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Setting one voluntary standard in a heterogeneous Europe - EMAS, corruption and stringency of environmental regulations

Stefan Borsky*and Esther Blanco†

November 17, 2014

Abstract

This article addresses the mediating effect of corruption on the influence of stringency of environmental regulation on firms' voluntary environmental performance. Using panel data from adoption of the EU Eco-Management and Audit Scheme (EMAS) across European Union countries from 1995 to 2011, we unveil a direct and an interacting effect of countries' corruption and regulatory stringency on the rate of adoption. First, stricter environmental regulation reduces the rate of EMAS certificates, thus supporting a crowding-out effect of mandatory regulation on voluntary action. Second, increased corruption reduces the rate of EMAS certificates. Third, the negative effect of stringency of regulation on EMAS certification rates is reinforced by corruption. An implication of these results is that previous studies addressing the implications from stricter regulations on firms' voluntary action that abstract from corruption might underestimate the potential negative effect of stringency of regulation on firms' voluntary action.

Keywords: Europe, voluntary environmental action, regulatory stringency, corruption, EMAS.

JEL: F53, Q23, Q27, F18, L15

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1 Introduction

The emergence and expansion of different forms of voluntary environmental action by firms has raised legitimate questions on what is the interrelation between mandatory regulation and voluntary firm behavior. Ideally one would desire to encourage voluntary action by firms to supplement existing regulations (Khanna 2001). Under this view, voluntary and mandatory environmental policies can separate their domains of action. This seems to be the prevalent view in the policy arena of some countries. Often the policies addressing the development and enforcement of environmental regulation are separate to those aiming to support firms' environmental social responsibility. For example the renewed EU strategy 2011-2014 for corporate social responsibility COM 2011-681 has a specific section on the role of public authorities and other stakeholders on corporate social responsibility but it does not mention the role that mandatory requirements have on firms' voluntary investments beyond regulations. Yet, by definition, legal requirements set the minimum threshold after which firms' environmental performance can be considered to go "beyond compliance". Several well-known programs such as ISO14001 or the EU Eco-Management and Audit Scheme (EMAS) explicitly require firms to comply with environmental regulation in order to register. Therefore, more stringent environmental regulation requires more advanced, and therefore more costly, environmental performance of firms in order to qualify under voluntary action.

In addition, the costs for firms to undertake voluntary action might also be defined by the prevalence of compliance with regulations in force. Under perfect compliance, any marginal improvement in environmental performance would allow firms to qualify in the domain of voluntary action and thus, firms would only need to take the marginal additional costs of one unit of abatement into consideration. However, under imperfect compliance not only firms' marginal abatement cost but also the extent of under-compliance is relevant in assessing the costs for firms to qualify under voluntary action. In this paper we focus on one source for undercompliance associated to weak monitoring and enforcement, namely corruption. Corruption fosters a culture of impunity, damages the rule of law, and undermines the functioning of public institutions and democracy.[1] Indeed, previous studies show that corruption can deteriorate the compliance with environmental regulation, inducing weaker monitoring and enforcement, under-reporting of pollution, and illegal extraction of natural resources (e.g., Damania 2002, Ivanova 2007, Ivanova 2011, Amacher, Ollikainen & Koskela 2012, Sundström 2012).

[1] See, for example, Transparency International (2009) and European Commission (2014).

The objective of this paper is to empirically address the mediating effect of corruption on the influence of stringency of environmental regulation on firms' voluntary environmental performance. There is an extensive empirical literature that abstracting from the impact of corruption addresses the influence of the stringency of environmental regulation on firms' voluntary action (see discussion in Section 2). Our contribution to this literature is twofold: First, we incorporate a direct and indirect effect of corruption in the analysis of the effect of stringency of regulation on firms' voluntary environmental performance. Second, we implement the analysis in a new panel dataset of the amount of EMAS registrations for all countries in the European Union for the period from 1995 to 2011.

The empirical analysis is based on a conditional maximum likelihood procedure to estimate a fixed-effects negative binomial regression model (Hausman, Hall & Griliches 1984). By including country-fixed effects and time fixed-effects we can estimate the influence of changes on environmental stringency and corruption on firms' aggregate rate of EMAS adoption in a country. In 2011, more than 4500 firms were members of EMAS and interestingly, despite the EU efforts to promote the program, its popularity in terms of registered firms varied substantially between countries.[2] Germany was the country with the most certified firms, whereas in other EU countries only a handful of firms had joined this certification scheme.[3] The use of EMAS registrations rates as a measure of voluntary environmental action presents several advantages. First, the data on EMAS certifications is highly reliable, insofar compliance to the standard is non-mandatory for firms and the program requires certification by independent third parties in registers which are EU supervised and publicly available. Second, certification in EMAS explicitly requires provision for regulatory compliance and is therefore well-suited as a measure of "beyond compliance" voluntary firm behavior. We believe results for EMAS have relevant implications beyond the context of the European Union, as these might extrapolate to other form of voluntary action. In addition, the institutional aspects of EMAS are very similar to those of ISO 14001. The international norm ISO14001 was issued by the International Organization of Standardization in 1999. Like EMAS, it is an environmental certification of production processes. Requirements for certification are very similar to EMAS but less demanding on public access to firms' environmental information. Moreover, ISO14001 has a wider international projection. As a

[2] http://ec.europa.eu/environment/emas/index_en.htm

[3] For a detailed overview on the number of yearly EMAS registrations in each country see Table A1 in the Appendix.

robustness check, we provide results in section 5.1 for the rate of ISO 14001 adoption between the period 2000-2011.

The two key explanatory variables that we use are national proxies for the stringency of environmental regulation and prevalence of corruption. As a measure of stringency of environmental regulation we use the total revenues from environmental taxes related to energy, transport, pollution and resources. .[4] This is a novel variable in this literature. Typical proxies of regulatory pressures in previous literature have been measures for environmental liabilities of firms [5] (Khanna & Damon 1999, Davidson & Worrell 2001, Khanna & Anton 2002, Anton, Deltas & Khanna 2004, Khanna, Deltas & Harrington 2009, Khanna & Kumar 2011), self-reported responses at the firm level on the motivation to adopt certain voluntary measures (Henriques & Sadorsky 1996, Dasgupta, Hettige & Wheeler 2000, Nakamura, Takahashi & Vertinsky 2001, Johnstone, Scapecchi, Ytterhus & Wolff 2004, Johnstone & Labonne 2009), or country, industry or other dummy variables (King, Lenox & Terlaak 2005, Potoski & Prakash 2005, Arimura, Hibiki & Katayama 2008, Bracke, Verbeke & Dejonckheere 2008). We believe total revenues from environmental taxes measures environmental stringency in a more direct way than other variables that have been used in previous literature, As a measure of corruption we use the corruption perception index released by Transparency International. This composite measure combines polls from a diverse collection of international organizations on the perception of corruption in the countries' public sector. The Transparency International index highly correlates with other corruption variables widely used in the literature (e.g., Kaufman, Kraay & Mastruzzi 2011, European Commission 2014) and has the advantage that it provides yearly data for the whole time scope of the study and countries under analysis.

