.24)	(1.84)*	(0.34)	(2.82)***	(1.97)**	(3.63)***	(1.74)*	(0.74)
$Unemp_{jt}$	-2.000	-2.546	-1.378	-0.751	2.900	-0.330	-1.809	-2.722
	(2.68)***	(5.41)***	(3.25)***	(0.70)	(4.79)***	(0.98)	(3.92)***	(1.57)
Loc_{it}	-1.388	-2.476	0.764	-5.483	-2.707	-2.896	-6.880	-7.175
	(6.91)***	(9.43)***	(1.41)	(4.19)***	(2.67)***	(3.96)***	(11.04)***	(2.50)**
$EnvNGO_{jt}$	0.017	0.072	0.067	0.032	0.148	1.096	2.241	6.431
	(1.30)	(0.65)	(1.20)	(0.44)	(2.64)***	(2.13)**	(3.72)***	(6.42)***
$Locpres_{it}$	0.010	0.0178	0.106	0.154	0.102	0.094	0.131	0.197
	(0.09)	(0.30)	(1.00)	(0.94)	(1.90)*	(2.01)*	(2.43)**	(2.10)**
PCI_{kt}	7.673	11.869	10.529	-7.470	17.110	13.651	20.128	23.993
	(2.78)***	(1.73)*	(1.42)	(1.59)	(3.02)***	(2.82)***	(4.16)***	(1.76)*
$EnvGUARD_{kt}$	0.758	0.213	0.683	0.229	0.846	1.010	5.005	0.638
	(1.31)	(0.70)	(1.43)	(0.48)	(3.50)***	(3.55)***	(4.24)***	(5.46)***
RSH_{kt}	0.091	0.101	0.113	0.107	0.187	0.162	0.178	0.253
	(1.31)	(1.87)*	(1.43)	(1.98)*	(2.12)**	(1.73)*	(1.82)*	(2.48)***
Constant	-67.230	37.000	22.931	22.278	-73.277	97.973	-354.923	125.385
	(2.26)**	(1.40)	(1.07)	(1.08)	(3.98)***	(3.71)***	(4.72)***	(1.91)*
Observations	816	632	760	508	568	748	936	720
R-squared	0.50	0.46	0.50	0.48	0.52	0.50	0.46	0.42
Log restricted-likelihood	-30245.12	-32175.62	-29413.21	-26625.67	-34215.54	-34414.13	-29313.25	-31442.46
Sd_reg	0.7932341	0.8721531	0.9125463	0.8874215	0.9022153	0.7985691	0.8751243	0.9075812
IS_reg	0.24	0.30	0.34	0.30	0.36	0.30	0.28	0.33
Sd_residual	1.413562	1.325642	1.275891	1.346521	1.192678	1.215642	1.402278	1.278954
LR test vs. OLS chi2	806.18	779.21	675.32	917.45	825.30	715.89	698.74	914.38
Prob>chi2	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Absolute value of t statistics in parentheses								
* significant at 10%; ** significant at 5%; *** significant at 1%								

Regions:	1 = North - East	4 = South - West	7 = Centre
	2 = South – East	5 = West	8 = Bucharest - Ilfov
	3 = South	6 = North – West	

As expected, in the regions with high income (West, Centre and Bucharest-Ilfov) informal pressure is more important and the population more reactive. Thus, local pressure and ONGs have a significant impact on pollution abatement. In contrast, in the poorer regions (North-East, South -West) informal pressure is weak, the population being less educated and having limited access to information.

Besides, formal regulations have a different impact on the eight regions. Specifically, environmental taxes and penalties are statistically insignificant for the low-income regions and become significant for the regions with high income per capita. Bucharest-Ilfov has the highest income per capita, the North-East region the lowest. Bucharest-Ilfov is also characterised by the availability of qualified human resources, and the presence of a number of EnvNGOs. Moreover, almost all plants in this region are clean (see table A2). In contrast, the poorest region is characterised by a high unemployment rate, a low percentage of skilled population and a low number of EnvNGOs. Plants polluting more are located in poorer regions (see table A3 and A4).

Overall, although Romania has improved its environmental performance considerably, formal and informal regulation are still only partially developed due to the difficulties of economic transition, and heterogeneity across regions remains considerable.

