The Promise of Different Types of Environmental Management Systems for Voluntary Governance

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Abstract

In spite of firms' global interest in adopting environment management systems (EMSs), there is little information about which types of EMSs are associated with greater environmental improvements. This research compares the environmental performance of facilities that adopt self-declared EMSs, complete EMSs, and ISO 14001-certified EMSs across multiple environmental impacts. We analyze these relationships using a two-stage model to control for selection bias, and OECD survey data for manufacturing facilities in Canada, France, Germany, Hungary, Japan, Norway, and the United States. Our findings indicate that adoption of all three EMSs is related to facilities' reductions in natural resource uses, solid waste, wastewater effluent, local air pollution, and global air pollutants. However, there lacks strong evidence that ISO 14001-certified EMSs lead to superior environmental improvements than other types of EMSs.

Keywords: Environmental management system, environmental performance, motivations, ISO 14001, EMS adoption

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INTRODUCTION

In many countries environmental policy has taken the form of mandatory command and control regulations in which governments prescribe legally binding performance standards such as emission limits and/or the use of “best available” production technologies (Khanna, 2001). While this approach of government endorsement has been successful in reducing the environmental impacts of industrial activities (Press & Mazmanian, 2006), it has been criticized because it does not promote source reduction. Instead, the traditional regulatory approach emphasizes end-of-pipe pollution control, which imposes high pollution abatement costs on both firms and regulators (Khanna, 2001).

Against this backdrop, many initiatives have emerged that encourage firms to self-regulate environmental performance (Mazurek, 1998; Carraro & Leveque, 1999). In particular, federal and state-level governments, industry associations and nonprofit organizations are promoting the merits of firms adopting voluntary-based environmental management systems (EMSs) (Coglianese & Nash, 2001; Khanna & Anton, 2002; Mazurek, 2002). For instance, the U.S. Environmental Protection Agency (EPA) supports and promotes the development and use of EMSs because they encourage the integration of a full range of environmental considerations into an organization’s central mission, which can improve environmental performance (EPA, 2005).

However, questions exist about the effectiveness of firms’ efforts to self-regulate their environmental impacts by way of EMSs. While some previous studies show that they have promise (e.g., Arimura, Hibiki & Katayama, 2008, Potoski & Prakash 2005a, 2005b; Russo, 2002), others are less optimistic (Dahlstrom, Howes, Leinster, & Skea, 2003; King, Lenox & Terlaak, 2005; Ziegler & Rennings, 2004). Moreover, these previous studies have generally assessed the merits of ISO 14001-certified EMSs, which are EMSs that undergo third-party audits to ensure conformance to an international EMS standard. However, most companies that adopt an EMS do not seek ISO 14001 certification, and many other companies implement only portions of an EMS.

Understanding how variations in EMS adoption are related to subsequent environmental performance is important because government programs that encourage EMS adoption generally do not require ISO 14001 certification, but endorse a more generic EMS. As such, evaluations of ISO 14001-certified firms offer only a partial picture of the potential promise that EMSs hold for policy practice.

Moreover, studies assessing EMS effectiveness generally have assessed changes to one environmental medium (toxic releases) (King et al., 2005; Potoski & Prakash, 2005a) or the extent to which EMSs help companies comply with environmental laws (Potoski & Prakash, 2005b). However, EMSs are integrated management systems that can affect *numerous* aspects of a company's environmental behavior that are designed to help companies move beyond mere compliance with environmental laws. As such, assessing whether EMS adoption affects firms' emissions related to one environmental medium or compliance may underestimate the potential ability that these management systems may have for reducing firms' overall environmental impacts.

Finally, to our knowledge, previous studies examining the effects of ISO 14001 certification on firms' environmental performance have assessed firm behavior within a single country (e.g. Arimura et al., 2008, King et al., 2005; Potoski & Prakash 2005a, 2005b). Yet EMSs are being adopted globally, and many governments are encouraging their use. An international view of their potential for improving the environment therefore would be useful to governments and business managers worldwide.

This paper addresses these issues by examining the broader landscape of EMS adoption and its relationship with firms' environmental performance. It assesses firms' environmental performance across five areas of environmental impacts— natural resource use, solid waste generation, and discharge of wastewater effluent, local and regional air pollution, and global pollutants. These relationships are examined for manufacturing facilities operating in Canada, France, Germany, Hungary, Japan, Norway, and the United States, by drawing on survey data collected by the Organisation for Economic Co-operation and Development (OECD) and using estimation techniques that control for selection bias associated with the EMS adoption decision.

EMSs AND ENVIRONMENTAL PERFORMANCE

EMSs are systems of management processes that enable organizations to continually reduce their impact to the natural environment. Most EMSs involve implementing a written environmental policy, training employees regarding environmental concerns, employing internal environmental audits, and developing environmental performance indicators and goals (Netherwood, 1998). However, there often is variation in how these practices are utilized, in large part, because EMSs arise in different organizational settings and organizations adhere to different types of EMS standards (Coglianese & Nash, 2001). Other EMSs require facilities to obtain external certification by independent third party auditors (Starkey, 1998). As a consequence, the typical approach of asking facilities whether they have adopted an EMS fails to account for the completeness of the EMS in that some facilities implement more of these environmental practices than others (Darnall, Henriques & Sadorsky, 2008). In spite of these variations, all EMSs are principally designed to improve the environmental performance of organizations that adopt them.

EMSs and Environmental Performance

At the most basic level an EMS can help organizations ensure that their management practices conform to environmental regulations. However, the EMS structure also encourages facilities to prevent pollution by substituting unregulated for regulated inputs and by eliminating some regulated processes altogether. As a result, some enterprises may no longer be subject to some costly regulatory mandates. Further, EMSs assist enterprises to scrutinize their internal operations, engage employees in environmental issues, continually monitor their progress, and increase their knowledge about their operations. All of these actions also can help organizations improve their internal operations, achieve greater efficiencies, and thus create opportunities to improve their environmental performance by way of pollution prevention.

In other instances, EMSs have the potential to encourage organizations to adopt more sophisticated environmental strategies that build on their basic pollution prevention principles. For example, as part of their EMS, some enterprises may implement life cycle cost analysis and assess their activities at each step of their value chain—from raw materials access to disposition of used products (Allenby, 1991; Fiksel, 1993). These more advanced environmental strategies leverage basic pollution prevention principles, but also extend them by integrating external stakeholders into product design and development processes (Allenby, 1991). By using these advanced strategies, organizations can eliminate environmentally hazardous production processes, redesign existing product systems to reduce life cycle impacts, and develop new products with lower life cycle costs (Hart, 1995). Such actions represent a significant departure from basic pollution prevention principles because they offer a vehicle for organizations to assess all aspects of their operations jointly, thus minimizing the shift of environmental harms from one subsystem to another (Shrivastava, 1995). In the process, EMSs can assist the whole organization in achieving greater organizational efficiency (Welford, 1992) and continual environmental improvement. For these reasons, we hypothesize that facilities that adopt an EMS are more likely to improve their environmental performance.

