**Responding to Regulatory Uncertainty:**

**Government Agency Signalling and Greenhouse Gas Emissions**

Abstract

Anticipating and mitigating the impact of regulatory changes are important tasks for firms; yet, this can be challenging when firms face constantly evolving and ambiguous policies such as those regarding climate change and when regulatory implementation is uncertain. We approach this issue by bringing government agencies center stage and exploring the factors that lead agencies to signal their policy implementation intentions as well as firm reactions to such signals in the context of electric power generation in the European Union from 2004 to 2009. We propose that agencies’ concern over resources motivates them to signal implementation intentions to political principals who support the policy goals in an effort to reduce uncertainty surrounding future budgets. We argue that firms will respond to these signals by altering strategy and reducing carbon emissions. We further show that the effect of resource dependency on agency signalling is moderated by pressures from local agency stakeholders and by the agency’s capacity to implement the policy.

Keywords: Regulation, uncertainty, resource dependence, sustainability, climate change

**Introduction**

 Research on institutions and organizations has chronicled how government policy can significantly affect firms by facilitating access to resources (Sine and Lee, 2009; York, Vedula and Lenox, 2018; Georgallis, Durand and Dowell, 2018), shaping market competition (Sine, Haveman and Tolbert, 2005), and enacting rules and standards that regulate organizational behavior (Lee, Hiatt, and Lounsbury, 2017; Hoffman, 1999). In turn, a large body of research particularly in the realm of environmental policy has focused on whether and when firms should take costly actions to comply with regulatory changes in order to maintain a competitive advantage (Hiatt, Grandy, and Lee, 2015; Maxwell, Lyon, and Hackett, 2000; Li and Zhou, 2017). This can be difficult, however, because the effect of government regulations on firms can be unpredictable: Some policies are strictly enforced while others are only symbolically implemented or sometimes ignored (Shimshack, 2014; Edelman, 1992). Much of this confusion derives from our limited understanding of the conditions that influence how bureaucratic officials interpret and implement policy, leaving administrative agencies a ‘black box’ (Hiatt and Park, 2013).

 Recently, scholars have begun to tackle this issue with a few studies showing that government-agency decision making is responsive to threats to agency reputation and legitimacy (Carpenter, 2001), as well as to the amount of regulatory discretion granted to agency officials (Grandy and Hiatt, 2018). Yet, research in this area is far from complete, and we know very little about the intentions of regulators to strictly enforce policy on one hand or to delay, diverge, and disregard it on the other. This is particularly important for firms given that regulations can fundamentally transform the competitive landscape and significantly impact future financial performance (Kolk & Pinske, 2005). Investments in compliance with expected regulatory changes could establish a first-mover advantage in a market position that differentiates the firm based on commitment to noneconomic objectives such as environmental sustainability (Hoffman, 2005). Most importantly for firms in regulated industries, taking proactive actions helps firms build political resources and capabilities to influence the course of regulatory development in their favor, and build resources and capabilities to comply with regulatory changes (Aragon-Correa & Sharma, 2003). In contrast, regulatory uncertainty reduces investment as firms take a wait-and-see approach.

We seek to address this limitation by bringing the administrative state center stage and exploring the factors that lead a regulatory agency to signal the degree to which it plans to execute a new policy. We suggest that agencies concern over their resources motivates them to signal implementation intentions in an effort to reduce uncertainty surrounding future budgets. Specifically, we argue that the more agencies believe that their budgets are at risk by political principals that favor the policy, the more they are likely to publicly signal their intentions to enforce the policy in an effort to appease the principals and reduce the risk, and that this effect is moderated by pressures from local civil society groups that monitor the agency and by the agency’s capacity to implement the new law (Skocpol and Finegold, 1982). In turn, we propose that firms will interpret these intentions as signals of future enforcement and will alter their investments and strategy in accordance with the new policy.

We test these hypotheses using financial and emissions information for electric power generation firms in the European Union (EU) during the early stages of EU climate change regulation. This context is appropriate to test our theory about firms’ strategic response to regulatory uncertainty for three reasons. First, during our sample period, firms in the EU faced great uncertainty in the enforcement of environmental regulations. The resolution at the EU level for strict control over greenhouse gas (GHG) emissions was compromised by a high level of ambiguity within each member country in terms of the timing and enforcement of actual emissions caps. Second, EU member countries differed significantly in their dependence on EU funding, which was often contingent upon the countries’ commitment to implement the EU’s policies and goals, including environmental policies. Finally, our detailed information about firms’ energy sources, financial resources, and competitive environment allows us to study firms’ heterogeneous responses to regulatory uncertainty.

This paper contributes to several strands of literature. First, it extends the literature on firm response to regulatory uncertainty by showing how firms respond to new policies by looking to regulatory agencies’ signals of enforcement intent. Second, policy makers have called for international collaboration to address global environmental issues (Keller and Levinson 2002; Doh et al. 2018), yet how these collaborations may in practice translate to firms’ environmental strategies has been less explored. By relating firms’ environmental strategies to their country’s political and economic coalitions, we complement recent efforts to place firms’ environmental strategies in a global setting (Ioannou and Serafeim 2012; Li and Zhou 2017).

**THEORY**

**Government Agency Signaling**

Regulatory uncertainty is a major challenge for business. Regulatory delays are prevalent (Lavertu & Yackee, 2014), and regulators’ stance on an issue may evolve over time, resulting in changes in regulatory directions (Marcus & Kaufman, 1986; Fabrizio 2013). Even with set regulations, there can be wide variation in interpretation, application, and enforcement (Marcus, 1981; Skocpol, 1985). One of the reasons it is difficult for firms to forecast the likelihood of actual regulatory implementation is because of the principal-agent relationship between elected officials and regulatory officials (Sabatier and Mazmanian, 1980; Edelman, 1992; Kiser, 1999). Regulatory agencies, as agents of elected officials who write public policies, are generally staffed with technical experts who possess more complete information about the subject matter of policies than the elected officials who write them (Huber and Shipan, 2002). Because writing detailed public policy takes time and effort away from campaign activities and other responsibilities, elected officials tend to write policies with vague goals and broad mandates and delegate decisions about implementation to regulatory agencies so that they may be implemented in a more appropriate and effective manner (Skocpol and Finegold, 1982).

At the same time, it difficult for elected officials to effectively monitor their agents, especially when they have been granted significant discretion (Weingast, 1984). This can allow for variation in policy enforcement, leading some agencies to strictly implement policy, and others to loosely enforce it or ignore it altogether. Because of the problems that politicians have in controlling bureaucracies, it is critical that firms look for signals from agencies themselves as to their intentions in implementing policy. Yet, management research has yet to investigate whether and when the administrative state will signal its intent to enforce newly passed and sometimes complex policies.

We seek to address this limitation by bringing the administrative state center stage and exploring the factors that lead a regulatory agency to signal the degree to which it plans to prioritize implementation of a new policy. In order to understand whether administrative agencies will signal future intent, it is necessary to understand their preferences and incentives. Research in political science and public administration assert that bureaucrats generally seek to maximize the budget of the agency they control (Niskanen, 1971). Any possibility of future budget adjustments may motivate agency employees to action to forestall resource curtailment (Carpenter, 2001; Hiatt & Park, 2013). For instance, if elected officials pass a new policy but are displeased with what they believe is the agency’s efforts to implement the new policy, they may seek to cut that agency’s budgets the next year (Skocpol and Finegold, 1982). Naturally, state agency officials as rational actors will want to signal their efforts to implement policy in order to appease the principals that control the budgetary purse strings. The risk of budgetary cuts as a monitoring action has its roots in early scholarship by Max Weber who argued that the more dependent the agents (bureaucrats) were on the principals (elected officials), the more they would comply with the principals’ wishes and goals (Weber, 1922/1968). Since Weber, political sociologists and economists have found empirical support of Weber’s arguments (Kiser and Tong, 1992). For example, in a study of bureaucrats in the Dutch East Indies, Adams (1996) showed that bureaucrats that were more financially accountable to Dutch political leaders were more likely to implement policy in line with their goals.