5. Conclusions

This paper has tested some hypotheses formulated in the environmental literature about PACE patterns at plant level. Its original contribution is to examine them using survey data in the case of a country such as Romania, which has undergone a process of economic and political transition and has been a EU member since 2007; also, we apply an appropriate econometric method, namely MRM.

Our results are generally consistent with the literature suggesting that plant characteristics, formal pressure through substantial regulatory actions and informal pressure through market incentives and community aspects may be important drivers of the level of plant PACE. However, unlike in the case of developed countries, we find that in Romania the potential for collective action in the environmental area is not significant. Whether the influence of stakeholders on PACE will strengthen as Romania completes its development process remains to be seen. Also, there is no evidence that environmental taxes work as incentives to adopt an environmental behaviour at plant level. As expected, the actions of regulators (command and control and liability instruments), market pressure and plant characteristics are the most important determinants of the level of PACE. Thus, the largest, most competitive and profitable private owned enterprises have made more efforts to reduce pollution.

These findings enable us to gain a better understanding of the factors affecting the level of plant PACE in the case of transition economies in general and Romania in particular. Even partially developed formal and informal regulations appear to increase abatement efforts. An increase in income per capita also increases local pressure on intensive pollution plants. From a policy perspective, this evidence points to the need to redesign environmental taxes in order to achieve better outcomes. Further, measures to increase environmental awareness would also be useful in this respect.

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Appendix

Table A1: Evolution of per capita income

	Region \ year	2002	2003	2004	2005
1	**North - East**	4970	5703	6442	6970
2	**South - East**	5967	6755	7465	7949
3	**South**	5563	6398	7222	7833
4	**South -West**	5553	6677	7177	7615
5	**Vest**	7527	8903	10132	11128
6	**North -West**	6538	7618	8537	9263
7	**Centre**	7505	8454	9429	10093
8	**Bucharest - Ilfov**	14467	15298	17091	17902

Table A2: Distribution of plants by region and ownership - 2005

Region		Total Plants	Dirty Plants	Domestic Plants	Foreign Plants	Air Pollution Plants	Water Pollution Plants	Air and Water Pollution Plants	Others Pollution Plants	State capital Plants	Private capital Plants	Mix capital Plants
1	**North - East**	618	409	380	29	66	204	84	55	16	372	21
2	**South - East**	530	351	327	24	38	181	79	53	15	314	22
3	**South**	608	397	344	53	48	204	90	55	28	335	32
4	**South -West**	391	259	233	26	32	141	51	35	20	222	17
5	**Vest**	476	304	240	64	37	165	61	41	30	243	31
6	**North -West**	654	424	365	59	64	203	96	61	24	364	37
7	**Centre**	669	444	390	54	63	202	108	71	26	368	50
8	**Bucharest - Ilfov**	520	275	205	70	33	128	75	39	27	209	40
	Total	**4466**	**2863**	**2484**	**379**	**381**	**1428**	**644**	**410**	**186**	**2427**	**250**

Table A3: Characteristics of the regions - 2005

Regions		Per capita Income (RON/year)	Unemployment rate (%)	Population	Density of Population (Hab/km$^{2)}$	Surface (Km$^{2)}$
1	**North- East**	9799.55	7.6	3737246	101	36850
2	**South - East**	11176.13	6.4	2841362	79	35762
3	**South**	11012.69	6.8	3325576	97	34453
4	**South - West**	10706.75	7	2305913	79	29212
5	**Vest**	15646.31	5.3	1931759	60	32034
6	**North - West**	13023.63	3.9	2728967	80	34159
7	**Centre**	14190.47	6.8	2536211	74	34100
8	**Bucharest- Ilfov**	25170.21	2.7	2205393	1211	1821

Table A4: Characteristics of the regions - 2005

Regions		ONG / million Habitant	ONG / region	Environmental Penalties (Mille RON)	Population with university studies	Students / 1000 habitant
1	**North- East**	5	17	2628.28	9.4	21
2	**South - East**	7	21	2781.27	10.4	17
3	**South**	2	5	1251.55	8.9	12
4	**South - West**	5	11	1762.81	11.1	19
5	**Vest**	5	10	2400.67	13.2	37
6	**North - West**	8	21	3545.71	10.7	33
7	**Centre**	9	24	1922.86	12.1	27
8	**Bucharest- Ilfov**	16	35	3775.01	30.2	95

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