Our results show, first, that stricter environmental regulation reduces the rate of EMAS certificates. This crowding-out effect is not surprising for voluntary environmental action requiring achievements "beyond regulation", as increased regulatory stringency raises the threshold to qualify for voluntary action. Second, increased corruption reduces the rate of EMAS certificates. This novel result is in line with previous empirical evidence supporting reduced firms' performance in other business dimensions under the prevalence of corruption (e.g., Dal Bó &

[4] Note that high environmental tax revenues might derive from a high tax base (high levels of pollution) or from a high tax rate (high taxation on every unit of pollution). The former is related to the pollution intensity in a country and the latter to the stringency of the environmental regulation. We include control variables measuring countries' pollution efficiency so that the environmental tax captures the stringency of environmental regulations.

[5] Such as the number of superfund sites or emissions of pollutants likely to be regulated in the future.

Rossi 2007, de Waldemar 2012, De Rosa, Gooroochurn & Gorg 2010, Fisman & Svensson 2007, Hallward-Driemeier 2009). Third, higher corruption reinforces the crowding-out of regulation on voluntary action. Results for the alternative performance variable of ISO 14001 registration also show a significant negative effect of environmental stringency, supporting also the crowding-out effect. Moreover, the interaction term between corruption and environmental stringency is negative and highly significant. Thus, previous estimates abstracting from the interaction effect of corruption and environmental stringency might underestimate the crowding-out effect of increased regulatory pressures on firms' voluntary abatement.

A policy implication of our findings is that policies that combine reductions in corruption with increased regulatory stringency might moderate the reductions in voluntary action accompanying increased stringency of regulation. Similarly, policies aiming to achieve equally advanced CSR practices throughout states or regions might require stronger support in areas with (1) more stringent environmental regulation and where (2) corruption is more prevalent.

The remainder of the paper is structured as follows. Section 2 discusses the conceptual framework and formulates the hypotheses. In Section 3 we present the data, Section 4 discusses the empirical strategy and Section 5 presents the main results and the results of various robustness checks. Section 6, finally, presents a discussion of results and concludes.

2 Conceptual framework

2.1 Environmental regulation and firms' voluntary environmental action

By definition, legal requirements set the minimum threshold after which firms' abatement and resource efficiency measures can be considered to go "beyond compliance". EMAS explicitly requires firms aiming to get the certification to comply with existing regulation. Therefore, embracing the standard assumptions of increasing marginal abatement costs and perfect compliance, the more stringent environmental regulation the higher the costs required in order to qualify under voluntary action. Thus, Hypothesis 1 follows:

Hypothesis 1 *Stricter environmental regulation reduces the number of EMAS certifications in a country.*

There is a rich literature addressing the influence of different measures of environmental stringency on firms' voluntary environmental performance. Portney (2008), Khanna (2001) and Alberini & Segerson (2002) offer excellent overviews of the earlier literature on the microeconomic motivations and the attributes of the institutional setting that affect firms' voluntary abatement.

A first branch of the literature takes the firm level as the unit of analysis and focuses on measures of voluntary action that do *not* necessarily imply action *beyond regulation*. The environmental measures under consideration include emission efficiency practices, membership in 33/50, reporting, establishing a board environmental committee, the size of environmental expenditures or establishing an *uncertified* environmental management system. In a nutshell, these studies show that firms extend their environmental efforts, as measured by the aforementioned variables, under higher perceptions of regulatory pressures and stronger threat of potential future liabilities. However, for actual enforcement of regulations, the effect is not significant or not robust. Henriques & Sadorsky (1996) is one of the first to incorporate the stringency of environmental regulation, as captured by firms' perception of regulatory pressure, to analyze the drivers for environmental action in a sample of 750 Canadian firms. Results show that firms perceiving higher regulative pressure were more likely to develop an environmental plan establishing the firm's position regarding environmental issues. Similarly, Dasgupta et al. (2000) find that perceived regulatory pressure by firms motivate unilateral environmental practices in a sample of Mexican firms. Yet, for firms in a set of European countries [6] Johnstone et al. (2004) show that it is only for a reduced subset of environmental practices that self-reported perceptions on the influence of public authorities play a significant positive role. Studies measuring regulatory stringency through stronger threats of potential future liabilities show that US firms in the S & P 500 are more likely to undertake abatement actions (membership in the 33/50 program, comprehensiveness of environmental management plans, emission efficiency). Khanna & Damon (1999), Khanna & Anton (2002) and Anton et al. (2004) focus on the effects of the number of superfund sites (being a liability threat) whereas Khanna et al. (2009) and Khanna & Kumar (2011) address the impact of the volume of emission of pollutants likely to be subject to regulation in the future. Remarkably, actual enforcement of regulations in the US, measured by the number of inspections, does not have a significant effect on the adoption or comprehensiveness of an environmental management plan (Khanna & Anton 2002, Anton et al. 2004) nor on the adoption of new pollution prevention techniques (Khanna et al. 2009), despite it increases the like-

[6] Belgium, France, Germany, Hungary, Netherlands, Norway, Sweden, Switzerland and UK

lihood of reporting environmental policies and establishing a board environmental committee (Davidson & Worrell 2001). Interestingly, for Irish firms, being subject to the Integrated Pollution Prevention and Control Scheme and the European Union's Emissions Trading Scheme, which are likely to increase monitoring on firms' environmental performance, reduces the likelihood of investment in equipment for pollution control (Haller & Murphy 2012).

A second branch of the literature maintains the unit of analysis at the firm level and specifically addresses the influence of regulatory stringency on the decision to adopt certified environmental management systems that *do* require environmental performance *beyond regulatory* requirements. These studies focus on ISO 14001 adoptions. Nakamura et al. (2001) show, for a sample of Japanese firms, that higher perceptions of pressure by the government to improve the environmental performance of firms reduce the likelihood of ISO14001 certification. The authors interpret this finding as supportive of a crowding-out effect whereby perceived regulatory pressure divert efforts away from voluntary actions. Other studies find a positive influence of regulatory stringency on ISO 14001 certification, but in general cannot provide strong robustness of this result. Johnstone & Labonne (2009) show that for firms in seven OECD countries[7] increased perceptions of policy obligations increases the likelihood of having a certified environmental management system. Yet, results are not robust to other variables of environmental regulatory stringency based on monitoring intensity (e.g. frequency of inspections), average environmental performance in a given state, or the presence of voluntary programs promoted at the local level. Potoski & Prakash (2005) find a significant positive effect of the frequency of regulatory inspections and stringent hazardous air pollution regulations on the likelihood of US facilities to certify under ISO 14001. However, other wide range of measures of government programs, laws and regulations do not show a significant effect on the likelihood of certification.[8] Similarly, results in King et al. (2005) show that although the likelihood of firms to implement an (uncertified) environmental management system increases if they are located in US states that are more efficient

[7] Canada, France, Germany, Hungary, Japan, Norway and the United States.