Expounding on these findings, we suggest that bureaucrats’ resource dependence upon principals is likely to also elicit public signals in the form of official statements that demonstrate alignment with the policy goals. Specifically, we argue that if administrative agency officers feel that their future budgets could be imperiled if they do not carry out the principals’ wishes, that they will publicly signal an intent to implement policies even if the details of the policies have yet to be composed and the deadline for implementation is far into the future. By publicly indicating their intentions to implement policy, they can signal to their political principals their compliance and thereby reduce the risk that their future budgets might be affected. Thus, we argue:

*Hypothesis 1: The greater the risk of future budgetary constraints, the greater state agencies will signal future intent of policy implementation through public statements.*

**Contingencies of Government Agency Signals of Intent to Implement Policy**

The hypothesized mechanism of government agency signaling their intent to implement policy highlights the preference of agency officials to maximize their budgets and to take actions to prevent future reduction in budgets. This section further strengthens our argument by examining the contingent nature of these signals. We propose that the main effects will become stronger when agencies face greater monitoring of their actions by third-party civil society groups that can inform the agents’ political principals of their actions. Moreover, we believe that the agency’s intent to signal policy implementation will also be affected by its capacity to enforce the policy.

**Civil Society Pressure.**  Because it is often difficult for political principals to monitor their agents, they often rely on indirect monitoring by ‘civil society’ such as concerned citizens and, churches, associations, and social movement organizations (Kiser, 1999). Civil society groups are motivated to monitor state agency actions and draw attention to their actions because they are affected by their implementation (Freeman, 2000). A number of studies have shown that these third-party groups can affect implementation outcomes (Rose-Ackerman, 1978; Hiatt & Park, 2013). For instance, Klitgaard (1988) argued that taxpayer associations, which have an incentive to assure that tax money is effectively spent, are a vital source of information to political principals regarding whether government agencies are fulfilling policy mandates and are effectively using the appropriated funds.

We argue that a greater number of civil society groups that seek strict implementation of newly passed policy will have a positive moderating impact on the agency’s signaling of intent. As the number of concerned civil society groups increase, so will the amount of monitoring of the agency and scrutiny that will be placed on the government agency. If an agency faces future budgetary risk, its signals of implementation intent (or lack thereof) are likely to be picked up more easily by the civil society groups and communicated to its political principals. Consequently, we argue that agency officials facing risk to future budgets will have a greater incentive to signal their intentions to implement policy.

*Hypothesis 2: A government agency’s signals of implementation intent will be positively moderated by agency stakeholders that support the new policy.*

**State Capacity.** At the same time, agencies efforts to signal their intentions to implement future policy may also be moderated by their capacity to implement the policy. One of the key factors that can affect implementation of policy is its administrative or state capacity (Skocpol, 1985). Capacity is defined as the ability of government agencies to effectively evaluate and implement official goals and policy created by elected officials (Guillen & Capron, 2016). It includes pursuing new opportunities, innovating when policy implementation fails, evaluating alternatives, and responding to new needs or past policy failures. According to the political science literature, capacity requires having skilled agency officials furnished with adequate staffing and resources (Skocpol, 1979). Capacity also requires collaborative linkages with the dominant players in civil society (e.g. social movement organizations, professional associations, academic institutions) in order to gain the information, resources and stakeholder support to effectively implement policy (Tilly, 1990).

If a government agency has skills, resources, and technologies to implement a new policy, it will likely be more willing to signal its future intent to enforce new policy under risk of budgetary pressures. On the other hand, if an agency does not have the required capabilities, it may be reluctant to signal its intent until it can assemble the necessary knowledge, technologies, and personnel needed to execute the policy (Skocpol and Finegold, 1982). Depending on the abilities of the agency, this could take some time, thereby delaying the promulgation of its intent. Consequently, we argue:

*Hypothesis 3: Government agency’s signals of implementation intent will be (negatively) moderated by its (lack of) capacity to enforce the new policy*

**Firm Strategic Response to Agency Signals**

 Regulations changes, including changes in environmental regulations, can fundamentally transform the competitive landscape and significantly impact firms’ future financial performance (Hoffman, 2005; Kolk & Pinske, 2005). Therefore, any uncertainty in government agency’s implementation of a regulation change provides room for firms’ competitive strategy. Firms that make timely changes to comply with an expected more stringent environmental regulation can establish a competitive advantage (Hoffman, 2005). First, preemptive social and environmental initiatives can strengthen a differentiation position by signaling attractive social/environmental attributes of the firm and its products to consumers (Sen and Bhattacharya 2001), investors (Becchetti et al. 2012), and even employees (Prendergast 2007). Second, firms that preemptively adjust their inputs, processes, products, or services (Hart, 1995) according to the anticipated regulatory change can strengthen their position in the new regulatory environment (Delmas, Russo, & Montes-Sancho, 2007). Finally, for firms in heavily regulated industries, taking proactive actions allows them to influence the regulatory development processes[[1]](#footnote-1) (Puller, 2006; Hoffman, 2005) and enforcement processes (Maxwell and Decker, 2006; Innes and Sam, 2008; Gray and Shimshack, 2010), preempt more stringent regulations (Maxwell, Lyon, & Hackett, 2000; Delmas and Montes-Sancho, 2010; Short and Toffel, 2010), and build resources and capabilities to comply with future regulatory changes (Aragon-Correa & Sharma, 2003).

Consistent with these arguments, we argue that firms will take cues from government agencies to forecast the likelihood of actual implementation of a regulatory change, and they will respond accordingly to establish a first-mover advantage against their competitors. Anticipating a stricter regulation in their home country as government agencies promulgate signals of enforcement intent, firms are more likely to respond by reducing GHG emissions. We therefore predict the following:

*Hypothesis 4: As agencies signal greater future intent of policy enforcement, firms will alter their investments and strategy in accordance to the new policy*.

**Empirical Context**

We test our hypotheses using financial and emissions data about electric power generation firms in the EU. This context has several unique features that suit our study. First, during our sample period, firms in the EU faced great uncertainty regarding environmental regulations. On the one hand, there were continuous discussions about strict control of GHG emissions at the EU level over time and high expectations for EU member countries to follow a common set of emission standards, both of which suggested that regulations would be stringent. For example, Croatia, which joined the EU in 2013, had environmental conditions included in its negotiation documents.

The EU encourages Croatia to ensure that environmental protection requirements are integrated into the definition and implementation of other sectoral policies and that sustainable development is promoted. The EU also points out that all new investments should comply with the environmental acquis…. As regards the climate change, the EU takes note of efforts made by Croatia to align its legislation with the acquis in this field, including ratification of the Kyoto Protocol. The EU takes note that the National Strategy with an Action Plan for the implementation of the UN Framework Convention on Climate Change and the Kyoto Protocol has been prepared. The EU also takes note of Croatia’s plans to complete transposition of the remaining parts of the acquis in this sector in 2008, including Directive 2003/87/EC, and the planned adoption of a National Allowance Allocation Plan and legislation on registries.[[2]](#footnote-2)

On the other hand, EU climate change policy was based on a directive, 2003/87/EC, not a regulation. In EU law, a directive is different from a regulation.[[3]](#footnote-3) Unlike a regulation, which is a binding legislative act that must be applied in its entirety across the EU, a directive is a legislative act that sets out a goal that all EU countries must achieve, but it is up to the individual countries to devise their own laws on how to reach these goals. Thus, any directives have to be transposed into national legal legislation. Transposition is a process by which the EU Member States give force to an EU directive. In order to implement the EU ETS Directive (2003/87/EC) that governs GHG emissions, the member countries had to adopt relevant national legislation and implementation measures. This means the EU ETS directive gave the Member States and their regulatory agencies the general responsibility to ensure its implementation. Accordingly, there was considerable uncertainty as to how the EU climate change policy would be implemented in each country, although the EU was adamant about limiting GHG emissions over time.[[4]](#footnote-4)