Hypothesis 1: *Organizations that adopt an EMS (of any sort) are more likely to improve their environmental performance.*

However, as mentioned previously, not all EMSs are designed similarly, and these design variations may be associated with differences in environmental outcomes. We anticipate that organizations that seek certification of their EMSs have a greater level of commitment towards the environment which is associated with greater environmental improvements. There are several reasons for our position. The first relates to the institutional structure of certified EMSs. The certification process is generally comprised of two stages. During the first stage, called the initial assessment, the organization's EMS documentation is reviewed by an independent auditor. The auditor identifies a range of issues to examine further in the second stage of the audit (Morrison, Cushing, Day, & Speir, 2000). The second-stage audit is performed on location. All non-conformances with the standard are documented and brought to the attention of the organization, and the audit team produces a report detailing the findings—conformances and non-conformances—in addition to a recommendation for or against certification (Morrison et al., 2000). Upon completion of the audit report, a member of the registrar organization (who did not participate in the audit) independently reviews the report and makes a final decision on whether to grant certification (Morrison et al., 2000). Over time, certified organizations are required to demonstrate the continued functioning of their EMSs in order to maintain their certification. This process helps organizations attend to their environmental concerns because they fear that someone might expose their shortcomings (Rondinelli & Vastag, 2000). At the same time, third party auditors are often more effective monitors than the organizations themselves (Rondinelli & Vastag, 2000), which may lead to greater environmental performance outcomes than are obtained from non-certified EMSs.

The second reason why we anticipate that organizations which certify their EMSs have a greater likelihood of achieving greater environmental improvements relates to the fact that certification can be costly. Certification requires significant documentation (taking up to two years to produce), multiple environmental assessments and dozens of meetings between managers, executives and employees beyond what is typically required by non-certified EMSs (Darnall & Edwards, 2006). Actual costs of certification can range from $29 - $88 per employee, beyond the cost of implementing a typical EMS, depending on the organization's structure and complexity (Darnall & Edwards, 2006). Organizations accrue these costs each time they re-certify their EMS. Because of these costs, organizations that seek certification may have better managerial support to maintain the system and achieve the EMS' environmental goals.

Finally, organizations that certify their EMS are more likely to have enhanced visibility for their environmental practices because certification lists are available through auditors and online services. Because of this greater visibility, organizations may feel greater external pressure to address environmental concerns that are important to external stakeholders. As such, the scope of certified organizations' proactive environmental efforts may be greater. Additionally, organizations that certify their EMS may perceive they have greater external pressure to maintain their certification. Such pressures derive from concerns related to forgoing certification once it has been obtained. In such instances, these organizations may be vulnerable to greater unwanted attention from critical stakeholders such as customers, regulators or environmental groups. In order to avoid enhanced external scrutiny that may come with a failed certification, organizations that implement a certified EMS have a greater incentive to meet their environmental goals.

For all these reasons, we hypothesize that organizations which adopt certified EMSs are more likely to improve their environmental performance than organizations that adopt non-certified EMSs.

Hypothesis 2. *Organizations that adopt certified EMSs are more likely to improve their environmental performance than organizations that adopt non-certified EMSs.*

MOTIVATIONS FOR EMS ADOPTION

Before exploring the relationship between an organizations EMS adoption and its environmental performance, it is necessary to consider whether organizations that adopt an EMS do so because of factors that are correlated with environmental performance. If these correlations exist, they must be addressed empirically.

Organizations whose industrial activities impact the natural environment are anticipated to be motivated by varying degrees of perceived stakeholder influences to improve their likely environmental performance. Stakeholders can be defined as ‘‘any group or individual who can affect or is affected by the achievement of an organization’s objectives” (Freeman, 1984, p. 46).

In general, there are two groups of stakeholders that influence organizations: internal and external stakeholders. Internal stakeholders include shareholders, management and non-management employees (Waddock & Graves, 1997). These internal stakeholders, which include parent companies, have a direct economic stake in the organization and are typically located within the organization (Freeman, 1984). In contrast, external stakeholders have more limited control of central organizational resources (Mitchell, Agle, & Wood, 1997; Sharma & Henriques, 2005). External stakeholder pressures originate from regulators and environmental interest groups (Darnall et al., 2008). Each of these stakeholder pressures are discussed below.

Parent company pressures

Previous research has shown that influence from parent companies is a key determinant to organizations adopting an EMS. Some parent companies may mandate that their operational units adopt a certified EMS, while other parent companies may influence facility-level environmental activities simply by encouraging EMS adoption in the absence of a corporate mandate (Darnall, 2006). Given that EMS adoption requires organization-wide commitment and incurs costs, which entail staff time, documentation, materials and equipment, training, and environmental consultants (Kollman & Prakash, 2001), support and leadership from parent company is anticipated to increase the likelihood that facilities adopt an EMS.

Regulatory Pressures

Other stakeholder pressures are derived from environmental regulators. For instance, organizations must comply with environmental regulations or face the threat of regulators levying legal action, penalties and fines (Henriques & Sadorsky, 1996). Failure to yield to regulatory stakeholders leaves organizations vulnerable to individual or class action lawsuits. Such threats, although infrequent, can be devastating to an organization's public image, customer relations and external legitimacy (Power, 1997). As a consequence, organizations may adopt EMSs as one means to preempt these regulatory threats.

Other regulatory influences are less coercive and more incentive-based. For instance, regulators are offering incentives to encourage organizations to adopt EMSs. Regulators' rationale for providing these incentives is the belief that EMSs can prevent larger environmental mishaps (Stafford, 2005). These incentives may encourage organizations to adopt an EMS.

In still other instances organizations yield to stakeholder influences from regulators in an effort to maintain or improve their informal relationships (Stafford, 2005) and accrue political capital. For example, by adopting an EMS, organizations may be able to form collaborative relationships with government to more easily and explore more non-regulatory ways in which government can encourage greater environmental improvements (Darnall et al., 2008). These collaborations can promote environmental learning, capacity-building (Darnall & Edwards, 2006), and trust between organizations and regulators (Hoffman, 2000). A good reputation with regulators also may give organizations greater political capital when negotiating with government officials about the terms of forthcoming regulations.

Environmental group pressures

External stakeholders' influences originating from the broader social context (Henriques & Sadorsky, 1999; Power, 1997; Wilmshurst & Frost, 2000) may also encourage facilities to adopt an EMS. Constituents in the social context include environmental groups (Hoffman, 2000) that generally utilize indirect approaches to influence organizational behavior (Sharma & Henriques, 2005). Such actions include public protests and calls for engagement. In particular, increased public protests may be due to highly publicized stories of catastrophic environmental disasters such as the Union Carbide toxic gas leak in Bhopal, and the *Exxon Valdez* oil spill, which have personalized the importance of organizations' environmental management activities (Rajan, 2001). Further, environmental groups may publicize information that could persuade consumers to favor the products of companies that have demonstrated a stronger regard for the environment (Gould, Schnaiberg, & Weinberg, 1996). In other instances, they may encourage consumers to boycott products of organizations and neutralize attempts that these organizations may take to promote their environmentally proactive management practices.

RESEARCH METHODS

Data

To evaluate our hypotheses, we relied on a twelve-page survey data derived from the OECD Environment Directorate and university researchers from Canada, France, Germany, Hungary, Japan, Norway and the U.S. The OECD survey was pre-tested in France, Canada and Japan before it was finalized. Prior to its dissemination, the survey was translated into each country's official language and validated for accuracy. The survey consisted of six major sections. Each section gathered information about facilities' environmental practices, their environmental performance, stakeholders' influences or motivations on environmental practices, nature of environmental policy that affects each facility, facility characteristics, and firm characteristics.

