# Can Encouraging Voluntary Development of Environmental Management Systems Augment Existing Regulations?*

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Prepared by:

**Toshihiro Uchida and Paul J. Ferraro**

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* Toshihiro Uchida is affiliated with the University of the West Indies, Mona and Paul Ferraro is affiliated with Georgia State University. The authors thank Ron Cummings and Laura Taylor for comments on previous versions of this paper, and the Nikkei Newspaper for permission to use data from its survey of Japanese manufacturers. Uchida thanks Resources for the Future for financial support. The authors gratefully acknowledge financial support for this work received from Georgia Soil and Water Conservation Commission, Contract No. 480-05-GSU1001; and the U.S. Department of Agriculture, Award Document No. 2003-38869-02007-1.

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## Abstract

Encouraging firms to voluntarily develop environmental management systems (EMSs) has been described as a potential policy tool for achieving environmental objectives in Georgia. We survey current thinking on the subject and note several shortcomings in current methods used to evaluate what motivates private firms to adopt comprehensive EMSs. Using a unique dataset of environmental management practices of Japanese manufacturers, we find that consumer pressures, regulatory pressures, and market power are major factors that motivate firms to develop comprehensive EMSs. We also find that after controlling for self-selection bias in survey response, the effects of regulatory pressures become more significant and larger in magnitude. These results suggest that although encouraging development of EMSs has the potential to augment existing regulations, the regulatory tools are fundamental to the success of such voluntary approaches.

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## 1. INTRODUCTION

Voluntary approaches to environmental protection are sometimes called the "next generation of environmental policies" (Esty and Chertow 1997). In contrast to traditional mandatory policies such as direct regulations, these approaches rely on voluntary actions of firms to improve their environmental performances. Examples include unilateral commitments by firms, public programs in which the government encourages firms to voluntarily achieve specified goals, and information disclosure strategies such as environmental labeling. The establishment of an environmental management system is one form of voluntary approaches. An environmental management system (EMS) is a principal means available to firms by which environmental concerns can be integrated into corporate decision-making. It involves organizational changes in management systems, such as introducing environmental staff and directors, setting environmental objectives, and establishing monitoring and audit systems.

Actively encouraging firms to voluntarily develop EMSs through offers of technical assistance, public recognition, and other benefits has recently been described as a potential policy tool for achieving environmental objectives in Georgia. For example, Georgia's Department of Natural Resources' Pollution Prevention Assistance Division ($P^2AD$) wishes to encourage private firms in Georgia to adopt EMSs, which are assumed to lead to reduced pollution emissions to surface water, groundwater and air. Georgia is not alone in attempting to encourage firms to voluntarily improve their environmental performance through the adoption of EMSs: such initiatives are common throughout OECD nations (OECD 2003; Rondinelli 2001; U.S. EPA 2004; Khanna 2001; Alberini and Segerson 2002).

Before promoting and relying on firms' voluntary development of EMSs, however, the potential of EMSs must be critically evaluated. Despite growing popularity of EMSs among firms, there are significant variations across firms in the comprehensiveness of their EMSs. Without accurate information on the factors that motivate firms to develop EMSs on their own, regulators will be unlikely to design and target incentives in a way

that leads to a net increase in the use of EMSs.

Although there are increasing numbers of informal analyses and anecdotal evidence of the factors that motivate firms to develop EMSs, formal econometric analyses are still relatively scant (Lyon and Maxwell 2004). Past studies include Henriques and Sadorsky (1996), who investigated the factors that motivate Canadian firms to adopt a single environmental plan. The adoption decision of ISO 14001 was investigated by Dasgupta et al. (2000) for Mexican firms, and by Nakamura et al. (2001) and Welch et al. (2002) for Japanese firms. Khanna and Anton (2002) and Anton et al. (2004) investigated the factors that motivate U.S. firms to adopt various environmental management practices. These studies tend to agree on the importance of pressures from shareholders and governments, but there is mixed evidence on the effects of consumers, industry structure, and financial status of firms (Lyon and Maxwell 2004).