Second, another unique feature of the EU context is that the EU member countries differ significantly in their financial dependence on the EU, including funding support from the EU (De La Fuente & Doménech, 2001). All member countries contribute to and receive funding from the EU, but some countries contribute more than they receive, and others receive more than they contribute. Also, the extent of how much the countries contribute versus receive varies. EU funds generally help member countries align their domestic policies with the EU’s policies and goals, and these funds can be withdrawn or curtailed if member countries fail to honor their commitments.[[5]](#footnote-5) The European Court of Auditors recommends that EU funds be conditional on results[[6]](#footnote-6) and penalizes member countries if they do not follow EU rules.[[7]](#footnote-7) Indeed, only expenditure in accordance with the EU legal framework is financed by EU funds, and financial corrections and recoveries (e.g., interruptions and suspension of payments) are made by the EU Commission if EU funds are not used in alignment with the Commission’s “budget focused on results strategy.”[[8]](#footnote-8) This ensures that EU funds are protected from expenditure in breach of law. For example, in 2014, financial corrections in the amount of 918 million EU in total were made in the area of sustainable growth and natural resources with regard to EU funds to its member states.[[9]](#footnote-9) Therefore, by exploiting heterogeneity in resource dependencies as represented by EU funding, we can gauge the likelihood of government agencies in EU member countries implementing and enforcing EU environmental policy and further study how firms respond to such regulatory signals.

 Lastly, by the time of our sample period, the European electricity markets had shifted away from a quasi-monopolistic structure to one that was increasingly competitive.[[10]](#footnote-10) The vertical value chain had been increasingly disintegrated into generation, transmission, and distribution. The transmission grids were open to all generators, with priority given to renewable energy suppliers. The electricity generators were subject to both price competition and consumer choice. They bid based on operating cost for the right to dispatch electricity to the transmission grid. The lower a generator’s cost and hence its bid price, the higher its profit would be, because the market price was determined by the bid of the highest-cost generator serving the load. At the same time, customers had some freedom in choosing (and switching) their electricity suppliers. For example, retail customers (e.g., residential, commercial, and industrial customers) were usually provided with detailed information about alternative electricity generation companies—including their energy mix and the environmental quality of supply—that they could choose from and switch to through their distribution companies. These were standard practices to ensure market competition in the electricity market (Kim, 2013). In making their choices, consumers could consider firm characteristics such as reputation and energy source in addition to price. For example, customers might choose to purchase electricity from firms that were known to be more environmentally friendly (Delmas, Russo, & Montes-Sancho, 2007). Thus, firms have incentives to move ahead with expected more stringent environmental regulations.

**Data and Method**

**Data and variable definitions**

In our empirical estimation, we proceed in two steps. We first predict the number of legal measures government agencies took to transpose and implement the EU climate change directive (2003/87/EC) in each EU Member State as a function of the country’s resource dependency on the EU at the country level.[[11]](#footnote-11) We then turn to whether and how firms responded to such public signals set forth by government agencies in the EU member countries by examining changes in GHG emissions at the firm level.

For the first analysis, we use country-level data collected from the World Bank’s World Development and Governance Indicators, Environmental Sustainability Index, International Union for Conservation Nature, and the European Commission’s EU-ETS and EU funds data.

For the second analysis, we complement the country-level data with firm-level data. We obtained GHG emissions data for firms that generate electric power in the EU for the years 2004 and 2009 from the Center for Global Development in Washington, DC. This dataset includes firm-level GHG emissions, specifically, carbon dioxide (CO2) emissions, energy generation, and share of fossil fuels. CO2 makes up the vast majority of GHG emissions from the electric power industry. Firm-level financials were collected from Orbis, a global company database produced by Bureau van Dijk.

Matching different datasets led to 422 firm-level observations for the years 2004 and 2009. We use changes in CO2 emissions between 2004 and 2009 as our firm-level dependent variable. To align our country-level analysis with this time period while avoiding endogeneity issues, we conduct our country-level analysis using the number of legal measures government agencies in each EU member country adopted to implement the EU environmental policy to reduce GHG emissions between 2004 and 2008.[[12]](#footnote-12) Below we explain our variables and empirical approach.

**Dependent variables**

*National transposition.* This variable refers to the number of legal measures government agencies in EU member countries adopted to implement the EU directive to reduce GHG emissions. As explained in the empirical context section, the EU’s effort to reduce GHG emissions is made through its EU ETS directive, 2003/87/EC. Because any directives have to be transposed into national legislation and appropriate implementation measures need to be adoped, we make use of the number of legal measures government agencies adopted to implement the EU ETS directive (2003/87/EC) between 2004 and 2008. We focus on the number of national implementing measures because the timing of transpositions of the directive was essentially the same across the EU member countries. This data is collected from the EUR-Lex national transposition website.

 *Changes in**carbon emissions at the firm level.* This variable refers to changes in carbon dioxide (CO2) emissions in tons between 2004 and 2009. Because this variable is measured as CO2 emissions in 2009 minus CO2 emissions in 2004, a positive number indicates CO2 emissions increased during 2004 and 2009, and a negative number indicates CO2 emissions decreased during 2004 and 2009.

**Independent variables**

 *Dependence.* This variable broadly captures resource dependency of an EU member country on the EU. The EU member countries both receive and contribute to EU funding. *Dependence* is measured using the annual amount of net funding received from the EU in 2004. A positive value indicates that the amount received from the EU is greater than the amount contributed to the EU, and a negative value indicates that the amount received from the EU is less than the amount contributed to the EU. Net funding is measured in billions of euros.

 *Dependence\*Environmental NGO pressure.* Our H2 proposes that a government agency’s signals of implementation intent will be positively moderated by agency stakeholders that support the new policy. We proxy agency stakeholders that support the new climate change policy by environmental NGO pressures. More specifically, we measure environmental NGO pressures by the presence of International Union for Conservation of Nature (IUCN) member organizations in each country, obtained from the 2005 Environmental Sustainability Index (ESI) as this is the closest year available to 2004. IUCN is an international environmental organization with more than 1,000 member organizations, including the most significant international environmental NGOs, such as Conservation International, the National Geographic Society, and the Sierra Club (Marquis, Toffel, & Zhou, 2016). Following prior work, we use the density of IUCN member organizations i.e., IUCN member organizations per million population. We interact this variable with *Dependence* to test H2.

 *Dependence\*Environmental stress.* Our H3 proposes that a government agency’s signals of implementation intent will be moderated by its capacity to enforce the new policy. We capture a government agency’s capacity to enforce the new policy with the 2005 Environmental Sustainability Index (ESI)’s environmental stress variable (Marquis, Toffel, & Zhou, 2016). This is a composite indicator that measures the extent to which various sources of pollution and resource consumption, such as SOx emissions, NOx emissions, fertilizer usage, and auto vehicle usage, are stressing a country’s environmental systems. A higher value indicates poor environmental quality. We interact this variable with *Dependence* to test H3.

**Control variables**

In the first analysis, where we predict national transpositions, we include several factors that could influence the number of legal measures government agencies adopted to implement the EU directive to reduce GHG emissions in addition to *Dependence* measured by net EU funding. All variables are measured in 2004 values except the emissions cap variable, as explained below.

First, since EU funding is earmarked for different purposes, we control for EU support for sustainable growth. During the time period studied, the amount of EU funding for member countries was categorized into six areas: sustainable growth, preservation and management of natural resources, citizenship, freedom and justice, EU as a global partner, administration, and compensations. The sustainable growth category refers to the amount of EU support related to the country’s sustainable growth, including research and innovation, education and training, development of enterprises, etc. It also covers regional policy which aims at helping the least developed EU countries and regions to catch up with the rest, strengthening all regions' competitiveness and developing inter-regional cooperation. Accordingly, EU support for sustainable growth may influence national transpositions at the country level and GHG reductions at the firm level. Thus, we control for EU support for sustainable growth in our regressions. In regressions not reported in the paper, we additionally control for EU support for preservation and management of natural resources, which addresses agricultural policy, rural development and environmental measures. The regression results are very similar.