In 2003, surveys were sent to individuals who worked in manufacturing facilities having at least 50 employees and who were responsible for the facility's environmental activities. The manufacturing sector was selected because it is commonly accepted that these industries produce more air, land, and water pollution than service facilities (Stead & Stead, 1992). The OECD sent two follow-up mailings to prompt additional responses. A total of 4,187 facility managers completed the survey. The response rate was 24.7 percent which is similar to previous studies of organizations' environmental practices (e.g. Christmann, 2000; Delmas & Keller, 2005; Melnyk, Sroufe & Calantone, 2003), where response rate were 20.1, 11.2 and 10.3 percent, respectively. Almost half of the sample consisted of either small- or medium-sized enterprises (<250 employees).

Respondents were identified by relying on public databases within each country. For instance, the Hungarian population was identified using data from the Hungarian Central Statistical Office and the Canadian population was identified using Dun & Bradstreet data. In France, Germany, Japan, Norway and the USA, the OECD surveyed the population of manufacturing facilities with more than 50 employees. Because of resource constraints, the OECD utilized random sampling of the same types of respondents to collect its data in Canada and Hungary.

Previous research assessing environmental performance has been performed predominantly using the U.S. EPA Toxic Release Inventory (TRI) emissions data (Anton et al, 2004, King et al., 2005, Potoski & Prakash, 2005a). TRI data are publicly available and contain information of facilities' releases of nearly 650 chemicals, which provide a good proxy measure for a facility's environmental impacts related to toxic chemicals. However, toxic releases offer only a partial view of a facility's overall environmental performance. Moreover, TRI data are not collected in all countries, which make it difficult to evaluate the effectiveness of EMSs in an international setting. In a similar way, previous studies that evaluate the relationship between EMSs adoption and environmental performance have focused on certified EMSs (King et al., 2005, Potoski & Prakash, 2005a; 2005b). By utilizing the OECD survey data, examines both certified and uncertified EMSs across multiple environmental impacts.

To check for common method variance, we relied on the post-hoc Harman's single-factor test (Podsakoff & Organ, 1986). The basic assumption of this test is that if a substantial amount of common method variance is present, a factor analysis of all the data will result in a single factor accounting for the majority of the covariance in the independent and dependent variables. The results of Harman's single-factor test revealed that no single factor accounted for the majority of the variance in the variables, offering evidence that this type bias was not a concern. Social desirability bias was addressed by ensuring anonymity for all respondents. We also found no evidence that respondents always over or under reported data in a consistent manner since there were wide variations in facility responses. The OECD examined non-response bias by evaluating the general distribution of its survey respondents. It assessed the industry representation and facility size of the survey sample relative to the distribution of facilities in the broader population, and found no statistically significant differences (Johnstone, et al., 2007). Issues related to generalizability were less of a concern because the OECD survey had broad applicability in that it targeted large and small operations across multiple industry sectors and countries.

Measures for Environmental Performance Equation

Dependent Variables. A facility's environmental performance may be influenced both by the use of natural resources (e.g., energy and water) and by the facilities' output levels to environmental medium (i.e., air, water, land). Environmental performance was measured using the OECD survey question which asked: "Has your facility experienced a change in the environmental impacts per unit of output of production processes in the last three years with respect to the following areas of impact?" We assessed five environmental impacts: (1) natural resource use, (2) wastewater effluent, (3) solid waste generation; (4) local or regional air pollutants, and (5) global pollutants (e.g., greenhouse gases). Facility mangers replied using a five-point scale indicating whether their impacts had "decreased significantly," "decreased," incurred "no change," "increased," or "increased significantly" per unit of output. To concentrate the analysis on whether or not environmental impacts had decreased per unit of output, we recoded environmental performance into a binary variable by combining the first two categories and the last three (1=significant decrease or decrease, 0=no change, increase or insignificant increase).

Independent Variables. To construct EMS adoption measures, we categorized EMSs in three ways: *self-designated, complete*, and *certified* EMSs. Self-designated and complete EMSs are both uncertified EMSs. The former was constructed by relying on an OECD survey question which asked, “Has your facility actually implemented an environmental management system?” Responses were coded 1 (=Yes) or 0 (=No).

To respond to concerns that a facility may claim to have an EMS when it only has portions of one, we considered the completeness of facilities’ EMSs. The completeness of a facility’s EMS is an unobserved quality (Darnall et al., 2008). However, it can be measured by examining a facility’s diverse environmental practices (Khanna & Anton, 2002). To develop our second EMS measure, complete EMS, we relied on OECD survey data that asked facility managers whether they had implemented four different environmental practices that have been recognized as core components of different types of EMSs: written environmental policy, environmental training program in place for employees, internal environmental audits (Netherwood, 1998), and environmental performance indicators/goals (Coglianese & Nash, 2001). Facilities responded by indicating 1 (=Yes) or 0 (=No). In instances where facilities had implemented all four practices, we considered it to have a complete EMS. To address concerns that facilities which adopt certified EMSs may also have a complete EMS, we eliminated these facilities from this variable grouping.

To construct our third measure, certified EMS, we relied on OECD survey data that asked facility mangers whether or not their facilities’ EMS was certified to ISO 14001, the international EMS standard. Responses were also coded 1 (=Yes) or 0 (=No). To address concerns that facilities which adopt a self-designated EMS or a complete (but uncertified) EMS may be included in the "No" grouping, we eliminated these facilities from this comparison.

Control Variables. Regulated facilities often report that the stringency of the environmental regulatory system is a primary motivator for their proactive environmental activities (Darnall, 2009). Facilities were asked to describe the environmental policy regime to which they were subject. Respondents indicated whether the environmental policy regime was "not particularly stringent in that obligations can be met with relative ease," "moderately stringent in that it requires some managerial and technological responses," or "very stringent in that it has a great deal of influence on decision-making within the facility." Responses were coded 1, 2 and 3, respectively. "Moderately stringent" and "very stringent" were then combined to account for whether facilities reported the regulatory system was "stringent" or not.

To address the potential concern that this variable might be based on managerial perception rather than actual regulatory stringency, we compared the responses of facilities in more polluting industrial sectors to those operating in cleaner industrial sectors. Polluting industries are more heavily regulated and therefore subject to a more stringent environmental policy regime, whereas less polluting industries are not regulated to the same extent and subject to a less stringent environmental policy regime. Relying on existing taxonomies of US manufacturing sectors (Mani & Wheeler, 1997; Gallagher & Ackerman, 2000), "polluting" industries were classified as pulp and paper, chemical, petroleum refining, primary metal and basic metal industries. "Clean" sectors consisted of fabricated metal products, industrial machinery, electronics, transportation equipment, instrumentation, and textile sectors. We performed a chi-square test, comparing sector groupings with the reported stringency of their environmental policy regime. The results showed that dirty sectors reported that the stringency of their environmental policy regime was greater than facilities operating in clean sectors ($p<.0001$), therefore adding confidence to the accuracy of our measure.

The natural logarithm of the number of employees in a facility was used as a measure of facility size. Dummy variables were included to control for industry effects and country effects. The chemical sector was the omitted sector dummy and the U.S. was the omitted country dummy variable.