[8] Particularly, none of the coefficients of the following variables show significant: a dummy variable for states that have ambient air regulations more stringent than EPA's requirements, the number of enforcement actions including notices of violations, dollar amount of any monetary penalty, a dummy variable for states that sponsor its own voluntary program and it is EMS based, or a dummy variable for states that sponsor their own voluntary program and it is non-EMS based, a dummy variable for states that offer immunity to information uncovered during certification audits, a variable for state litigiousness measured as the ratio of environmental court cases to TRI facilities in each state and a variable for enforcement flexibility as the proportion of out of compliance facilities sanctioned through monetary penalties in the state where the facility is located.

in terms of emissions per unit of output, it does not significantly affect the likelihood of ISO14001 certification. Similarly, Arimura et al. (2008) show that for Japanese firms the presence of performance standards as well as voluntary programs encouraged by local governments increases the likelihood of joining ISO14001, but once implemented, mandatory regulation does not affect the level of the firms' voluntary environmental performance. Firm level studies on the influence of environmental stringency on EMAS certifications are lagging behind. One of the few studies that addresses the influence of the regulatory context on EMAS certification taking the firm level as the unit of analysis is Bracke et al. (2008). The focus of analysis in this study is though on supportive policies to certification (not on regulatory stringency). Using a sample of 436 EU firms including 38 EMAS certified firms, these authors find a weakly significant positive influence of a dummy variable for Germany, Spain, Italy and Austria, which are the countries with a higher number of supportive policies to encourage EMAS certification, on the likelihood of certification. These results are however not robust to different specifications of the dummy variable or to a reduction of the sample to firms that are located in a country that has at least one EMAS registered company.

A third branch of the literature switches the unit of analysis to the *country level*. The econometric analysis that we implement builds on the literature addressing the influence of aspects of the regulatory context on the prevalence of ISO 14001 or EMAS certification across countries. To the best of our knowledge the effect of regulatory stringency or level of corruption has not been previously studied. Neumayer & Perkins (2004) show that for a subsample of developing countries, higher interventionism and burdensome styles of business regulation as measured by the Index of Economic Freedom[9] reduces the number of firms ISO14001 certified (per capita). Perkins & Neumayer (2004) present similar results for differences in EMAS certifications among EU countries. Higher interventionism reduces the number of EMAS certified firms (per capita).

[9] This variable does not capture the environmental stringency of regulations but general business practices. The index is a 1-5 variable depending on: (a) the level of government consumption as a percentage of the economy; (b) the extent of government ownership of businesses and industries; (c) the share of government revenues from state-owned enterprises; (d) government ownership of property; and (e) economic output produced by the government.

2.2 Corruption, environmental regulation and firms' voluntary environmental action

Despite previous literature shows that the prevalence of corruption affects several dimensions of firms' decision-making, it remains silent on the effect of corruption on voluntary environmental action. Empirical studies show that corruption is likely to adversely impact economic growth and industrial development through its impact on investment, taxation, public expenditures, human development, and firms' growth productivity, innovation and efficiency (e.g., Mauro 1995, Méon & Sekkat 2005, Aidt 2009, Ugur 2014). A recent EU anti-corruption report shows that at the European level, more than 4 out of 10 firms consider corruption to be problem for doing business (European Commission 2014). Similarly, nearly two in five polled business executives in a report by Transparency International have been asked to pay a bribe when dealing with public institutions (Transparency International 2009). These figures are particularly remarkable when considering the cost of corruption for firms. For example, almost half of respondents in a survey of 390 senior executives in 14 countries[10] state they have not entered a specific market or pursued a particular opportunity because of corruption risks (PwC 2008). In addition, previous empirical studies show that higher levels of corruption are associated with more inefficient firms (Dal Bó & Rossi 2007), lower levels of product innovation (de Waldemar 2012), lower firm productivity (De Rosa et al. 2010), lower rates of firm growth (Fisman & Svensson 2007), and even higher probabilities of firm exit (Hallward-Driemeier 2009). This leads to our second hypothesis based on the adverse effects of corruption on firms' economic performance, suggesting also a reduced investment in voluntary environmental action:

Hypothesis 2 *Increasing prevalence of corruption reduces the number of EMAS certifications.*

In addition, we argue, the effect presented in Hypothesis 1 is reinforced by the prevalence of corruption in a country. In a system with perfect compliance with environmental regulations, firms would only need to take the marginal costs of one additional unit of abatement into consideration to quantify the costs for them to undertake voluntary action. However, corruption is a potential source of imperfect compliance (Polinsky & Shavell 2001), and therefore might affect the initial level of environmental efforts of firms. Previous literature has shown that corruption can affect the law enforcement process by allowing for payments of bribes to

[10] The respondent locations were approximately, 42% Asia-Pacific, 16% Middle East and Africa, 23% Western Europe, 8% North America, 5% Latin America and 5% Central and Eastern Europe.

bureaucrats who are responsible for monitoring and enforcing environmental regulations. Damania (2002) theoretically identifies a deteriorating impact of corruption on the enforcement of environmental policy. Ivanova (2007) and Ivanova (2011) empirically show that in countries with a high level of corruption, the monitoring and enforcement system becomes ineffective and polluting firms have an incentive to under-report their emission levels. Similarly, Amacher et al. (2012) show that corruption decreases the enforcement efficiency of the government, increasing in turn the degree of illegal logging in a country. In this same direction Sundström (2012) experimentally shows that perceived corruption by South African fishermen has a significant and negative effect on the individual fisher's level of compliance. An implication of the potential for under-compliance in a corrupt setting is that the necessary efforts for firms to qualify under "beyond compliance" voluntary programs might be higher. Under imperfect compliance not only firms' marginal abatement cost but also the extent of under compliance is relevant in assessing the costs for firms to undertake voluntary action.[11] This potential effect has not been tested in the previous literature analyzing the effect of regulatory stringency on firms' voluntary environmental action. In sum, we conjecture that an interacting effect between stringency of environmental regulation and corruption exists that exacerbates the negative implications of mandatory environmental requirements on voluntary performance efforts by firms.

Hypothesis 3 *Stricter regulations accompanied by increasing prevalence of corruption further reduce the number of EMAS certifications.*

3 Data

The empirical analysis is based on country panel data from 1995 to 2011 and covers all countries in the European Union evolutionary, i.e., every country is observed beginning with their accession to the European Union. This results in an unbalanced

[11] Arguably, also EMAS registration could suffer the negative effects of prevalent corruption in a country. However, the mechanisms of formulation and control for EMAS certification are different than those for national environmental regulations. First, to register for EMAS an independent third-party environmental verifier needs to verify that the organization's environmental policy, its environmental management system, and the environmental audit comply with the provisions of the EMAS regulation, and finally validate the environmental statement. After the validated environmental statement is sent to the national competent body it has to be made publicly available. Then the organization is listed in the EMAS register and has the right to use the EMAS logo. And second, the conditions to qualify for EMAS certification are formulated on EU-level and are therefore not directly affected by a country's degree of corruption.

panel with 345 observations.[12] The dependent variable, $EMAS_{it}$ consists of integer annual counts of EMAS registration per year t per country i.[13] Annual data on firms' registrations under EMAS is provided directly by the EU EMAS Help Desk, the EU unit for EMAS enquiries.