Second, stringency of a country’s environmental regulations could influence the extent to which government agencies adopt legal measures to implement the EU climate change directive. To capture context-specific stringency, we make use of the EU-ETS emissions trading caps imposed at the national level during the period of our study. We normalize a nation’s emissions cap by its GDP. We use the EU ETS Phase I caps (2005-2007), Phase II caps (2008-2013), and their average in turn, and the regression results are very similar. We report the results using the EU ETS Phase I caps.

Third, we control for the number of international environmental agreements the country signed up for since such commitments could influence the number of legal measures government agencies take to implement the EU climate change policy. Fourth, population growth could influence national transpositions since population growth could affect energy generation and carbon emissions. Also, we control for GDP per capita and export to EU member countries since the level of development and EU-specific trade could affect decisions of government agencies regarding the transpositions of the EU climate change policy. In addition, we control for democracy index as political regime could influence government agency decisions.

In the second analysis, where we predict GHG emissions at the firm level, we include a few firm-level control variables that might affect GHG emissions. All variables are measured in 2004 values. We use the amount of energy generated as a proxy for firm size. We also control for the share of fossil fuel use. Energy generation from fossil fuel sources such as coal, oil, and natural gas emits GHG, whereas energy generation from other sources such as nuclear or renewable energy does not discharge GHG emissions. Financial performance is measured as ROA and financial resources is measured as cash flow. Carbon intensity is measured as the ratio of carbon emissions to energy generation. This variable addresses a potential concern that there may be more low-cost opportunities to reduce GHG emissions in high-emitting firms. Lack of competitionis measured at the country level using the Herfindahl Hirschman Index (HHI), as in prior studies (Fernández-Kranz & Santaló, 2010). We divide HHI by 10,000 such that HHI falls within the range of 0 to 1.

**Empirical methodology**

In the first analysis, we predict the number of legal measures government agencies of EU member countries adopted to implement and enforce the EU climate change policy using country-level data. Our variables of interest are *Dependence* and its interactions with *Environmental NGO pressure* and *Environmental stress*.

$$National Transpositions\_{i}=β\_{1}Dependence\_{i}+β\_{2}(Dependence\_{i}\*Environmental NGO pressure\_{i})+ β\_{3}(Dependence\_{i}\*Environmental stress\_{i})+ β\_{5}X\_{i}$$

The *National transposition* variable indicates the number of legal measures a country adopted to implement the EU-ETS directive (2003/87/EC) at the country level. Since our carbon emissions data covers the 2004-2009 period, we count the number of measures up to 2008. There are a few cases where a country implemented additional measures in 2009. Our regression results are very similar if we use the number of measures up to 2009 instead. Because the *National transposition* variable is a count variable, we use Poisson and negative binomial models.

 *X* is a vector of country-year-level controls. Since our regression is cross-sectional, in the right-hand side of the equation, we use 2004 values to the extent possible. The *Environmental NGO pressure* variable and the *Environmental stress* variable are collected from 2005 Environmental Sustainability Index. The emissions cap per GDP variable makes use of the Phase I caps, which cover the period from 2005 to 2007. The regression results are very similar if we use the Phase II caps, which cover the period from 2008 to 2012, or the average of the Phase I and Phase II caps.

H1 predicts that $β\_{1}$ >0, suggesting that as an EU member country becomes more dependent on the EU for funding, a government agency will adopt a greater number of legal measures to implement the EU-ETS directive at the country level. H2 predicts that $β\_{2}$ >0, as environmental NGO pressure goes up, a government agency will adopt a greater number of legal measures to implement the EU-ETS directive. H3 predicts that $β\_{3}$ <0, as poor overall environmental quality of the country is likely to indicate a lack of a government agency’s capacity to improve the environmental condition of the country.

In the second analysis, we predict changes in carbon emissions between 2004 and 2009 at the firm level. An increase in emissions during the period would show a positive change and a decrease in emissions would show a negative change.

$$Changes in Carbon Emissions (2009 Emissions-2004 Emissions)\_{i}=β\_{1}National Transposition\_{i}+β\_{2}(Dependence\_{i}\*Firm size\_{i})+ β\_{3}(Dependence\_{i}\*Financial Resources\_{i})+ β\_{5}X\_{i}+β\_{6}Z\_{i}$$

*X* is a vector of firm-year-level controls, and *Z* is a vector of country-year-level controls. Since our regression is cross-sectional, in the right-hand side of the equation, we use 2004 values to the extent possible as in the country-level analysis. All firm-level variables are in terms of their 2004 values. We employ robust standard errors clustered at the country level to account for non-independence across observations within the same country.

H4 predicts that $β\_{1}$ <0, suggesting that as a government agency adopts more legal measures to implement the EU-ETS directive, firms within the country will emit less carbon emissions.

 Table 1 displays the summary statistics and correlations for our variables.

[Table 1 about here]

 The first and second panels are based on country-level observations and the third panel is based on firm-level observations. The average number of legal measures a country has taken to implement the EU directive (2003/87/EC) was about 6 with a standard deviation of 4.8. The average EU member country received a net support of 376 million from the EU in 2004, and the standard deviation is 2.8 billion. EU support in the member countries is earmarked for different purposes, and an average country received 2 billion dollars for sustainable growth. On average, emissions cap over GDP is 402 million metric tonnes per trillion GDP in US dollars. The average EU member country signed up for 25 international environmental treaties. The average population growth rate is 0.2% and GDP per capita is 16,288 US dollars. An EU member country’s average export to the rest of the EU countries is 88 billion Euros. The average number of environmental NGOs (IUCN member organizations) per million population is 0.8. The Environmental stress variable ranges from 0 to 100, and the average value is 43. The democracy index varies from -10 to 10 (most democratic) and shows an average value of 9.6 with a standard deviation of 0.9.

 The third panel shows additional firm-level variables. Firms on average reduced carbon emissions by 22,800 tons between 2004 and 2009. An average firm generated about 27,722 =(exp(10.23)) megawatt hours of electricity per year, and emitted 615 tons of carbon emissions per thousand megawatt hours generated. Firms mostly used fossil fuel (around 90%) to generate electricity. Most firms operated in a competitive environment with an average HHI (HHI divided by 10,000) of 0.05. The average return on total assets was 4.4%, and the average cash flow was 194 million dollars. As shown, most correlations are relatively low.

**Results**

The regression results of the first analysis predicting *National transpositions* as a function of *Dependence* are shown in Table 2.

[Table 2 about here]

 The first five columns show the results using Poisson models and the next five columns show the results using negative binomial models. As shown, the *Dependence* variable shows a significant and negative relationship with *National transpositions*, suggesting that as an EU member country became more dependent on the EU for funding, its government agency implemented a greater number of measures to implement the EU directive. This provides support for our H1. For every one-hundred-million-dollar increase in net funding from the EU, the country adopted two more measures related to the implementation of the EU directive. Given that the average value of *National transposition* is 4 with a standard deviation of 4, and the average value of *Dependence* is 376 million, this is a significant impact.

The impact of the control variables is mostly as expected. For example, a higher emissions cap at the country level (i.e., larger emissions allowed at the country level) led a government agency to adopt a lesser number of measures to implement the EU ETS directive. The greater the number of international environmental treaties a country signed up for, the greater the number of implementation measures in the country. High population growth is likely to raise energy consumption and carbon emissions, and thus in a country with high population growth, a government agency adopted a lesser number of measures. A more affluent country might have been able to take up a greater number of implementation measures. Greater exports to EU countries generally imply greater resource dependence on the EU, and thus in such countries government agencies adopted a greater number of implementation measures. The negative impact of EU support for sustainable growth seems counterintuitive, but this reminds us that this support is fundamentally meant to promote economic growth, albeit sustainably, including helping the least developed EU countries economically.