Measures for Environmental Adoption Equation

The relationship between EMS adoption and environmental performance is subject to selection bias in that firms will "self-select" into voluntary adoption of EMS because of observed or unobserved characteristics that are correlated with their environmental performance. To address this potential problem, we accounted for the factors that might affect facilities' decisions to adopt a facility adopted a self-designated, complete, or ISO 14001-certified EMS. We utilized the same form of these six environmental performance measures that was described earlier in our discussion related to *Measures for Environmental Performance Equation.*

Instrumental Variable. Some local governments encourage facilities to adopt EMS by financially supporting the adoption of EMSs (Arimura et al., 2008). If an EMS is adopted, governments often reduce the frequency of regulatory inspections. Hence, these initiatives are expected to have direct effects on the adoption of EMS. However, programs do not request improvement in environmental impacts. Following Arimura, Hibiki & Katayama (2008) we therefore assume that "assistance program by local government" does not directly affect environmental performance. In the OECD survey data, managers were asked whether the local regulatory authorities have programs and policies in place to encourage their facility to use an EMS. Responses were coded as binary (1=Yes, 0=No).

Independent variables. Parent company influences on facilities' environmental practices were accounted for by using OECD survey data that asked facility managers how important they considered the influence of corporate headquarters on the environmental practices of their facility (Darnall, 2006). Facility managers reported that these influences were “not applicable or not important,” “moderately important,” or “very important.” These influences were coded 1, 2, and 3, respectively.

In estimating the impact of regulatory stringency on EMS adoption, we relied on the same OECD variable discussed earlier, which asked environmental managers to describe the environmental policy regime to which they were subject. Responses were coded as binary (1=stringent, 0=not stringent,). To account for the pressure from environmental interest groups, the OECD asked facility managers how important they consider the influence of environmental groups on the environmental practices of their facility (Darnall, 2006). Responses were coded on three point scales (1=not important, 2=moderately important, and 3=very important).

Control Variables. Previous research suggests that adopting an EMS has the potential to enhance an organization’s environment-friendly image (Bansal & Hunter, 2003). Facilities operating in a competitive or global market are more likely to adopt EMSs in order to be recognized as being green or environment-friendly. Likewise, publicly traded or multinational organizations that are more sensitive to brand image are more likely to encourage their facilities to adopt EMSs. For these reasons, we included a set of dummies to account for market scope, market concentration, whether a facility’s parent company are publicly traded, and whether a firm’s head office is in a foreign country. Finally, additional facility heterogeneities were controlled using industry, country dummies, and facility size (logged number of employees).

Table 1 describes the distribution of all explanatory variables included in both EMS adoption and environmental performance equations.

Analytic Method

The relationship between EMS adoption and environmental performance was analyzed using bivariate probit estimation which belongs to the general class of simultaneous equation models as the Heckman selection model (Baum, 2006). While both Heckman selection and bivariate probit models can control for self selection, bivariate probit was chosen because facilities' decision to adopt an EMS is a binary endogenous variable and our measures for environmental performance were *not continuous*.

In a bivariate probit model, there are two probability equations (Maddala, 1983); a first reduced form equation for the potentially endogenous dummy (1) and a second structural form equation determining the outcome of interest (2),

$$Y_1^* = \beta_1 X_{1i} + u_1 \quad (1)$$

$$Y_2^* = \beta_2 X_{2i} + u_2 = \delta_1 Y_1 + \delta_2 Z_2 + u_2 \quad (2)$$

where Y_1, Y_2 are observed as 1 if their latent variables Y_1^*, Y_2^* are positive and zero otherwise. ($Y_1=0$ if $Y_1^* \leq 0$, $Y_1=1$ if $Y_1^* > 0$, $Y_2=0$ if $Y_2^* \leq 0$, $Y_2=1$ if $Y_2^* > 0$). In the equations, X1 and Z_2 are vectors of exogenous variables, $\beta_1$and δ_2 are parameter vectors, δ_1 is a scalar parameter, $\beta_2 = (\delta_1, \delta_2)$, and the error terms ($u_1$, u_2) are identically distributed as bivariate normal with zero mean, unit variance and correlation coefficient ρ.

As the random error terms (u_1, u_2) are assumed to be correlated, a correlation of equations' disturbance plays an important role in the bivariate probit model.

$$\rho = \mathrm{Cov}\,(u_1, u_2) \neq 0$$

That is, the covariance of (u_1, $u\varepsilon_2$) equals a constant rather than zero, as is assumed in the case of the individual probit models[2]. Therefore, if $\rho \neq 0$, the two probit equations can be jointly

[2] The statistical test for ρ=0 provides an indication of the interdependence of the two equations.

determined and coefficients will be estimated in a two-stage process in which the second equation is observed conditional on the outcome of the first. In this study, the correlation of the error terms may be likely in that unobserved factors that caused facilities to adopt EMSs are likely to influence their environmental performance.

To account for the selection bias associated with EMS adoption, we needed to add at least an exogenous instrument (X_1), which was correlated with the first equation (estimating EMS adoption) but is not correlated with second equation (estimating EMS performance). The variable we used was whether or not EMS adoption assistance programs were offered by local governments since it is not directly related to environmental performance (Arimura et al., 2008), as described earlier. This variable was not included in our second stage environmental performance equation. In the absence of controlling for endogeneity, a simple probit model examining the relationship between EMS adoption and environmental performance will yield estimates that potentially overestimate our relationships of interest (Monfardini & Radice, 2008).

We developed fifteen bivariate probit model specifications that estimated the relationship between our three types of EMSs and five different environmental performance variables. Model significance in bivariate probit estimation was determined by evaluating the Wald chi-square values for each of the models.

RESULTS

Environmental Performance Equations

Table 2 and Table 3 present estimated coefficients of the environmental performance equations. The Wald chi-square statistics were significant at $p<.01$ across all models. In examining the model coefficients, the results show that both complete and ISO-14001 certified EMS adoption were associated with increased environmental performance ($p<.01$). Facilities that adopted a self-identified EMS showed positive relationships with decreased environmental impacts in natural resource use, solid waste generation, air pollution, and global pollutants ($p<0.1$-1.0). These findings offer evidence in support of hypothesis 1, suggesting that facilities that have any type of EMS is more likely to decrease all five types of environmental impacts.

-INSERT TABLE 2 & 3 ABOUT HERE-

Our results also show that holding other variables constant, regulatory stringency was positively related with environmental performance ($p<.01$- .10), in 12 of our 15 models. These findings suggest that facilities which reported that their environmental policy regime is stringent are more likely to decrease their environmental impacts.

Facility size had no significant effect on reductions in environmental impacts across all models. Related to the country dummies, the results were very varied. In case of ISO-14001 certification, the U.S. facilities were more likely to reduce their environmental impacts on local air pollution than Japanese, Norwegian and French facilities ($p <.01$-.05), whereas the U.S. facilities were less likely to decrease their environmental impacts on natural resource use and global pollutants than German facilities ($p<.01$).