Additional to a set of other control variables previously used in the literature we include two key explanatory variables and their interaction to test for each of the three hypotheses. The first key explanatory variable $ETAX_{it}$ is a proxy variable for regulatory stringency. It measures total revenue from environmental taxes in country i in year t in percent of the country's annual GDP. This variable is retrieved from the Eurostats yearly environmental accounts and covers all taxes whose tax base is a physical unit that has a proven negative impact on the environment and is related to energy, transport, pollution and resources. Previous studies addressing the determinants of adoption of ISO 14001 or EMAS have typically used as proxy for environmental regulation country, industry or other dummy variables (King et al. 2005, Potoski & Prakash 2005, Arimura et al. 2008, Bracke et al. 2008), self-reported perceptions on government pressure (Nakamura et al. 2001), or has focused on other aspects of the regulatory context different to the stringency of environmental regulations (Perkins & Neumayer 2004, Neumayer & Perkins 2004, Bracke et al. 2008). The analysis presented here aims to address more directly the effect of stringency of environmental regulations by using the sum of environmental taxes collected in each country and year. $ETAX_{it}$, captures a combination of two effects, namely the stringency of environmental taxes (or tax rate) and the pollution intensity of the industry (or tax base). Controlling for a country's pollution intensity (in combination with country fixed effects) disentangles these two effects. Consequently, a first group of control variables that we include in the analysis measures the pollution levels in a country and is instrumental for the use of $ETAX_{it}$ as a measure of regulatory stringency.[14] As a global pollutant, GHG_{it-1} measures greenhouse gas emissions and, as a more local pollutant, $SULPHUR_{it-1}$ measures sulphur emissions, both relative to the country's GDP. To avoid potential endogeneity issues pollution variables are lagged one year. Since textitGHG$_{it-1}$ and $SULPHUR_{it-1}$ capture pollution intensity, $ETAX_{it}$ captures the stringency of environmental taxes.

[12] Due to missing data for some years in some of the explanatory variables (perceived corruption index, labor cost and EU export-ratio) the final sample includes 335 observations.

[13] This measures the number of EMAS registered firms in a year t, and does not account for the turnover in the program.

[14] Arguably, the environmental tax rate in a country does not define "requirements" for firms' environmental performance, since firms are allowed to pollute and pay the corresponding tax. However, static efficiency criteria imply that ceteris paribus higher tax rates induce higher abatement efforts by firms.

Hypothesis 1 supports a significant and negative coefficient of $ETAX_{it}$ in explaining the rate of EMAS adoption.

The second key independent variable, $CORRUPTION_{it}$, is the corruption perception index released by Transparency International. This corruption index is a composite measure of how corrupt a country's public sector is perceived to be. The index measures any kind of abuse of entrusted power for private gain that takes place within the government or government bodies. This includes for example bribery, embezzlement, patronage and nepotism [15] As compared to other measures of corruption, this index has the advantage of providing information for all countries under analysis for the whole period under consideration. A recent EU Anti-Corruption report analyzing the state of corruption and anti-corruption measures in the different EU-member countries in 2013 show a high degree of correspondence with the corruption perception index published by Transparency International (European Commission 2014). Similarly, the corruption perception index shows a 96% correlation with the corruption measure by Kaufman et al. (2011) that is widely used.[16] $CORRUPTION_{it}$ ranges between 0 and 10, with 10 indicating the highest corruption. Testing Hypothesis 2 will be based on the significance and sign of $CORRUPTION_{it}$. Whereas, testing Hypothesis 3 will based on the results of the interaction term between $ETAX_{it}$ and $CORRUPTION_{it}$.

Additional control variables are based on the rich empirical literature on incentives of firms to participate in voluntary abatement. The variable $LABCOST_{it}$ measures average yearly labor costs in country i. Empirical evidence in Bracke et al. (2008) suggests that two variables related to high labor costs, namely firms active in sectors with rather unsafe working conditions and firms with higher educated employees, are more likely to implement EMAS. Therefore we expect a positive coefficient for $LABCOST_{it}$.The variable $LABPROD_{it}$, captures the effect of labor productivity, measured as revenue per employee, as a proxy for the degree of efficiency in a country's productive capacity. Highly productive companies are in general more efficient and, therefore, potential efficiency gains for these companies derived from EMAS implementation are lower, as suggested by the existence of "low hanging fruits" for less productive firms (Hartl & Ahuja 1996, Schaltegger & Synnestvedt 2002, Wagner, VanPhu, Azomahou & Wehrmeyer 2002). Per capita in-

[15] The composite measure include polls from the African Development Bank, the Asian Development Bank, the Bertelsmann Stiftung, the Economist Intelligence Unit, Freedom House, IHS Global Insights, the International Institute for Management Development, Political and Economic Risk Consultancy Ltd., the World Bank, the World Economic Forum.

[16] All our findings are robust to the use of the the corruption measure by Kaufman et al. (2011). This measure is only available biannually for the period 1995-2000 and thus we use the Transparency International Index. The EU Eurobarometer data is only available for the year 2013.

come in a country, $GDPpc_{it}$, is a proxy for the demand of green products. We assume that for high enough levels of per capita income, such as those in most EU countries, it is likely that environmental quality is a normal good, so that the demand for environmental quality (including EMAS certified products) increases with income (e.g., Gylfason 2001). In addition, the size of the population, $TOTPOP_{it}$, in each country captures potential market size effects. Similarly, demand for EMAS certified products might extend beyond the national borders in form of exports. $EXPORT_{it}$ controls for the ratio of exports of country i to other EU-countries relative to its total exports (Perkins & Neumayer 2004). EMAS certification is potentially more salient for companies exporting to markets in the EU than for companies in countries exporting outside of the EU. Finally, to capture the effect of innovativeness in a country the variable $PATENT_{it}$ measures the amount of patents relative to GDP. Previous empirical evidence supports that firms that are more innovative have lower costs of adopting environmental management systems (Anton et al. 2004), and, therefore, certification is more likely. However, strongly standardized environmental management systems might be obstructive in the development of innovative processes through bureaucracy and reduced flexibility. Thus, the expected sign for $PATENT_{it}$ is ambiguous.

3.1 Descriptive statistics

Table 1 presents the descriptive statistics of the variables and Table A2 in the appendix presents a pairwise correlation matrix for the explanatory variables. The number of new EMAS certifications in a year for a given country varies between 0 and 229 with a right skewed distribution with a mean of 13.43 and a standard deviation of 34.31. The average revenue of environmental taxes of a country in a year is 2.79 percent of the country's GDP and varies between 1.57% (Spain in 2011) and 6.17% (Denmark in 2006). The perceived corruption index varies between a highest perceived corruption of 10 (Italy in 1995) and a lowest perceived corruption of 3 (Denmark in 1998 and 1999 and Finland in 2000) with a mean of 6.91 and a standard deviation of 1.84.