Our H2 and H3 are about moderating effects of the environmental NGOs and environmental stress variables. In countries with a larger number of environmental NGOs, government agencies tended to adopt a greater number of measures, and this tendency was significant and more pronounced as resource dependence on the EU went up. This provides support for our H2. The main effect of the environmental stress variable is positive. However, the interaction of *Dependence* and *Environmental stress* is negative and counteracts the two main effects, suggesting that environmental stress mitigates the effect of *Dependence*. In other words, the higher the *Environmental stress* variable is, the more negative the effect of *Dependence* on *National transposition* becomes. This supports our H3.

The regression results of the second analysis predicting *Changes in carbon emissions* at the firm level are shown in Table 3.

[Table 3 about here]

Since the dependent variable subtracts carbon emissions in 2004 from carbon emissions in 2009, a positive number indicates carbon emissions increased during 2004 to 2009, and a negative number indicates carbon emissions decreased during 2004 to 2009. As shown, larger firms and firms that used more fossil fuels reduced emissions more. Carbon intensity controls for the possibility that firms with a higher level of carbon intensity in 2004 might have had lower-cost opportunities to reduce emissions, and thus made greater emissions reductions. Our results show that firms that operated in a more competitive environment and firms with larger cash flow tended to make greater emissions reductions. In addition, in countries with more support for sustainable growth from the EU, with greater commitments to international environmental treaties, or with larger GDP per capita, firms reduced emissions more. The non-significance of emissions cap over GDP, which was imposed at the country level during the period of our study, is consistent with the evidence that the emissions caps were not effectively binding during the time period, although the emissions caps were becoming more stringent over time.[[13]](#footnote-13)

Concerning our variables of interest, a greater number of legal measures to implement the EU directive had a negative impact on changes in carbon emissions at the firm level. This provides support for our H4. On average, as the number of legal measures increased by one, firms reduced carbon emissions by about 7,000 tons.

Robustness checks

We face three challenges in estimating the impact of *Dependence* on *National transpositions* at the country level. First, two countries, Bulgaria and Romania, joined the EU after 2004 (in 2007). Although these countries started to receive funding from the EU before they joined the EU, they did not contribute to the EU in 2004, and thus the *Dependence* variable reflects EU support only. In order to make sure that these anomalies do not drive our results, we ran regressions excluding Bulgaria and Romania. Second, our key independent variable, *Dependence*, which is measured with net EU funding for each country, may not be randomly assigned because countries that joined the EU since 2004 tend to rely more heavily on EU funding than those that joined the EU earlier.[[14]](#footnote-14) To address this issue, we created a dummy variable that indicates EU earlier joiner countries (EU 15) and used it as an additional control variable. Third, one might argue that joint implementation matters. Joint implementation is a program under the Kyoto Protocol that allows countries to meet part of their emissions cuts by reducing emissions outside of the country.[[15]](#footnote-15) Accordingly, we collected this data from the United Nations Framework Convention on Climate Change (UNFCC) Joint Implementation website[[16]](#footnote-16) and used it as an additional control variable. As shown in Table 4, our main results hold in all three cases described above, and the effects of the control variables are similar.

[Table 4 about here]

Regarding our second analysis at the firm level, we face two challenges. The first challenge is that firms that operate in countries that joined the EU more recently may differ from those that operate in countries that joined the EU early. In particular, firms in countries that joined the EU more recently may use more outdated fossil fuel-based technology, emitting more GHG emissions and leaving more room for future emissions reduction, in which case we could mistakenly attribute GHG emissions reductions to resource dependency. To address this issue, in our robustness checks, we use coarsened exact matching (CEM) (Iacus, King, & Porro, 2012) to account for unobservable heterogeneity across firms that might influence firms’ GHG emissions reduction over time. In particular, larger firms have greater potential for scale efficiency, and fossil fuel-intensive firms have greater potential for fuel replacement and hence improvement in energy efficiency. Therefore, larger and/or more fossil-fuel-intensive firms are likely to experience greater GHG emissions reduction. Applying CEM based on firm size and fossil fuel usage for year 2004 using the default binning algorithm in Stata, Scott’s rule, led to dropping more than 20% of our firm-level observations and resulted in 337 observations (out of 422). We ran the same regressions as in Table 3 using the 337 observations, and as shown in the first two columns of Table 5, the results are very similar.

[Table 5 about here]

 The second challenge is that there may still be concerns about potential omitted variable bias. One might argue that firms with greater liabilities may have fewer resources to spare for emissions reduction even if they have high ROA or cash flow. Also, highly aggregated variables such as ROA or cash flow may not adequately capture more specific operating performance. Thus, we additionally control for firms’ liability, and earnings before interest, tax, depreciation and amortization (EBITDA), which is not confounded by financing, accounting or tax-related decisions, as a measure of operating performance. As shown in the last four columns of Table 5, the regression results are very similar.

**Discussions and Conclusions**

In this paper we have shown that government agency decision-making is amenable to resource dependency at the international level, and that firms respond to a government agency’s signals of enforcement intent that alleviate regulatory uncertainties when cross-country policy is developing but implementation rests on domestic government agencies. We further show that the extent to which government agencies are influenced by resource dependency is moderated by pressures from local agency stakeholders and by the agency’s capacity to enforce the new law.

Our findings extend recent work that examines drivers of government agency decision-making and a growing body of work that studies how firms respond to extra-jurisdictional regulation.

 The context in which we examine this issue is greenhouse gas emissions in the EU. We make use of the early period of EU climate change policy when stringent EU policy was developing over time at the EU level, but implementation and enforcement at the country level was uncertain. We argue that a country’s dependence on EU funding would influence how its national government agencies administer and implement the climate change policy. Due to agencies’ concern over their resources, greater resource dependency would induce greater domestic implementation and enforcement, and this in turn would prompt firms to pursue strategies in line with the EU environmental policy.

 While the EU provides a good setting to explore how government agencies respond to resource dependency at the international level and how firms in turn respond to signals of agency implementation intent, we only studied one sector. The electric power sector is the largest contributor to global GHG emissions, 25%, and thus is of great significance. However, it also has some idiosyncratic features that caution against simplistic generalization of our findings to other industry settings. One unique feature is that electricity is a commodity. Even though customers can opt to purchase electricity from more renewable sources or more environmentally friendly companies, the potential for differentiation is more limited in the electric power sector than some other sectors. Another feature is that the electric power sector might be more regulated and less competitive than other sectors even though the electric power industry in the EU is vertically unbundled and increasingly competitive. It would be valuable to study other industry settings where GHG emissions are associated with specific product features that allow greater or lesser differentiation, and where the markets are more competitive.

 Our work opens a door to an under-explored but important area in management and strategy research—whether and how international collaboration to address global issues influences firms. Our findings demonstrate the importance of taking into account cross-country differences in resource dependency in international relations. In the context of climate change, we show that resource dependency surrounding environmental sustainability governance matters for firm response because incentives and pressures at the country level trickle down to the firm level via government agency decision-making. Thus, disregarding country-level heterogeneity in resource dependency is likely to mislead our understanding of how international collaboration to address global issues influences firms. In a statement before the 2005 meeting of the Parties to the Kyoto Protocol in Montreal, former British Prime Minister Tony Blair, a proponent of emission targets, said, “The blunt truth about the politics of climate change is that no country will want to sacrifice its economy in order to meet this challenge.”[[17]](#footnote-17) Our findings suggest that some countries may reluctantly push emissions-reduction efforts due to their resource dependency.

 In sum, this paper examines the influence of resource dependency on government agency decision-making, and firms’ response to these decisions. Despite the limitations, it extends the literature on firm response to regulatory uncertainty, places firms’ environmental strategies in a global setting, and highlights the tradeoffs firms face in short-term profitability/survival vs. long-term competitiveness in an uncertain regulatory environment.