To further investigate the differential effect of EMS adoption on reductions in environmental impact, we examined the marginal effects of complete and ISO 14001-certified EMSs (Table 4). Marginal effects were estimated using bivariate probit post-estimation tools. In estimating the effects of ISO 14001-certified EMS on environmental performance, we observed varying effects (from 0.267-0.396) of ISO 14001 certification on five different types of environmental impacts. The adoption of ISO 14001 is associated with a 39.6% increased predicted probability of reducing global air pollutants compared to EMS non-adopters; and a 26.7% increased predicted probability of decreasing wastewater effluent. Similarly, facilities that adopted complete EMS increased the predicted probability of reducing their environmental impacts by 26.9% to 40.8%.

In comparing the marginal effects of certified and complete EMSs, the key finding is that ISO 14001 showed a relatively greater association with decreases in natural resource use, while a complete EMS showed a greater association with reductions in local air pollution than ISO 14001. In other words, facilities that adopted ISO 14001-certified EMSs were associated with a 5.3% (0.374 minus 0.321) greater reduction in natural resource use over facilities that adopted complete EMSs. However, a complete EMS was associated with an 8.2% (0.391 minus 0.309) greater reduction in local air pollutants. For other environmental impacts (wastewater effluent, solid waste generation, and global air pollutants), facilities that adopted complete and ISO 14001-certified EMS behaved similarly. As such, these results offer little evidence in support of hypothesis 2, which states that facilities with certified EMSs are more likely to improve their environmental performance rather than facilities with uncertified EMSs.

EMS Adoption Equations

Estimated coefficients of the adoption equations are presented in Table 5 for uncertified EMS and Table 6 for certified EMS. Across all models, assistance programs by local regulatory authorities appear to promote both certified and uncertified EMS adoption as indicated by the positive and significant coefficients ($p<.01$). These results illustrate that local government assistance programs satisfy a condition as a relevant instrument[3] in which an exogenous instrument should be strongly correlated with an endogenous variable. These results also suggest that there is an indirect effect of assistance programs on facilities' environmental performance

[3] As excluded instruments (Z) are used to consistently estimate an impact of an endogenous variable X^T on Y (in $Y= \beta_0 + \beta_T X^T + \beta c X^C + e$), they should satisfy two assumptions: (1) excluded instruments are uncorrelated with the error term (e), but strongly correlated with endogenous variable X^T. If there is more than one instrument for an endogenous variable, it can be statistically tested by over-identification test (Nichols, 2007).

and assistance programs are valid as an environmental policy tool.

-INSERT TABLE 5 & 6 ABOUT HERE-

The results further show that parent company pressures were highly associated with facilities' EMS adoption, indicating that facilities which reported their parent companies had a greater degree of influence on their environmental practices were more likely to adopt EMSs ($p<.01$). Related to regulatory stringency, the results were varied depending on the type of EMS that facilities adopted. Regulatory stringency had a very strong positive relationship with facilities' decision to complete EMSs ($p<.01$), whereas a stringent regulatory regime had a relatively weak ($p<0.5$-.10) or no relationship with facilities' decisions to certify ISO 14001 or to adopt self-identified EMSs. There was no statistical significance between environmental group pressures and facilities' decision to adopt all types of EMSs.

Related to our control variables, facility size was associated with facilities' EMS adoption and ISO 14001 certification ($p<.01$). Market scope at the global level was associated with the adoption of a complete EMS and ISO 14001-certification ($p<.01$), as was the presence of a parent company characteristics ($p<.01$), and whether or not the facility was part of a publicly traded firm ($p<.01$-.05, respectively).

Related to our country dummy variables, the U.S. facilities were more likely to adopt complete EMSs than facilities in France, German, Canada, Hungary, Japan, and Norway ($p<0.1$-1.0) and, Japanese facilities are more likely to certify ISO 14001 than the U.S. facilities ($p<0.1$).

DISCUSSION AND CONCLUSIONS

This study evaluates the effects of EMS adoption on environmental performance. It shows that multiple types of EMSs—self-designated, complete, and ISO 14001-certified—are associated with facilities' reductions in environmental impacts related to their natural resource uses, solid waste generation, wastewater effluent, local air pollution, and global air pollutants. The findings exist even after controlling for selection biases associated with EMS adoption decisions.

These findings are important because they offer a broader understanding of the potential EMSs in achieving societal objectives for a cleaner environment. They also extend previous studies that have evaluated the effects of EMSs (King et al., 2005; Potoski & Prakash, 2005a; 2005b) by assessing a range of environmental impacts and multiple types of EMSs (Arimura et al., 2008; Dahlstrom et al., 2003; King et al., 2005; Potoski & Prakash, 2005a; 2005b). Since our findings showed that all three EMSs are related to reductions in a variety of environmental impacts, this study offers support for the idea that EMSs may be important voluntary governance options.

However, our findings underscore the need for careful interpretation, since regulatory stringency was also directly associated with facilities' environmental performance. That is, in the absence of traditional regulatory pressures, it seems uncertain whether facilities will be motivated to adopt an EMS (of any sort). These findings have important implications to public policy. Environmental regulation is predicated on market failure theory. Under this view, price signals in prevailing markets do not capture the full cost that stems from the production of a good, but rather some of the production costs are imposed on society at large. Regulation is an attempt to reduce pollution in that it creates incentives by imposing costs on facilities that pollute. However, political forces consistently push to reduce the stringency of environmental regulations. This research offers reason to pause in response to these pressures since regulatory stringency is an important factor associated with facility-level actions to improve environmental performance.

These findings also support conventional arguments that market failures can be remedied through the use of coercive regulation. However, some coercive regulations impose more transaction costs on firms than others, and less costly regulations may be equally (or more) effective at delivering equivalent environmental value. For instance, reflexive regulatory systems create incentives and procedures that induce organizations to assess their actions (hence the reflexivity) and adjust them to achieve socially desirable goals, rather than relying on coercive rules and laws (Fiorino, 2006). Therefore, some reflexive policies and programs, like those that encourage EMS adoption, may achieve equivalent environmental outcomes and allow organizations to benefit financially from their green production activities. Future research should study this issue to a greater degree.

This research contributes to our understanding of different types of EMSs and relationship towards improved environmental performance. By comparing the marginal effects among a variety of EMSs—self-designated, complete, and certified—we found that externally accredited EMSs are not always related to greater environmental performance in all aspects of the environment. We conjectured that EMSs with external certification would be more likely to improve environmental performance because of their institutional structure. Our findings show facilities having ISO 14001 EMSs are more likely to reduce the impact of natural resource uses than facilities with complete EMSs by 5.3%. However, facilities that adopted complete EMSs are more likely to decrease impact in local or regional air pollution than facilities having ISO 14001 by 8.2%. Facilities that adopted complete and ISO 14001-certified EMS behaved similarly in regards to their reductions in wastewater effluent, solid waste generation, and global air pollutants. These mixed findings offer insufficient support our proposition that EMSs with greater external credibility are associated with greater reductions in environmental impacts. They suggest that facilities may not need to certify their EMSs to derive environmental performance benefits inasmuch as they implement a written environmental policy, environmental training program, internal audits, and environmental performance indicators/goals. Governments that have developed programs that encourage facilities to adopt non-certified EMSs may therefore have greater confidence in their approach in that these EMSs and certified EMSs are related to environmental improvements in a similar way.

Alternatively, our findings may suggest that the institutional structure of ISO 14001 is not strong enough to lead to superior environmental gains. For instance, third party auditors do not make available their audit results or specific information about an organization's environmental objectives, targets and goals public. Rather, it is the responsibility of the certified organization to make audit information publicly accessible, which rarely occurs. Moreover, facilities that certify to ISO 14001 also rarely lose their certification and lists of facilities that do are not published. These features diminish the institutional strength of the EMS standard and potentially are related to our weaker findings.