Table 1: Descriptive Statistics

Variable	Obs.	Mean	Std.Dev.	Min.	Max.	Expect.
EMAS	335	13.433	34.311	0	229	
Environmental Tax (% GDP)	335	2.786	0.761	1.570	6.170	-
Corruption	335	6.911	1.837	3	10	-
GHG-Emission per GDP (in tons)	335	0.595	0.330	0.159	2.226	.
Sulphur Emission per GDP (in tons)	335	1.458	2.390	0.043	26.638	.
GDP/per capita (current 1.000 US$)	335	23.541	12.752	4.000	82.100	+
Total Population (in million)	335	21.538	24.644	0.400	82.537	+/-
EU-export rate	335	0.499	0.162	0.082	0.863	+
Labour cost (index 2005=100)	335	102.589	15.778	72.000	179.400	+
Labour productivity (Euro per hour)	335	30.581	14.771	4.300	64.900	-
Patent/GDP (per nom. GDP)	335	3.691	2.926	0.160	11.680	+/-

4 Empirical approach

The estimation of the impact of regulatory stringency and corruption on the number of new EMAS certifications is based on the following equation:

$$\begin{aligned} EMAS_{it} = \alpha_i + ENVTAX_{it-1}\beta_1 + CORRUPTION_{it}\beta_2 \\ +ENVTAX_{it-1} \times CORRUPTION_{it}\beta_3 + X_{it}\beta + \epsilon_{it} \end{aligned} \tag{1}$$

where , as defined in Section 3, $EMAS_{it}$is the annual counts of EMAS registration per year t per country i, $ENVTAX_{it-1}$is the amount of environmental tax revenues in country i in year $t-1$, $CORRUPTION_{it}$, is the index-measure of perceived corruption in country i in year t. $ENVTAX_{it-1} \times CORRUPTION_{it}$ is the interaction term between these two key independent variables.[17] X_{it} is a vector of additional country attributes as discussed in Section 3, including time-specific dummies to capture time-specific unobservables that are constant across all countries in the sample, e.g., a change in the requirements for EMAS certification, or the EU-enlargements in 2004 and 2007. α_i captures the unobserved individual country characteristics, which are stable over time and are correlated with the stringency in environmental regulation, perceived corruption and the amount of newly EMAS registrations, i.e., fixed unobserved industrial, geographic and institutional characteristics.

[17] The interaction term is demeaned to avoid excessive multicollinearity.

Since the number of new EMAS certification is a non-negative integer value over time, which is highly overdispersed, using a poisson model will lead to biased estimates of the standard errors of the coefficients and to overstated t-statistics.[18] Therefore, we estimate a negative binomial model, which allows for a less restrictive variance function than the standard poisson model by introducing an individual unobserved effect into the conditional mean, $ln\lambda_{it} = X_{it}\beta + \epsilon_{it}$, where ϵ_{it} captures the unobserved heterogeneity of the data and is uncorrelated with the explanatory variables. The negative binomial model can be derived by assuming ϵ_{it} to be gamma distributed with a mean equal to 1 and variance equal to $1/\theta$:

$$Prob(y_{it}|X_{it}) = \frac{\Gamma(\lambda_{it} + y_{it})}{\Gamma(\lambda_{it})\Gamma(y_{it} + 1)}(\frac{1}{1+\theta_i})^{\lambda_{it}}(\frac{\theta_i}{1+\theta_i})^{\lambda_{it}} \tag{2}$$

To accommodate the heterogeneity in panel data, we follow Hausman et al. (1984) by estimating Equation 1 via the fixed-effects negative binomial regression model using a conditional maximum likelihood procedure.

5 Empirical results

The results for the two key explanatory variables and the interaction term show wide support to the three hypotheses presented in Section 2. Table 2 presents the results of estimating the fixed effects negative binomial model for five different specifications (models). Model 1 and Model 2 are two base models that include the proxy for regulatory stringency $ETAX_{it-1}$ and the perception of corruption $CORRUPTION_{it}$, with country fixed effects. Model 1 presents the results without time dummies and Model 2 with time dummies. Model 3 extends Model 2 by including the control variables described in Section 3. The full model specification, as outlined in Equation 1,

[18] The rate of EMAS certifications presents a distribution skewed to the left with a long right tail. This is a common feature of overdispersion, which shifts the mean towards the origin. A likelihood ratio test, testing for overdispersion in the data, by comparing the log-likelihoods of a negative binomial regression model and a poisson regression model, results in a chi-squared of 269.660 with a p-value of 0.000, which suggests a statistically significant degree of overdispersion. The standard approach of estimating non-negative integer count data is using a poisson model. This model is based on the strong assumption, that the variance of the dependent variable in this model equals its mean. This assumption is violated by having overdispersion in the data. Based on the distributional form in the binomial model, it is possible to obtain a model that has the same conditional mean as the poisson model, $E(y_{it}|X_{it}) = \lambda_{it}$, but allows for over-dispersion since the variance is defined by, $Var(y_{it}|X_{it}) = \lambda_{it}(1 + \theta\lambda_{it})$ and, therefore, allowed to be greater than the mean.

including the interaction term of environmental taxes and perceived corruption is presented in Model 4 without time dummies and in Model 5 with time dummies.

Table 2: Emas certification – estimation results

	Model 1	Model 2	Model 3	Model 4	Model5
$ENVTAX_{t-1}$	-0.245^{*}	-0.394^{***}	-0.338^{**}	-0.488^{***}	-0.670^{***}
	(0.146)	(0.150)	(0.157)	(0.169)	(0.179)
$CORRUPTION$	-0.524^{***}	-0.488^{***}	-0.309^{***}	-0.304^{***}	-0.290^{**}
	(0.074)	(0.085)	(0.120)	(0.105)	(0.121)
$ENVTAX_{t-1}\times$				-0.310^{***}	-0.299^{***}
$CORRUPTION$				(0.079)	(0.082)
GHG_{t-1}			2.205^{***}	2.214^{***}	2.027^{**}
			(0.794)	(0.756)	(0.793)
$SULPHUR_{t-1}$			-0.139	-0.239^{**}	-0.155
			(0.103)	(0.115)	(0.107)
$GDPpc$			2.697^{***}	2.794^{***}	3.031^{***}
			(0.977)	(0.820)	(0.972)
$TOTPOP$			0.561^{**}	0.569^{***}	0.679^{***}
			(0.263)	(0.172)	(0.258)
$EXPORT$			2.414	-0.234	1.988
			(1.608)	(1.010)	(1.580)
$LABCOST$			0.029^{**}	-0.011	0.016
			(0.012)	(0.010)	(0.013)
$LABPROD$			-1.107	-2.504^{***}	-1.692^{*}
			(1.017)	(0.867)	(1.018)
$PATENT$			0.201	0.614^{***}	0.359
			(0.230)	(0.227)	(0.233)
CountryFE	Yes	Yes	Yes	Yes	Yes
YearFE	No	Yes	Yes	No	Yes
LogLike.	-656.492	-635.232	-607.286	-619.581	-600.580
N	342	342	335	335	335

Notes: Constant and fixed effects not reported. Standard errors are in parenthesis. *, ** and *** indicate 10%, 5% and 1% levels of significance. *GDPpc*, *TOTPOP*, *LABPROD* and *PATENT* are in logarithms.