Our study adds new empirical evidence on the factors that motivate firms to develop EMSs and extends previous research in two important ways. First, we examine the factors that determine the *comprehensiveness* of a firm's EMS, rather than the adoption of a single environmental practice. With the exception of Khanna and Anton (2002), studies of EMSs have focused on a single aspect of environmental management practices or systems.[1] Successful environmental improvement, however, requires a systematic and integrated effort of planning, implementation, and monitoring (Denton 1994). Thus, it is informative to investigate the determinants of variations in the comprehensiveness of EMSs rather than the adoption decision of a single environmental practice. We draw on a unique dataset from a survey that examined environmental management practices of Japanese manufacturing firms and analyze the determinants of comprehensiveness of EMSs.

Second, our study is the first that controls for self-selection in econometric estimation. The existing studies (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Nakamura et al. 2001; Welch et al. 2002; Khanna and Anton 2002; Anton et al. 2004) used firm-level survey data on environmental practices, but none of them controlled for self-selection in survey responses. Firms with poorly developed EMSs may be less

[1] Dasgupta et al. (2000) analyzed the determinants of each of the four different environmental practices separately and did not study the determinants jointly. Anton et al. (2004) used the same dataset as Khanna and Anton (2002).

likely to respond to the survey because responding to the survey may reveal their poor performances and may lead to bad publicity. Estimation procedures that ignore this self-selection may result in biased estimates. Although self-selection by non-response is always an issue in surveys, it is typically difficult to control for it because of the absence of requisite data. We take advantage of the characteristics of our dataset and econometrically control for non-response bias.

In addition to the above contributions, our regression analysis tests influences of parent companies, which were not previously studied but nonetheless we believe are important in explaining firms' motivations to develop EMSs.

After the regression analysis, we examine how comprehensiveness of firms' EMSs changes when firm characteristics are changed. Such information is critical in evaluating the potential of future incentive programs that encourage firms to develop more comprehensive EMSs. If incentive programs are going to be effective, they must be able to create sufficiently large changes in firms' comprehensiveness of EMSs with appropriate incentives. Furthermore, such information makes it possible to compare and analyze the effectiveness of various forms of incentives in inducing firms to develop more comprehensive EMSs.

The rest of the paper is organized as follows. Section 2 presents the hypotheses on the factors that determine the comprehensiveness of a firm's EMS and defines the variables that are used to test the hypotheses. Section 3 describes the data and empirical methods. Section 4 presents the results and discusses policy implications. Section 5 concludes the paper.

## 2. HYPOTHESES AND MEASURES

### 2.1. Hypotheses

The past theoretical studies on voluntary over compliance assume that firms' voluntary actions are based on their profit-maximizing behaviors (Arora and Gangopadhyay 1995; Segerson and Miceli 1998; Maxwell et al. 2000; Lutz et al. 2000). Under this assumption, profit-maximizing firms develop EMSs as long as expected benefits exceed expected costs. Expected benefits may include reduced risk of liabilities, competitive advantages in green markets, increased efficiency in input use, and improved investor relations. Expected costs may include training of personnel, investment in new

machines and technologies, and hiring consulting assistance (U.S. EPA and NSF International 2000).

We hypothesize that the following five factors affect expected benefits and costs, and therefore explain why firms develop EMSs: stakeholder pressures, regulatory pressures, ability, parent company's influence, and market conditions. We explain the rationale for these factors below and then, in Section 2.2, we describe how we will measure these factors.

(1) Stakeholder pressures

Stakeholder pressures include pressures from consumers and shareholders. Numerous surveys have shown that consumers make decisions with an awareness of their environmental impacts. Arora and Gangopadhyay (1995) argued that consumers can create pressures on firms to be environmentally-friendly because such firms can command a price premium in the product market by differentiating themselves from other firms. Empirically, consumer pressures were found to be important in motivating the adoption of an environmental plan in Canada (Henriques and Sadorsky 1996) and environmental practices in the U.S. (Khanna and Anton 2002; Anton et al. 2004), but were found to explain only some aspects of ISO 14001 adoption among Japanese firms (Nakamura et al. 2001). In this study, we hypothesize that firms in closer contact with consumers develop more comprehensive EMSs.