This research also contributes to public policy scholarship by offering evidence that EMS adoption is strongly related to local governments' EMS assistance programs. Such programs include government-funded grants and technical assistance (Darnall, 2003). For instance, in the U.S., the Environmental Protection Agency (EPA), in partnership with state-level environmental agencies, has encouraged facilities to adopt EMSs by offering EMS support grants and staff-sponsored technical assistance (USEPA, 2001). These programs may be particularly useful at encouraging EMS adoption in facilities that have limited complementary resources and capabilities, such as prior experiences with pollution prevention or quality management systems (Darnall, 2006).

Future research would benefit from studying our relationships of interest using secondary data. Such an examination most likely would need to take place for facilities within a single country since environmental ministries use different metrics and indicators to assess environmental performance, which makes a cross-country evaluation problematic.

In sum, this research offers evidence of the relationship between EMS adoption and environmental performance. It takes an important step by considering this issue across multiple countries as well as by assessing the extent to which EMSs are related to numerous types of environmental impacts. Our findings show that self-designated, complete and ISO 14001-certified EMS are all related to reductions in use of natural resources, solid waste, wastewater effluent, local air pollution, and global air pollutants, controlling for facilities decisions to adopt EMSs. However, there is limited evidence for the notion that ISO 14001-certified EMSs lead to superior environmental improvements over other types of EMSs.

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Table 1. Descriptive statistics for explanatory variables.

Variable	Mean	Standard	Min	Max
Complete EMS adoption	0.277	0.448	0	1
Self-identified EMS adoption	0.295	0.456	0	1
ISO 14001 certification	0.341	0.474	0	1
Assistance programs by local governments	0.211	0.408	0	1
Regulatory stringency	0.622	0.485	0	1
Parent company pressure	2.347	0.694	1	3
Environmental interest group pressure	1.714	0.700	1	3
Market scope	0.499	0.500	0	1
Market concentration	0.729	0.445	0	1
Number of employees (Log)	5.106	1.047	0.693	10.262
Publicly traded	0.167	0.373	0	1
Firm's head office is in a foreign country	0.120	0.325	0	1
Food, beverage, textiles (ISIC15-19)	0.151	0.358	0	1
Pulp, paper, publishing, print (ISIC 20-22)	0.105	0.306	0	1
Nonmetallic minerals, metals (ISIC27-33)	0.236	0.424	0	1
Machinery, transport equip. (ISIC 29-35)	0.310	0.463	0	1
Furniture recycling (ISIC 36-37)	0.032	0.176	0	1
U.S.	0.117	0.321	0	1
Germany	0.215	0.411	0	1
Hungary	0.111	0.315	0	1
Japan	0.358	0.479	0	1
Norway	0.074	0.262	0	1
France	0.064	0.245	0	1
Canada	0.061	0.240	0	1

Table 2. Assessing the Relationship between Complete and Self-identified EMSs† and Environmental Performance

	Complete EMS										Self-identified EMS									
Variables	**Decrease in use of natural resources**		**Decrease in wastewater**		**Decrease in solid waste generation**		**Decrease in local air pollution**		**Decrease in global pollutants**		**Decrease in use of natural resources**		**Decrease in wastewater**		**Decrease in solid waste generation**		**Decrease in local air pollution**		**Decrease in global pollutants**	
	Coef.	Std.err.	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.err.	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.e
EMS adoption	0.863***	0.228	0.710***	0.239	1.157***	0.210	1.052***	0.186	1.082***	0.222	0.946***	0.276	0.511	0.364	1.140***	0.236	1.047***	0.281	0.689*	0.412
Regulatory stringency	0.211***	0.074	0.354***	0.077	0.071	0.072	0.324***	0.086	0.114	0.094	0.257***	0.086	0.486***	0.091	0.088	0.081	0.379***	0.102	0.284**	0.117
Facility size	0.054	0.039	0.05	0.042	0.022	0.039	0.016	0.037	0.051	0.044	0.037	0.042	0.055	0.045	-0.005	0.040	0.057	0.046	0.058	0.054
Germany	0.481***	0.094	0.112	0.099	0.184	0.095	0.150	0.098	0.509***	0.110	0.674***	0.156	0.134	0.198	0.343**	0.158	0.510***	0.170	0.593***	0.208
Hungary	0.223*	0.126	-0.181	0.137	0.202	0.125	0.105	0.123	0.144	0.154	0.325*	0.183	-0.227	0.219	0.215	0.178	0.397**	0.192	0.003	0.242
Japan	0.431***	0.104	0.009	0.113	0.468***	0.103	0.158	0.106	0.486***	0.114	0.132	0.145	-0.149	0.169	0.026	0.145	0.144	0.157	0.005	0.185
Norway	0.351***	0.123	0.154	0.128	0.638***	0.122	-0.132	0.135	0.169	0.157	0.361*	0.181	0.276	0.214	0.576***	0.171	0.267	0.209	0.105	0.262
France	0.307**	0.129	0.196	0.131	-0.040	0.127	-0.179	0.138	0.166	0.160	0.188	0.151	-0.092	0.163	-0.320**	0.154	-0.243	0.176	-0.169	0.207
Canada	0.092	0.128	0.212	0.135	0.302**	0.127	-0.051	0.133	0.185	0.143	-0.042	0.150	0.07	0.161	-0.006	0.145	-0.244	0.159	-0.144	0.179
ISIC 15-19	0.155	0.109	0.232**	0.112	0.004	0.109	0.175	0.111	0.026	0.131	0.235*	0.122	0.169	0.133	0.148	0.119	0.081	0.134	-0.136	0.161
ISIC 20-22	0.14	0.113	0.237**	0.118	0.105	0.112	0.174	0.117	0.113	0.131	0.181	0.129	0.119	0.138	0.135	0.126	0.096	0.142	-0.046	0.167
ISIC 27-33	0.013	0.090	0.237**	0.093	-0.029	0.089	0.131	0.092	0.030	0.106	0.071	0.110	0.186	0.118	0.049	0.108	0.144	0.117	-0.033	0.139
ISIC 29-35	-0.034	0.083	-0.013	0.087	-0.094	0.082	-0.116	0.089	0.036	0.098	-0.115	0.106	-0.193*	0.114	-0.16	0.103	-0.202*	0.118	-0.095	0.140
ISIC 36-37	0.146	0.166	-0.03	0.180	0.159	0.163	0.538***	0.171	0.456**	0.205	0.108	0.198	-0.42	0.230	0.063	0.190	0.479**	0.218	0.281	0.264
Constant	-0.997***	0.173	-1.098***	0.181	-0.643***	0.172	-1.038***	0.184	-1.548***	0.213	-1.089***	0.231	-1.052***	0.263	-0.577**	0.228	-1.412***	0.249	-1.428***	0.296
Observations	2314		2149		2328		1900		1545		1515		1393		1527		1191		956	
Wald Chi2 (34)	637.8***		647.97***		730.38***		727.59***		560.22***		452.84***		414.37***		506.82***		447.44***		258.20***	
Rho	-0.257		-0.213		-0.389		-0.511		-0.446		-0.422		-0.175		-0.559		-0.561		-0.259	
Wald test of rho=0 Chi2(1)	2.765***		1.192		6.055**		12.738***		7.222***		4.652**		0.593		9.233***		6.841***		0.946	

† Complete EMS denotes that facility has implemented four practices that have been recognized as important components of different types of EMSs: written environmental policy, environmental training program in place for employees, internal environmental audits (Netherwood, 1998), and environmental performance indicators/goals (Coglianese & Nash, 2001). Self-identified EMS indicates that facility indicates that it has adopted an EMS that may or may not include all four components of a comprehensive EMS.