The base Models 1 and 2 show that $ETAX_{it-1}$ and $CORRUPTION_{it}$ have a significant impact on the adoption rate of EMAS. As hypothesized in Hypothesis 1, increasing environmental taxes are associated to lower rates of EMAS certification, which suggest a crowding-out (substituting) effect between mandatory regulation and voluntary approaches. Moreover, in line with Hypothesis 2, increasing prevalence of corruption significantly decreases the rate of EMAS certification. These two effects are robust in all specifications.

In Model 3 adding the control variables, $ETAX_{it-1}$ and $CORRUPTION_{it}$ remain negative and significant. In general the sign of the various control variables is as expected. Countries with increasing labor costs have a higher rate of EMAS certifications. Additionally, countries with increasing labor productivity have a lower rate of EMAS registrations. The market size has a significant positive effect on the rate of EMAS certification and so does GDP per capita. Yet countries that have increasing trade ties to other EU countries, and thus higher potential EMAS demand in foreign markets, have a non-significant higher EMAS adoption rate. Similarly, increasing patents per GDP has a non-significant (positive) effect on EMAS. Finally, the variables capturing the pollution characteristics of a country's industries have a mixed effect on the rate of EMAS registrations. The relevance of these two variables is instrumental in controlling for the environmental impact of a country's production, so that the regulatory stringency measure captures the strictness of environmental regulation disentangled from the level of pollution.

Models 4 and 5 in Table 2 additionally include the interaction term between environmental taxes and corruption. The coefficient of the interaction term is negative and highly significant. Thus, the negative effect of stringency of regulation on EMAS certification rates is reinforced by corruption through the indirect interacting effect, in line with Hypothesis 3.

5.1 Robustness Analysis

$ETAX_{it-1}$, $CORRUPTION_{it}$ and the interaction term remain robust to a variety of robustness exercises as presented in Table 3. Additionally, Table A3 in the appendix shows the results of a sensitivity analysis on multicollinearity.

Column (1) in Table 3 presents an extended Model 5 by including the variable $EPE\text{-}GOV_{it}$, which measures all public payments for environmental protection services in a country, including subsidies and investment grants, in percentage of GDP. Previous literature shows that Government's policy support for the adoption of environmental management systems, (e.g., grants) substantially varies between countries and significantly affect firms' efforts to register under EMAS (e.g., Perkins & Neumayer 2004, Bracke et al. 2008). Including $EPE\text{-}GOV_{it}$ does not vary the sign of $ETAX_{it-1}$, $CORRUPTION_{it}$ and the interaction term of these two variables, all of which remain significant. Interestingly, after controlling for the key explanatory variables, there is no significant impact of increased governmental support for environmental action on the adoption rate of EMAS.

The results stay also robust to a reduced sample excluding countries with an exceptionally high number of adherents to EMAS. Column 2 in Table 3 presents the results of estimating the specification of Model 5 excluding Germany, Italy and Spain.[19] The number of EMAS certified firms in these three countries is substantially higher than for the rest of EU (see Table A1 in the Appendix).

Likewise, changing the estimation method does not affect the results for the key explanatory variables. Column 3 in Table 3 presents the results of using a standard fixed effect poisson panel model with heterogeneity robust standard errors. Again, all key explanatory variables stay robust.

In addition, we test for the robustness of results to variations in the length of the lag of environmental taxes. Columns 4 and 5 in Table 3 present the results from re-estimating Model 5 using the second lag and the third lag of the environmental taxes per country per year respectively. Using the second lag of $ETAX_{it-1}$ reduces the number of observations to 314 and the third lag reduces it to 290. Irrespective of the lag considered, $ETAX_{it-1}$, $CORRUPTION_{it}$ and the interaction term of $ETAX_{it-1}$ and $CORRUPTION_{it}$ show the expected negative sign based on hypotheses 1 to 3 and remain statistically significant.

We also test for the robustness of results to an alternative measure of firms CSR. Column 6 in Table 3 presents the estimation of Equation 1with the number of ISO14001 certifications in country i in time t as the dependent variable. The number of observations reduces to 268 mainly due to the fact that data on ISO14001 certification is available starting from 2000. The direction and significance of $ETAX_{it-1}$ and the interaction term stay robust, but $CORRUPTION_{it}$ has no significant impact on the number of ISO14001 certifications.

Lastly, we reestimated Model 5 using ratios rather than counts of EMAS certifications which capture market size effects on the producer and the consumer side. First, we use the amount of EMAS certification relative to the number of firms which are active in country i and year t as a dependent variable (see Column 7 in Table 3). This is a natural ratio to consider, as it balances the new number of EMAS registrations on the total size of production. Again, $ETAX_{it-1}$, $CORRUPTION_{it}$ and the interaction term of $ETAX_{it-1}$ and $CORRUPTION_{it}$ show the expected sign and remain statistically significant. Second, we follow Perkins & Neumayer (2004) and reestimate Model 5 using amount of EMAS certification relative to a country's size of population as an dependent variable (see Column 8 in Table 3). The direction

[19] Also when we exclude only Germany all results hold.

Table 3: Emas certification – Robustness Tests

	EPE-Gov (1)	Small (2)	Poisson FE (3)	Lag t-2 (4)	Lag t-3 (5)	ISO14001 (6)	EMAS/firm (7)	EMAS/pop (8)
$ENVTAX_{t-1}$	-0.994^{***}	-0.964^{***}	-0.803^{*}	-0.602^{***}	-0.640^{***}	-0.344^{***}	-1.195^{***}	-1.267^{***}
	(0.192)	(0.297)	(0.422)	(0.151)	(0.139)	(0.069)	(0.343)	(0.324)
$CORRUPTION$	-0.467^{***}	-0.280^{*}	-0.197^{**}	-0.347^{***}	-0.396^{***}	0.064	-0.544^{**}	-0.654^{**}
	(0.127)	(0.169)	(0.093)	(0.126)	(0.124)	(0.050)	(0.251)	(0.309)
$ENVTAX_{t-1}\times$	-0.469^{***}	-0.326^{***}	-0.287^{***}	-0.257^{***}	-0.236^{***}	-0.136^{***}	-0.261^{*}	-0.230
$CORRUPTION$	(0.091)	(0.122)	(0.093)	(0.073)	(0.069)	(0.029)	(0.133)	(0.153)
GHG_{t-1}	1.537^{*}	0.942	1.860	3.227^{***}	5.225^{***}	-0.940^{***}	0.101	0.398
	(0.844)	(1.093)	(1.235)	(0.931)	(1.163)	(0.234)	(0.993)	(1.292)
$SULPHUR_{t-1}$	-0.242^{**}	-0.107	-0.194	-0.317^{**}	-0.485^{***}	-0.018	-0.001	-0.063
	(0.115)	(0.141)	(0.202)	(0.147)	(0.165)	(0.021)	(0.993)	(0.175)
$GDPpc$	2.736^{***}	0.338	2.959^{**}	2.660^{***}	2.038^{**}	-0.425	1.197	1.036
	(0.929)	(1.744)	(1.235)	(0.999)	(0.966)	(0.312)	(1.495)	(1.596)
$TOTPOP$	1.104^{***}	0.373	-9.338^{*}	0.865^{***}	1.049^{***}	-0.082	-10.081	$--$
	(0.276)	(0.427)	(5.203)	(0.255)	(0.244)	(0.098)	(6.554)	$--$
$EXPORT$	0.796	2.235	4.681^{*}	1.161	0.237	0.775^{*}	0.632	4.861
	(1.468)	(2.578)	(2.539)	(1.675)	(1.728)	(0.417)	(3.649)	(2.986)
$LABCOST$	0.016	0.008	0.072^{**}	0.022^{*}	0.028^{**}	-0.003	0.009	0.013
	(0.012)	(0.022)	(0.029)	(0.013)	(0.012)	(0.003)	(0.018)	(0.020)
$LABPROD$	-3.718^{***}	0.954	-8.302^{***}	-1.359	-0.434	0.077	-3.959	-2.259
	(1.148)	(2.353)	(1.992)	(1.076)	(1.076)	(0.298)	(4.242)	(3.886)
$PATENT$	0.562^{**}	0.453	0.312	0.289	0.162	0.180^{*}	0.851	0.718
	(0.253)	(0.276)	(0.578)	(0.242)	(0.259)	(0.098)	(0.885)	(0.785)
$EPE\text{-}GOV$	-0.153							
	(0.352)							
$CountryFE$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$YearFE$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$LogLike.$	-536.580	-387.325	-735.411	-585.062	-603.544	-1568.116		
R^2							0.275	0.245
N	305	284	335	314	290	268	335	335