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Table 1. Summary statistics and correlations at the country level

Panel A: Correlations (N=27): Country-level

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Mean | S.D. | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| (1) | National transposition | 5.704 | 4.754 |  |  |  |  |  |  |  |
| (2) | EU funding | 0.380 | 2.575 | 0.074 |  |  |  |  |  |  |
| (3) | EU support for sustainable growth | 0.001 | 0.002 | -0.215 | 0.293 |  |  |  |  |  |
| (4) | Emissions cap over GDP | 0.415 | 0.435 | -0.108 | 0.049 | -0.328 |  |  |  |  |
| (5) | International environmental treaty | 25.667 | 2.370 | 0.162 | 0.184 | 0.003 | 0.419 |  |  |  |
| (6) | Population growth | 0.301 | 0.769 | -0.343 | 0.266 | 0.367 | -0.523 | -0.356 |  |  |
| (7) | GDP per capita | 16704 | 11712 | -0.076 | -0.171 | 0.119 | -0.663 | -0.422 | 0.615 |  |
| (8) | Exports to EU countries | 0.077 | 0.099 | -0.158 | -0.425 | 0.629 | -0.395 | -0.145 | 0.186 | 0.338 |

Panel B: Correlations (N=23): Country-level

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Mean | S.D. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| (1) | National transposition | 6.174 | 4.933 |  |  |  |  |  |  |  |  |  |  |
| (2) | EU funding | 0.376 | 2.795 | 0.079 |  |  |  |  |  |  |  |  |  |
| (3) | EU support for sustainable growth | 0.002 | 0.002 | -0.301 | 0.304 |  |  |  |  |  |  |  |  |
| (4) | Emissions cap over GDP | 0.402 | 0.451 | -0.151 | 0.054 | -0.334 |  |  |  |  |  |  |  |
| (5) | International environmental treaty | 25.739 | 2.261 | 0.147 | 0.192 | -0.020 | 0.440 |  |  |  |  |  |  |
| (6) | Population growth | 0.211 | 0.704 | -0.243 | 0.320 | 0.541 | -0.526 | -0.328 |  |  |  |  |  |
| (7) | GDP per capita | 16288 | 9969 | 0.031 | -0.249 | 0.184 | -0.693 | -0.604 | 0.643 |  |  |  |  |
| (8) | Exports to EU countries | 0.088 | 0.103 | -0.250 | -0.444 | 0.600 | -0.412 | -0.211 | 0.341 | 0.480 |  |  |  |
| (9) | Environmental NGO pressure | 0.766 | 0.445 | 0.091 | 0.005 | -0.179 | -0.128 | -0.333 | 0.167 | 0.436 | -0.057 |  |  |
| (10) | Environmental stress | 42.778 | 11.828 | 0.254 | 0.054 | -0.342 | 0.406 | 0.128 | -0.561 | -0.500 | -0.571 | -0.241 |  |
| (11) | Democracy Index | 9.609 | 0.941 | 0.094 | 0.066 | 0.232 | -0.606 | -0.029 | 0.432 | 0.411 | 0.218 | -0.183 | -0.451 |

Panel C: Correlations (N=422): Firm-level

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Mean | S.D. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| (1) | Changes in Carbon emissions (2009-2004)  | -22847 | 182859 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| (2) | Firm size  | 10.231 | 2.542 | -0.265 |  |  |  |  |  |  |  |  |  |  |  |  |
| (3) | Carbon intensity | 615.89 | 314.03 | -0.151 | 0.044 |  |  |  |  |  |  |  |  |  |  |  |
| (4) | Fossil fuel | 0.896 | 0.259 | -0.026 | -0.154 | 0.522 |  |  |  |  |  |  |  |  |  |  |
| (5) | Competition | 0.051 | 0.040 | -0.067 | -0.029 | 0.016 | 0.097 |  |  |  |  |  |  |  |  |  |
| (6) | Return on total assets | 4.426 | 10.068 | -0.006 | -0.106 | -0.005 | -0.025 | 0.013 |  |  |  |  |  |  |  |  |
| (7) | Cash flow | 0.194 | 1.364 | -0.305 | 0.265 | 0.022 | -0.062 | 0.026 | 0.098 |  |  |  |  |  |  |  |
| (8) | National transpositions | 4.363 | 4.358 | -0.057 | 0.160 | -0.140 | -0.214 | -0.136 | 0.013 | 0.053 |  |  |  |  |  |  |
| (9) | Emissions cap over GDP | 0.200 | 0.199 | -0.008 | 0.051 | 0.262 | 0.006 | 0.077 | 0.028 | 0.137 | 0.031 |  |  |  |  |  |
| (10) | EU support for sustainable growth | 0.005 | 0.003 | -0.011 | -0.050 | -0.086 | 0.180 | 0.010 | -0.039 | -0.106 | -0.305 | -0.261 |  |  |  |  |
| (11) | International environmental treaty | 25.263 | 1.821 | -0.052 | 0.135 | -0.003 | 0.132 | 0.011 | -0.072 | 0.131 | 0.329 | 0.245 | 0.357 |  |  |  |
| (12) | Population growth | 0.489 | 0.607 | 0.040 | 0.097 | -0.206 | 0.145 | -0.206 | -0.101 | -0.048 | 0.230 | -0.304 | 0.613 | 0.601 |  |  |
| (13) | GDP per capita | 20911 | 6299.9 | -0.004 | -0.101 | -0.102 | -0.127 | -0.348 | 0.105 | -0.158 | -0.017 | -0.537 | -0.245 | -0.625 | -0.136 |  |
| (14) | Exports to EU countries | 0.222 | 0.140 | -0.064 | -0.203 | 0.123 | 0.084 | -0.030 | 0.059 | -0.102 | -0.631 | -0.283 | 0.328 | -0.462 | -0.350 | 0.377 |

Table 2. National transpositions of the EU climate change directive as determined by resource dependence at the country level