†† Industry dummies are Food, beverages, textiles (ISIC 15-19), Pulp, paper, print (ISIC 20-22), Nonmetallic minerals, metals (ISIC 27-33), Machinery, transport equipment (ISIC 29-35), Machinery, transport equipment (ISIC 29-35), and Furniture recycling (ISIC 36-37).

*Statistically significant at p<.10; ** statistically significant at p<.05; *** statistically significant at p<.01

Table 3. Assessing the Relationship between ISO 14001 Certified EMS and Environmental Performance. +

	ISO 14001 Certified EMS									
Variables	**Decrease in use of natural resources**		**Decrease in wastewater**		**Decrease in solid waste generation**		**Decrease in local air pollution**		**Decrease in global pollutants**	
	Coefficient	Std.err.	Coefficient	Std.err.	Coefficient	Std.err.	Coefficient	Std.err.	Coefficient.	Std.err.
EMS adoption	1.025***	0.210	0.716***	0.218	1.074***	0.206	0.844***	0.194	1.145***	0.203
Regulatory stringency	0.252***	0.078	0.369***	0.081	0.146*	0.077	0.460***	0.092	0.278**	0.101
Facility size	-0.005	0.047	0.026	0.049	-0.007	0.047	-0.007	0.046	0.004	0.053
Germany	0.348***	0.127	-0.004	0.130	0.136	0.128	-0.026	0.131	0.753***	0.156
Hungary	-0.031	0.145	-0.388**	0.150	-0.041	0.145	-0.192	0.144	0.314	0.182
Japan	0.008	0.135	-0.334**	0.135	0.161	0.136	-0.279**	0.134	0.413*	0.163
Norway	0.146	0.153	-0.118	0.156	0.515***	0.156	-0.393**	0.161	0.247	0.194
France	-0.037	0.171	-0.055	0.169	-0.266	0.167	-0.579***	0.183	0.251	0.210
Canada	-0.072	0.168	-0.070	0.180	0.230	0.172	-0.114	0.180	0.621**	0.201
ISIC 15-19	0.230*	0.137	0.286*	0.137	0.101	0.137	0.224	0.141	0.056	0.162
ISIC 20-22	0.170	0.134	0.313*	0.139	0.081	0.135	0.031	0.143	0.010	0.157
ISIC 27-33	0.040	0.106	0.197*	0.108	-0.027	0.106	0.057	0.111	-0.068	0.125
ISIC 29-35	-0.081	0.097	-0.041	0.101	-0.137	0.098	-0.140	0.105	0.016	0.117
ISIC 36-37	0.137	0.205	0.101	0.217	-0.014	0.203	0.434**	0.218	0.440	0.267
Constant	-0.581**	0.232	-0.809***	0.239	-0.388*	0.233	-0.691***	0.244	-1.591***	0.295
Observations	1706		1577		1707		1370		1110	
Wald Chi2 (34)	618.09***		588.77***		643.40***		576.62***		556.25**	
Rho	-0.244		-0.261		-0.253		-0.430		-0.499	
Wald test of rho=0 Chi2(1)	3.046*		3.392*		3.278*		9.904***		9.066***	

+ Industry dummies are Food, beverages, textiles (ISIC 15-19), Pulp, paper, print (ISIC 20-22), Nonmetallic minerals, metals (ISIC 27-33), Machinery, transport equipment (ISIC 29-35), Machinery, transport equipment (ISIC 29-35), and Furniture recycling (ISIC 36-37).

*Statistically significant at p<.10; ** statistically significant at p<.05; *** statistically significant at p<.01

Table 4. Estimated Marginal Effects of Complete and ISO 14001-Certified EMSs†

Dependent variable	ISO Certified EMS		Complete EMS		Differences in Marginal Effects (a) – (b)
	Coefficient (a)	*Standard error*	*Coefficient (b)*	*Standard error*	
Natural resource use	0.374***	0.022	0.321***	0.014	0.053
Wastewater effluent	0.267***	0.016	0.269***	0.010	-0.002
Solid waste generation	0.385***	0.025	0.408***	0.028	-0.023
Local air pollution	0.309***	0.023	0.391***	0.013	-0.082
Global air pollutants	0.396***	0.033	0.388***	0.023	0.008

† For each coefficient in (a) and (b), observations are different. Marginal effect is defined as average changes in probability of environmental performance=1 given a change from EMS adoption=0 to EMS adoption=1.

* Statistically significant at p<.10; ** statistically significant at p<.05; *** statistically significant at p<.01