Notes: Constant and fixed effects not reported. Standard errors are in parenthesis. *, ** and *** indicate 10%, 5% and 1% levels of significance. Poisson Fixed Effect estimation with robust standard errors. *GDPpc*, *TOTPOP*, *LABPROD* and *PATENT* are in logarithms. OLS regression with robust standard errors. $--$ indicates that this variable is not included in the specification.

and significance of $ETAX_{it-1}$ and $CORRUPTION_{it}$ stay robust, and despite the sign of the interaction term does not change, it appears with a t-value of 1.50 just to be insignificant.

6 Conclusion and Discussion of Results

This article adds to the literature addressing the influence of regulatory stringency on firms' voluntary action by controlling for a direct and interacting effect of corruption. The measure of firms' voluntary environmental action under consideration is the rate of registration in the EU Eco-Management and Audit Scheme. This variable is well-suited as a measure of voluntary environmental action "beyond compliance", since a precondition for certification is to comply with environmental regulation. Capturing voluntary firm behavior *beyond* the regulatory requirements is critical in studying the interrelation between mandatory and voluntary action. Our results show that stricter regulation reduces the rate of EMAS certificates. Thus, the results support the existence of a crowding-out effect between mandatory and voluntary environmental action by firms, in line with previous results in Nakamura et al. (2001) for the decision of Japanese firms to certify under ISO 14001.

Further, we test both for a direct influence of corruption on firms' voluntary action and its interaction effect with regulatory stringency, and find in both cases a highly robust significant negative effect. Thus, results suggest that corruption has a direct effect in reducing firms' investment in voluntary environmental action. This finding adds to empirical studies showing that higher levels of corruption are associated with more inefficient firms, lower levels of product innovation, lower firm productivity, lower rates of firm growth, and even higher probabilities of firm exit (Dal Bó & Rossi 2007, Fisman & Svensson 2007, Hallward-Driemeier 2009, De Rosa et al. 2010, de Waldemar 2012). In addition our results show that corruption has a mediating role on the effect of stricter environmental regulation on firms' voluntary environmental action. We attribute this result to the prevalence of lower levels of compliance with environmental regulation in settings with high corruption levels, as empirically shown for example in Ivanova (2007), Ivanova (2011), Amacher et al. (2012) and Sundström (2012). An implication of lower compliance with environmental regulations is that when firms aim to certificate under EMAS, they need not only to consider their marginal abatement costs but also their current gap of undercompliance.

All results are highly robust to a range of robustness exercises, including control for governmental financial support for EMAS adoption, a smaller sample excluding countries with exceptional high EMAS adoption rates, different time lags for environmental taxes and using ratios (on production and consumption) instead of counts of EMAS certifications as dependent variable. Similarly, results also show a significant negative effect of regulatory stringency and the interaction term for new certifications under the ISO14001 program.

An implication of the results both for EMAS and ISO 14001 is that the crowding-out of mandatory regulation on firms' voluntary action can be reinforced or counter-balanced depending on the prevalence of corruption in a country. For countries with high corruption levels, this crowding-out effect is even stronger, after accounting for the interaction effect of corruption on firms' responses to environmental stringency. Following a more optimistic approach, reducing the level of corruption in a country, increases the number of certifications through the indirect effect by moderating the crowding-out effect of mandatory environmental regulation.

In addition, our findings suggest that implementing standardized CSR certification programs across countries that differ in their regulatory stringency and prevalence of corruption will result in a heterogeneous extent of implementation. This paper complements previous literature supporting that policy makers should acknowledge that firms' CSR decisions depend not only on market incentives and non-monetary motivations but also on the institutional context, by highlighting the relevance of the prevalence of corruption. It follows that an alternative policy option for governmental agencies aiming to support environmental certifications is to invest in limiting the prevalence of corruption in EU countries where there is a more widespread perception of corruption. More generally, if the objective is to achieve an equally advanced implementation of CSR practices across EU economies, public support policies need to differ among countries, supporting in a larger extent voluntary efforts of firms in countries with more stringent environmental regulation and countries where corruption is a more prevalent problem.

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Appendix

Table A1: Number of Emas (biannual sum)

Country Country	1995/ 1996	1997/ 1998	1999/ 2000	2001/ 2002	2003/ 2004	2005/ 2006	2007/ 2008	2009/ 2011
Austria	12	30	52	38	16	23	37	54
Belgium	0	2	1	8	11	14	8	1
Bulgaria	-	-	-	-	-	-	0	2
Cyprus	-	-	-	-	0	0	4	1
CzechRepublic	-	-	-	-	3	11	6	4
Denmark	6	17	13	9	10	8	6	5
Estonia	-	-	-	-	0	2	0	1
Finland	0	2	0	3	2	0	3	1
France	0	0	1	3	3	1	2	8
Germany	155	169	179	187	232	160	134	133
Greece	0	0	0	1	1	23	7	21
Hungary	-	-	-	-	0	8	9	3
Ireland	1	1	1	0	1	0	1	1
Italy	0	10	22	58	111	240	403	305
Latvia	-	-	-	-	0	0	5	0
Lithuania	-	-	-	-	0	0	0	6
Luxembourg	0	1	0	0	0	0	1	0
Malta	-	-	0	-	1	0	0	0
Netherlands	0	2	1	0	1	0	1	0
Poland	-	-	-	-	0	1	12	12
Portugal	0	0	1	0	15	19	20	16
Romania	-	-	-	-	-	-	1	3
Slovakia	-	-	-	-	0	0	4	1
Slovenia	-	-	-	-	0	0	2	1
Spain	0	10	59	125	167	262	395	199
Sweden	4	22	20	15	7	6	1	1
UnitedKingdom	2	4	8	10	5	6	4	20