|  |  |
| --- | --- |
|  | DV: National Transpositions |
|  | Poisson | Poisson | Poisson | Poisson | Poisson | Negative binomial | Negative binomial | Negative binomial | Negative binomial | Negative binomial |
|   | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|   |   |   |   |   |   |   |   |   |   |   |
| Dependence: EU funding | 0.108\*\* | 0.175\*\*\* | 0.245\*\*\* | -0.0549 | 1.170\*\*\* | 0.120\* | 0.166\* | 0.214\*\* | -0.0704 | 1.239\*\*\* |
|  | (0.0450) | (0.0588) | (0.0695) | (0.154) | (0.332) | (0.0636) | (0.0872) | (0.0873) | (0.176) | (0.389) |
| EU support for sustainable growth | -121.3\*\* | -179.0\*\* | -244.7\*\* | -274.4\*\*\* | -62.87 | -102.8 | -140.3 | -194.4 | -247.3\*\* | -42.64 |
|  | (52.76) | (78.90) | (96.06) | (93.92) | (108.0) | (71.14) | (112.6) | (122.0) | (113.8) | (120.2) |
| Emissions cap over GDP | -1.194\*\*\* | -1.006\*\*\* | -0.876\*\* | -0.914\*\*\* | -0.809\*\* | -1.141\*\*\* | -0.966\*\* | -0.879\* | -0.932\*\* | -0.817\*\* |
|  | (0.297) | (0.325) | (0.350) | (0.352) | (0.354) | (0.395) | (0.442) | (0.454) | (0.411) | (0.402) |
| International environmental treaty | 0.0842 | 0.0880\* | 0.211\*\*\* | 0.198\*\*\* | 0.150\*\* | 0.0727 | 0.0764 | 0.213\*\* | 0.200\*\*\* | 0.142\* |
|  | (0.0512) | (0.0529) | (0.0689) | (0.0683) | (0.0761) | (0.0689) | (0.0686) | (0.0835) | (0.0768) | (0.0831) |
| Population growth | -0.546\*\*\* | -0.718\*\*\* | -0.652\*\* | -0.516\* | -0.481 | -0.626\*\*\* | -0.740\*\*\* | -0.689\* | -0.536 | -0.469 |
|  | (0.133) | (0.197) | (0.303) | (0.293) | (0.313) | (0.237) | (0.285) | (0.400) | (0.356) | (0.362) |
| GDP per capita |  | 1.27e-05 | 4.55e-05\*\* | 3.00e-05 | 1.30e-05 |  | 1.22e-05 | 4.84e-05 | 3.05e-05 | 1.12e-05 |
|  |  | (1.31e-05) | (2.23e-05) | (2.28e-05) | (2.45e-05) |  | (2.01e-05) | (3.09e-05) | (2.83e-05) | (2.93e-05) |
| Exports to EU countries |  | 2.323 | 4.202\* | 3.197 | 0.540 |  | 1.544 | 2.805 | 2.392 | -0.0651 |
|  |  | (1.726) | (2.479) | (2.536) | (2.732) |  | (2.700) | (3.281) | (3.081) | (3.106) |
| Environmental NGO pressure |  |  | 0.157 | 0.446 | 0.467 |  |  | 0.139 | 0.456 | 0.478 |
|  |  |  | (0.308) | (0.358) | (0.341) |  |  | (0.404) | (0.416) | (0.387) |
| Environmental stress |  |  | 0.0260\*\* | 0.0256\*\* | 0.0307\*\* |  |  | 0.0193 | 0.0212 | 0.0287\*\* |
|  |  |  | (0.0124) | (0.0123) | (0.0126) |  |  | (0.0162) | (0.0151) | (0.0144) |
| Democracy Index |  |  | 0.0771 | 0.118 | 0.182 |  |  | -0.0352 | 0.0599 | 0.147 |
|  |  |  | (0.146) | (0.146) | (0.150) |  |  | (0.201) | (0.184) | (0.179) |
| EU funding \* Environmental NGO pressure |  |  |  | 0.365\*\* |  |  |  |  | 0.362\* |  |
|  |  |  | (0.175) |  |  |  |  | (0.196) |  |
| EU funding \* Environmental stress |  |  |  |  | -0.0300\*\*\* |  |  |  |  | -0.0324\*\*\* |
|  |  |  |  | (0.0105) |  |  |  |  | (0.0122) |
| Constant | 0.247 | -0.227 | -6.072\*\* | -5.979\*\* | -5.316\*\* | 0.509 | 0.0815 | -4.721 | -5.242\* | -4.631 |
|  | (1.287) | (1.392) | (2.522) | (2.497) | (2.562) | (1.750) | (1.838) | (3.083) | (2.882) | (2.867) |
|  |  |  |  |  |  |  |  |  |  |  |
| Observations | 27 | 27 | 23 | 23 | 23 | 27 | 27 | 23 | 23 | 23 |
| Standard errors in parentheses |  |  |  |  |  |  |  |  |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 |  |  |  |  |  |  |  |  |  |  |

Table 3. Changes in carbon emissions at the firm level

|  |  |
| --- | --- |
|  | DV: Changes in Carbon Emissions between 2004 and 2009(Carbon Emissions 2009 – Carbon Emissions 2004) |
|   | With “EU funding”(1) | Without “EU funding”(2) |
|   |   |   |
| Firm size | -15,100\* | -15,118\* |
|  | (7,681) | (7,699) |
| Carbon intensity | -81.13\*\*\* | -78.73\*\*\* |
|  | (25.33) | (25.00) |
| Fossil fuel | -8,726 | -12,704 |
|  | (24,291) | (23,696) |
| Competition | -621,564\*\*\* | -568,239\*\*\* |
|  | (112,222) | (82,024) |
| Return on total assets | 512.6 | 535.3 |
|  | (589.6) | (589.3) |
| Cash flow | -36,331\*\*\* | -36,664\*\*\* |
|  | (7,808) | (7,866) |
| Dependence: EU funding | 6,032 |  |
|  | (3,544) |  |
| National transpositions | -7,462\*\*\* | -6,688\*\*\* |
|  | (1,373) | (1,387) |
| Emissions cap over GDP | -35,840 | -18,410 |
|  | (35,400) | (30,775) |
| EU support for sustainable growth | -1.266e+07\*\*\* | -1.120e+07\*\* |
| (3.825e+06) | (4.104e+06) |
| International environmental treaty | -10,739\*\*\* | -13,206\*\*\* |
| (3,062) | (3,239) |
| Population growth | 11,995 | 46,913\*\* |
|  | (34,598) | (20,606) |
| GDP per capita | -5.026\*\*\* | -6.198\*\*\* |
|  | (1.078) | (1.237) |
| Exports to EU countries | -46,366 | -124,935 |
|  | (54,088) | (74,658) |
|  |  |  |
| Constant | 709,753\*\*\* | 777,524\*\*\* |
|  | (114,055) | (147,451) |
| Observations | 422 | 422 |
| R-squared | 0.201 | 0.199 |
| Robust standard errors in parentheses |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 |  |

Table 4. Robustness checks at the country level

|  |  |
| --- | --- |
|   | DV: National Transpositions |
|  | Poisson | Poisson | Poisson | Negative binomial | Negative binomial | Negative binomial |
|  | Without Bulgaria & Romania | EU15 countries | Joint implementation | Without Bulgaria & Romania | EU15 countries | Joint implementation |
|  | (1) | (2) | (3) | (4) | (6) | (8) |
|   |   |   |   |   |   |   |
| Dependence: EU funding | 0.171\*\*\* | 0.165\*\*\* | 0.169\*\*\* | 0.159\* | 0.158\* | 0.166\* |
|  | (0.0593) | (0.0629) | (0.0576) | (0.0884) | (0.0912) | (0.0860) |
| EU support for sustainable growth | -171.5\*\* | -189.8\*\* | -180.7\*\* | -137.0 | -150.5 | -143.0 |
|  | (79.42) | (83.21) | (78.39) | (114.0) | (117.5) | (111.4) |
| Emissions cap over GDP | -0.677\* | -0.996\*\*\* | -1.081\*\*\* | -0.640 | -0.954\*\* | -0.978\*\* |
|  | (0.375) | (0.326) | (0.336) | (0.529) | (0.443) | (0.438) |
| International environmental treaty | 0.119\*\* | 0.0926\* | 0.0773 | 0.115 | 0.0782 | 0.0688 |
|  | (0.0580) | (0.0541) | (0.0535) | (0.0790) | (0.0689) | (0.0687) |
| Population growth | -0.736\*\*\* | -0.700\*\*\* | -0.794\*\*\* | -0.728\*\* | -0.713\*\* | -0.777\*\*\* |
|  | (0.201) | (0.203) | (0.204) | (0.291) | (0.298) | (0.287) |
| GDP per capita | 1.77e-05 | 6.58e-06 | 1.33e-05 | 1.68e-05 | 4.40e-06 | 1.28e-05 |
|  | (1.36e-05) | (1.93e-05) | (1.31e-05) | (2.10e-05) | (3.29e-05) | (1.98e-05) |
| Exports to EU countries | 2.379 | 2.063 | 2.374 | 1.533 | 1.309 | 1.692 |
|  | (1.739) | (1.822) | (1.702) | (2.738) | (2.813) | (2.670) |
| EU15 country |  | 0.184 |  |  | 0.201 |  |
|  |  | (0.421) |  |  | (0.673) |  |
| Joint implementation (net) |  |  | -4.37e-06 |  |  | -2.92e-06 |
|  |  |  | (3.09e-06) |  |  | (4.37e-06) |
| Constant | -1.215 | -0.317 | 0.127 | -1.071 | 0.0754 | 0.300 |
|  | (1.588) | (1.415) | (1.416) | (2.171) | (1.841) | (1.842) |
|  |  |  |  |  |  |  |
| Observations | 25 | 27 | 27 | 25 | 27 | 27 |
| Standard errors in parentheses |  |  |  |  |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 |  |  |  |  |  |  |