Table 5. Predicting Facilities' Complete and Self-identified EMS Adoption

Variables	Complete EMS										Self-identified EMS									
	Decrease in use of natural resources		Decrease in wastewater		Decrease in solid waste generation		Decrease in local air pollution		Decrease in global pollutants		Decrease in use of natural resources		Decrease in wastewater		Decrease in solid waste generation		Decrease in local air pollution		Decrease in global pollutants	
	Coef.	Std.err	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.err	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er	Coef.	Std.er
Local government	0.264**	0.068	0.290**	0.070	0.284**	0.067	0.262**	0.070	0.200**	0.079	0.399**	0.089	0.427**	0.093	0.434**	0.085	0.390**	0.100	0.342**	0.112
Parent Company	0.340**	0.048	0.329**	0.051	0.322**	0.047	0.361**	0.050	0.368**	0.056	0.317**	0.057	0.327**	0.062	0.302**	0.055	0.331**	0.063	0.352**	0.072
Regulatory stringency	0.292**	0.074	0.248**	0.078	0.291**	0.073	0.301**	0.083	0.359**	0.090	0.165*	0.090	0.09	0.095	0.173*	0.089	0.101	0.102	0.107	0.113
Env. Group Pressure	0.008	0.044	0.001	0.047	0.007	0.043	-0.008	0.046	0.043	0.054	0.019	0.055	-0.008	0.059	0.04	0.053	-0.004	0.061	-0.008	0.072
Market scope	0.127**	0.032	0.122**	0.033	0.118**	0.031	0.121**	0.033	0.133**	0.038	0.081**	0.038	0.071*	0.042	0.058	0.037	0.078*	0.043	0.085*	0.049
Market concentration	0.020	0.038	0.011	0.039	0.008	0.037	0.012	0.039	0.024	0.045	0.010	0.046	-0.002	0.050	-0.003	0.044	0.019	0.050	0.014	0.059
Publicly traded	0.256**	0.076	0.222**	0.077	0.252**	0.074	0.165**	0.079	0.128	0.086	0.065	0.105	0.047	0.111	0.068	0.100	0.033	0.112	0.061	0.128
Foreign head office	0.288**	0.083	0.250**	0.086	0.253**	0.083	0.353**	0.087	0.358**	0.101	0.156	0.108	0.191*	0.114	0.126	0.105	0.193*	0.116	0.206	0.138
Facility size	0.271**	0.030	0.300**	0.031	0.280**	0.030	0.235**	0.032	0.258**	0.035	0.174**	0.039	0.175**	0.041	0.182**	0.039	0.172**	0.043	0.167**	0.047
France	-	0.131	-	0.133	-	0.129	-	0.141	-	0.159	-0.074	0.160	-0.154	0.165	-0.086	0.157	-0.057	0.179	-0.133	0.195
Canada	-	0.130	-	0.139	-	0.129	-	0.136	-	0.149	-0.309*	0.153	-0.245	0.165	-0.219	0.153	-0.11	0.169	-0.072	0.182
Germany	-	0.097	-	0.100	-	0.097	-	0.105	-	0.118	-	0.129	-	0.134	-	0.128	-	0.142	-	0.157
Hungary	-	0.123	-	0.127	-	0.122	-	0.124	-	0.150	-	0.162	-	0.166	-	0.157	-	0.169	-	0.193
Japan	-	0.105	-	0.109	-	0.105	-	0.108	-	0.117	-0.204	0.147	-0.279*	0.152	-0.22	0.146	-0.216	0.156	-0.166	0.167
Norway	-0.235	0.133	-0.254*	0.138	-0.250*	0.131	-	0.143	-	0.161	-	0.172	-	0.182	-	0.170	-	0.192	-	0.214
ISIC 15-19	-	0.107	-	0.110	-	0.107	-	0.116	-	0.130	-	0.129	-	0.134	-	0.128	-	0.143	-0.25	0.157
ISIC 20-22	-	0.117	-	0.123	-	0.116	-	0.123	-0.220	0.138	-0.158	0.143	-0.096	0.151	-0.188	0.142	-0.106	0.156	0.104	0.174
ISIC 27-33	-	0.089	-	0.093	-	0.089	-	0.095	-	0.107	-	0.115	-	0.120	-	0.114	-	0.125	-0.146	0.138
ISIC 29-35	-	0.086	-	0.091	-0.168	0.086	-	0.093	-0.128	0.105	-0.089	0.113	-0.024	0.119	-0.061	0.112	0.058	0.126	0.189	0.141
ISIC 36-37	-	0.178	-0.275	0.190	-0.385*	0.175	-0.344*	0.187	-0.158	0.218	-0.105	0.222	0.066	0.244	-0.058	0.212	-0.008	0.241	0.231	0.278
Constant	-	0.244	-	0.256	-	0.241	-	0.259	-	0.285	-	0.322	-	0.342	-	0.317	-	0.353	-	0.396
Observations	2314		2149		2328		1900		1545		1515		1393		1527		1191		956	
Wald Chi2 (34)	637.8**		647.97*		730.38*		727.59*		560.22*		452.84*		414.37*		506.82*		447.44*		258.20*	
Rho	-0.257		-0.213		-0.389		-0.511		-0.446		-0.422		-0.175		-0.559		-0.561		-0.259	
Wald test of rho=0	2.765**		1.192		6.055**		12.738*		7.222**		4.652**		0.593		9.233**		6.841**		0.946	

* Statistically significant at p<.10; ** statistically significant at p<.05; *** statistically significant at p<.01

+ Industry dummies are Food, beverages, textiles (ISIC 15-19), Pulp, paper, print (ISIC 20-22), Nonmetallic minerals, metals (ISIC 27-33), Machinery, transport equipment (ISIC 29-35), Machinery, transport equipment (ISIC 29-35), and Furniture recycling (ISIC 36-37).

Table 6. Predicting Facilities' ISO 14001 Adoption

Variables	ISO 14001 Certified EMS									
	Decrease in use of natural resources		**Decrease in wastewater**		**Decrease in solid waste generation**		**Decrease in local air pollution**		**Decrease in global pollutants**	
	Coefficient	Std.err.	Coefficien	Std.err.	Coefficient	Std.err.	Coefficien	Std.err	Coefficient	Std.err.
Local government program	0.416***	0.087	0.407***	0.090	0.381***	0.087	0.416***	0.092	0.418***	0.102
Regulatory stringency	0.179**	0.087	0.112	0.091	0.158	0.086	0.142	0.099	0.195	0.108
Parent company pressure	0.477***	0.058	0.483***	0.061	0.460***	0.058	0.539***	0.063	0.551***	0.068
Environmental interest group pressure	-0.043	0.055	-0.023	0.057	-0.023	0.055	-0.035	0.059	-0.008	0.069
Market scope	0.140***	0.040	0.127***	0.042	0.129***	0.040	0.115***	0.043	0.118*	0.050
Market concentration	0.049	0.046	0.056	0.048	0.036	0.046	0.069	0.050	0.077	0.056
Publicly traded	0.315***	0.099	0.296***	0.100	0.295***	0.098	0.252**	0.104	0.205	0.114
Foreign head office	0.345***	0.102	0.289***	0.105	0.311***	0.102	0.370***	0.109	0.446***	0.127
Number of employees (Log)	0.415***	0.038	0.426***	0.040	0.423***	0.038	0.378***	0.041	0.395***	0.046
France	0.342*	0.194	0.382**	0.193	0.338*	0.190	0.445**	0.204	0.307	0.228
Canada	-0.080	0.190	0.023	0.201	-0.044	0.190	0.069	0.202	0.088	0.220
Germany	-0.064	0.143	-0.095	0.146	-0.105	0.143	-0.120	0.150	-0.074	0.168
Hungary	0.151	0.167	0.025	0.170	0.081	0.165	0.070	0.168	0.035	0.199
Japan	1.226***	0.158	1.166***	0.160	1.149***	0.157	1.198***	0.161	1.276***	0.177
Norway	0.504***	0.176	0.510***	0.181	0.455***	0.174	0.465**	0.186	0.600**	0.205
Food, beverage, textiles (ISIC 15-19)	-0.994***	0.134	-0.964***	0.138	-1.010***	0.135	-0.948***	0.145	-0.961***	0.165
Pulp, paper, publishing, print (ISIC 20-	-0.451***	0.144	-0.414***	0.150	-0.429***	0.143	-0.310**	0.154	-0.120	0.168
Nonmetallic minerals, metals (ISIC,	-0.472***	0.108	-0.442***	0.113	-0.437***	0.108	-0.393***	0.117	-0.348**	0.130
Machinery, transport equip. (ISIC 29-	-0.157	0.105	-0.109	0.111	-0.150	0.105	-0.054	0.116	0.043	0.131
Furniture recycling (ISIC 36-37)	-0.285	0.220	-0.124	0.230	-0.284	0.216	-0.153	0.234	-0.284	0.282
Constant	-4.409***	0.322	-4.438***	0.332	-4.326***	0.319	-4.327***	0.347	-4.639***	0.380
Observations	1706		1577		1707		1370		1110	
Wald Chi2 (34)	618.09***		588.77***		643.40***		576.62***		556.25**	
Rho	-0.244		-0.261		-0.253		-0.430		-0.499	
Wald test of rho=0 Chi2(1)	3.046*		3.392*		3.278*		9.904***		9.066***	

*Statistically significant at p<.10; ** statistically significant at p<.05; *** statistically significant at p<.01