Table A2: Emas certification – Robustness Tests on multicollinearity 1

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) EMAS	**1.0000**	-0.2304*	-0.1815*	-0.1060*	-0.1278*	0.2625*	0.2520*	0.0413	0.2315*	0.0718	0.1078*
(2) Environmental Tax	-0.2100*	**1.0000**	-0.0647	0.2543*	0.1711*	-0.3788*	-0.3849*	0.2775*	-0.3889*	-0.3378*	0.1943*
(3) Corruption	0.0409	-0.4021*	**1.0000**	0.0587	-0.0245	-0.0979*	0.0070	-0.2796*	-0.0213	-0.0251	-0.2217*
(4) GHG-Emission/GDP	-0.1747*	-0.1284*	0.5400*	**1.0000**	0.6789*	-0.6639*	-0.4026*	0.1239	-0.7203*	-0.6037*	0.0134
(5) Sulphur Emission/GDP	-0.0984	-0.0418	0.4187*	0.7403*	**1.0000**	-0.4295*	-0.2487*	0.1037*	-0.5354*	-0.3490*	-0.0638
(6) GDP/per capita	0.1149	0.2157*	-0.7486*	-0.7537*	-0.5838*	**1.0000**	0.7026*	-0.2583*	0.7972*	0.8738*	0.0590
(7) Total Population	0.4039*	-0.2062*	0.0657	-0.1384*	-0.1139*	-0.0448	**1.0000**	-0.4470*	0.6110*	0.5721*	0.0348
(8) EU-export rate	-0.0212	-0.0757	0.1104*	0.2371*	-0.0905*	-0.2745*	0.3053*	**1.0000**	-0.2934*	-0.2236*	0.0620
(9) Labour cost	-0.0025	-0.2247*	0.3184*	0.1728*	0.1810*	-0.2657*	-0.1677*	0.0065	**1.0000**	0.6860*	0.0322
(10) Labour productivity	0.1299*	0.2409*	-0.7538*	-0.7309*	-0.5656*	0.8738*	0.1341*	-0.1696*	-0.4706*	**1.0000**	0.0541
(11) Patent/GDP	0.1405*	0.2476*	-0.77462*	-0.5097*	-0.4472*	0.6743*	0.1870*	0.0794	-0.2552*	0.7400*	**1.0000**

Notes: * indicates significance at least at the 10% level. Entries above the diagonal represent the correlation between the demeaned variables (x_i-$\bar{x}$).

Table A3: Emas certification – Robustness Tests on multicollinearity 2

	Specification (1)	Specification (2)	Specification (3)	Specification (4)	Specification (5)	Specification (6)	Specification (7)	Specification (8)
$ENVTAX_{t-1}$	-0.690^{***}	-0.682^{***}	-0.609^{***}	-0.828^{***}	-0.654^{***}	-0.729^{***}	-0.685^{***}	-0.648^{***}
	(0.176)	(0.178)	(0.176)	(0.180)	(0.175)	(0.175)	(0.180)	(0.180)
$CORRUPTION$	-0.262^{**}	-0.254^{**}	-0.440^{***}	-0.166	-0.340^{***}	-0.256^{**}	-0.289^{**}	-0.317^{**}
	(0.114)	(0.116)	(0.113)	(0.113)	(0.117)	(0.115)	(0.124)	(0.125)
$ENVTAX_{t-1}\times$	-0.307^{***}	-0.294^{***}	-0.271^{***}	-0.274^{***}	-0.307^{***}	-0.329^{***}	-0.276^{***}	-0.275^{***}
$CORRUPTION$	(0.081)	(0.082)	(0.081)	(0.082)	(0.081)	(0.079)	(0.080)	(0.080)
GHG_{t-1}	$--$	1.334^{**}	1.694^{**}	1.993^{**}	2.081^{***}	1.919^{**}	2.409^{***}	2.438^{***}
	$--$	(0.680)	(0.793)	(0.843)	(0.800)	(0.811)	(0.727)	(0.736)
$SULPHUR_{t-1}$	-0.025	$--$	-0.263^{**}	-0.132	-0.203^{*}	-0.168	-0.187^{*}	-0.188^{*}
	(0.077)	$--$	(0.117)	(0.106)	(0.108)	(0.110)	(0.112)	(0.114)
$GDPpc$	2.718^{***}	3.358^{***}	$--$	3.085^{***}	2.781^{***}	3.558^{***}	2.127^{***}	2.895^{***}
	(0.947)	(0.931)	$--$	(1.034)	(0.952)	(0.909)	(0.788)	(0.968)
$TOTPOP$	0.571^{**}	0.632^{**}	0.619^{**}	$--$	0.731^{***}	0.582^{**}	0.557^{**}	0.704^{***}
	(0.234)	(0.255)	(0.260)	$--$	(0.244)	(0.229)	(0.258)	(0.264)
$EXPORT$	1.858	2.704^{*}	1.055	3.420^{**}	$--$	1.547	2.967^{*}	2.726^{*}
	(1.368)	(1.517)	(1.462)	(1.607)	$--$	(1.443)	(1.606)	(1.648)
$LABCOST$	0.012	0.018	0.030^{***}	0.011	0.012	$--$	0.027^{**}	0.024^{**}
	(0.013)	(0.013)	(0.012)	(0.013)	(0.012)	$--$	(0.011)	(0.012)
$LABPROD$	-2.481^{***}	-1.910^{*}	0.310	-0.867	-1.999^{**}	-2.356^{***}	$--$	-0.798
	(0.914)	(0.997)	(0.796)	(1.035)	(0.946)	(0.853)	$--$	(0.876)
$PATENT$	0.557^{**}	0.422^{*}	0.291	0.394^{*}	0.434^{*}	0.455^{**}	0.149	$--$
	(0.219)	(0.231)	(0.235)	(0.239)	(0.229)	(0.217)	(0.195)	$--$
CountryFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LogLike.	-603.603	-501.857	-605.786	-603.925	-601.503	-601.373	-601.913	-602.081
N	335	335	335	335	335	335	335	335

Notes: Standard errors are in parenthesis. Constant and fixed effects not reported. *, ** and *** indicate 10%, 5% and 1% levels of significance. *GDPpc*, *TOTPOP*, *LABPROD* and *PATENT* are in logarithms. $--$ indicates that this variable is not included in the specification.

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Stefan Borsky, Esther Blanco

Setting one voluntary standard in a heterogeneous Europe - EMAS, corruption and stringency of environmental regulations

Abstract
This article addresses the mediating effect of corruption on the influence of stringency of environmental regulation on firms' voluntary environmental performance. Using panel data from adoption of the EU Eco-Management and Audit Scheme (EMAS) across European Union countries from 1995 to 2011, we unveil a direct and an interacting effect of countries' corruption and regulatory stringency on the rate of adoption. First, stricter environmental regulation reduces the rate of EMAS certificates, thus supporting a crowding-out effect of mandatory regulation on voluntary action. Second, increased corruption reduces the rate of EMAS certificates. Third, the negative effect of stringency of regulation on EMAS certification rates is reinforced by corruption. In sum, these results suggest that previous studies address- ing the implications from stricter regulations on firms' voluntary action that abstract from corruption might underestimate the potential negative effect of stringency of regulation on firms' voluntary action.

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