Table 5. Robustness checks at the firm level

|  |  |
| --- | --- |
|   | DV: Changes in Carbon Emissions between 2004 and 2009(Carbon Emissions 2009 – Carbon Emissions 2004) |
|  | Coarsened Exact Matching (CEM) | With Liability | With EBITA |
|  | With “EU funding” | Without “EU funding” | With “EU funding” | Without “EU funding” | With “EU funding” | Without “EU funding” |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
|   |   |   |   |   |   |   |
| Firm size | -17,353\*\*\* | -17,353\*\*\* | -15,897\* | -15,908\* | -13,812\* | -13,811\* |
|  | (4,962) | (4,954) | (7,672) | (7,692) | (7,469) | (7,472) |
| Carbon intensity | -62.88\* | -62.89\* | -79.31\*\*\* | -76.86\*\*\* | -85.54\*\*\* | -83.28\*\*\* |
|  | (34.20) | (33.69) | (24.62) | (24.28) | (25.69) | (25.27) |
| Fossil fuel | 1.305e+06 | 1.305e+06 | -11,858 | -15,916 | -5,248 | -8,903 |
|  | (914,258) | (912,805) | (25,222) | (24,869) | (23,120) | (22,821) |
| Competition | -63,031 | -63,417 | -627,54\*\*\* | -572,67\*\*\* | -614,16\*\*\* | -567,06\*\*\* |
|  | (120,425) | (93,951) | (119,661) | (87,766) | (116,006) | (86,959) |
| Return on total assets | -378.6 | -378.7 | 534.1 | 557.2 | 461.1 | 481.0 |
|  | (434.6) | (434.4) | (586.3) | (587.2) | (569.5) | (565.4) |
| Cash flow | 6,598 | 6,597 | -41,881\*\*\* | -42,168\*\*\* | -84,754\*\* | -85,732\*\* |
|  | (3,899) | (3,886) | (8,292) | (8,305) | (31,021) | (31,113) |
| Dependence: EU funding | -40.55 |  | 6,201 |  | 5,385 |  |
|  | (3,749) |  | (3,630) |  | (3,425) |  |
| National transpositions | -3,066\* | -3,071\*\* | -7,569\*\*\* | -6,773\*\*\* | -7,612\*\*\* | -6,919\*\*\* |
|  | (1,754) | (1,412) | (1,455) | (1,451) | (1,411) | (1,332) |
| Emissions cap over GDP | 35,669 | 35,539 | -25,343 | -7,531 | -36,398 | -20,761 |
|  | (40,930) | (34,458) | (38,525) | (34,903) | (34,081) | (28,830) |
| EU support for sustainable growth | -1.26e+07\*\*\* | -1.26e+07\*\*\* | -1.10e+07\*\*\* | -9.52e+06\*\* | -1.22e+07\*\*\* | -1.09e+07\*\* |
| (3.17e+06) | (3.39e+06) | (3.85e+06) | (4.17e+06) | (4.08e+06) | (4.26e+06) |
| International environmental treaty | -5,204\* | -5,188\* | -10,627\*\*\* | -13,164\*\*\* | -10,865\*\*\* | -13,059\*\*\* |
| (2,739) | (2,777) | (3,233) | (3,443) | (3,077) | (3,228) |
| Population growth | 58,099 | 57,855\*\*\* | 7,015 | 42,955\*\* | 15,382 | 46,659\*\* |
|  | (35,612) | (16,776) | (34,008) | (20,487) | (34,279) | (20,967) |
| GDP per capita | -3.475\*\*\* | -3.468\*\*\* | -4.459\*\*\* | -5.670\*\*\* | -4.993\*\*\* | -6.035\*\*\* |
|  | (1.156) | (1.079) | (1.102) | (1.226) | (1.151) | (1.164) |
| Exports to EU countries | 58,391 | 58,881 | -65,248 | -145,820\* | -59,774 | -129,426 |
|  | (54,467) | (78,593) | (56,180) | (75,556) | (59,232) | (76,825) |
| Liabilities |  |  | 8.00e-06 | 7.92e-06 |  |  |
|  |  |  | (5.30e-06) | (5.22e-06) |  |  |
| Ebitda |  |  |  |  | 5.06e-05 | 5.13e-05 |
|  |  |  |  |  | (3.08e-05) | (3.09e-05) |
| Constant | -880,085 | -880,513 | 699,678\*\*\* | 769,437\*\*\* | 699,172\*\*\* | 759,093\*\*\* |
|  | (932,160) | (932,002) | (117,132) | (151,534) | (115,856) | (140,674) |
|  |  |  |  |  |  |  |
| Observations | 337 | 337 | 422 | 422 | 421 | 421 |
| R-squared | 0.175 | 0.175 | 0.205 | 0.203 | 0.214 | 0.213 |
| Robust standard errors in parentheses |  |  |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 |  |  |  |  |  |

1. Regulators often consult private-sector experts in the regulatory development processes, and firms that have made proactive moves are often considered experts and invited to the table. See, for example, <http://www.sciencemag.org/news/2016/04/us-looking-expert-panel-predict-future-gm-products>,

 a science magazine article about how U.S. regulatory agencies prepare to update the legal framework regarding new biotechnologies by learning from the private sector as well as from academics. [↑](#footnote-ref-1)
2. Accession Negotiations with Croatia, Chapter 27: Environment, Council of Brussels, 17 December 2008. [↑](#footnote-ref-2)
3. https://europa.eu/european-union/eu-law/legal-acts\_en [↑](#footnote-ref-3)
4. https://ec.europa.eu/clima/policies/ets/pre2013/nap\_en#tab-0-1 [↑](#footnote-ref-4)
5. Report from the Commission to the Council and the European Parliament (52010DC0382), Sep 23, 2010. [↑](#footnote-ref-5)
6. 2013/537/EU, Euratom: Decision of the European Parliament of 17 April 2013 on discharge in respect of the implementation of the general budget of the European Union for the financial year 2011. [↑](#footnote-ref-6)
7. What was case C-304/02, Commission v French Republic about? http://europa.eu/rapid/press-release\_MEMO-05-482\_en.htm?locale=en [↑](#footnote-ref-7)
8. Communication from the Commission to the European Parliament, the Council, and the Court of Auditors. Protection of the EU budget to End 2015. European Commission, Brussels, 18.7.2016. COM(2016)486 final. [↑](#footnote-ref-8)
9. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2015:0503:FIN [↑](#footnote-ref-9)
10. European Parliamentary Research Service, Understanding electricity markets in the EU, November 2016. [↑](#footnote-ref-10)
11. We focus on the number of national implementation measures because the timing of transpositions of the EU-ETS directive (2003/87/EC) was essentially the same across the EU member countries. [↑](#footnote-ref-11)
12. In regressions not shown in the paper, we alternatively use the number of legal measures government agencies adopted between 2004 and 2009, and the regression results are very similar. [↑](#footnote-ref-12)
13. “In phase one (2005-2007), almost all allowances were given to businesses free of charge. The total allocation of EU-ETS allowances exceeded demand by a sizeable margin and in 2007 the price of phase one allowances fell to zero…. In phase two (2007-2013), the proportion of general allowances given away for free fell slightly to at least 90%.... On the basis of the veriﬁed emissions reported during phase one, the European Commission tightened the cap by cutting the total volume of emission allowances by some 6.5% compared with the 2005 level. However, the economic crisis that began in late 2008 depressed emissions, and thus demand for allowances, by an even greater margin. This led to a large and growing surplus of unused allowances and credits which weighed heavily on the carbon price throughout the second trading period.” (http://ec.europa.eu/clima/policies/ets/pre2013/index\_en.htm) [↑](#footnote-ref-13)
14. The EU was formally established in 1993 with 12 member states and expanded through a series of accession waves. Austria, Finland, and Sweden joined in 1995 (EU-15). Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia joined in 2004 (EU-25). Bulgaria and Romania joined in 2007 (EU-27). Croatia joined in 2013 (EU-28). [↑](#footnote-ref-14)
15. http://unfccc.int/kyoto\_protocol/background/items/2882.php [↑](#footnote-ref-15)
16. This site provides information for each joint implementation program with start year and end year, so we assumed equal distribution across years and aggregated that information to the country level. [↑](#footnote-ref-16)
17. “On Climate Change, a Change of Thinking,” *The New York Times*, December 4, 2005. [↑](#footnote-ref-17)