Shareholders can also create pressures. The efficient market hypothesis predicts that a firm's current stock price reflects investors' beliefs about the firm's future profitability. If investors believe that the absence of a well-developed EMS implies lower future profits for a firm, they will bid down the stock price, which would put pressures on the firm to develop an EMS (Hamilton 1995). The absence of a well-developed EMS may imply lower future profits because investors may believe it reflects, among other things, potential liabilities and inefficiency in input use. Individual investors may also have preferences for environmentally-friendly firms. Such preferences are behind the increasing popularity of socially responsible investment funds, including Japan's "eco-fund" (Tsukushi 2000). Moreover, foreign shareholders, especially those in Europe and North America, may have stronger preferences for environmentally-friendly firms or may be more likely than the average

Japanese investor to avoid potential environmental risks associated with the absence of a well-developed EMS. We hypothesize that firms that receive stronger domestic and foreign shareholder pressures develop more comprehensive EMSs. Empirically, both Khanna and Anton (2002) and Henriques and Sadorsky (1996) found that shareholders are important in motivating firms to take proactive actions, but neither study explicitly separated domestic shareholders and foreign shareholders.

(2) Regulatory pressures

Past studies found regulatory pressures to be an important driver for voluntary adoption of environmental practices. Perceived regulatory pressures were found to motivate firms to adopt ISO 14001 (Nakamura et al. 2001) and an environmental plan (Henriques and Sadorsky 1996). Existing and anticipated regulatory pressures were also found to be important (Khanna and Anton 2002). Firms under stronger regulatory pressures are likely to have higher compliance costs and a greater potential for government sanctions. Therefore, these firms may develop EMSs to reduce current and anticipated costs associated with regulatory pressures. Alternatively, firms may develop EMSs for strategic reasons. Several theoretical studies have postulated that firms employ unilateral initiatives to preempt future regulatory threats (Segerson and Miceli 1998; Maxwell et al. 2000) or to weaken forthcoming new regulations (Lutz et al. 2000).

Firms may also receive pressures from foreign governments. For example, firms that export may need to satisfy more stringent environmental requirements by foreign governments and are thus likely to develop higher quality EMSs. There is anecdotal evidence that Japanese firms take environmental actions to penetrate EU and North American markets (for example, see Roht-Arriaza 1997). Regardless of the source of regulatory pressure, we hypothesize that firms under stronger regulatory pressures develop more comprehensive EMSs.

(3) Ability

Ability measures the ease with which firms can make organizational changes to develop EMSs. Ability includes technical ability and financial ability. Technical ability is likely to be important because, unlike traditional regulations that typically impose specific technologies, EMSs provide firms with the flexibility to develop their own management practices that internalize environmental concerns (Coglianese and Nash 2001). Firms

with a higher stock of technical knowledge may thus have a higher ability to develop innovative management practices. Empirically, Khanna and Anton (2002) found that R&D expenditures are important factors in firm adoption of environmental practices in the United States.

Financial ability is important because establishing an EMS imposes substantial costs on firms. For example, implementation of ISO 14001 takes approximately six months to two years, depending on the existing internal environmental practices of the firm (ISO Information Center 1996). Substantial start-up costs are also required for consulting, training of personnel, and capital investment. Therefore, financially healthier firms are more likely to have the ability to develop EMSs. Empirical evidence of the impact of financial health is mixed. While Henriques and Sadorsky (1996) found no evidence, Nakamura et al. (2001) found that a higher debt ratio has a significantly negative impact on ISO 14001 adoption.

Based on these arguments, we hypothesize that firms with higher technical and financial abilities develop more comprehensive EMSs.

(4) Parent company's influence

A firm's management and operations can be influenced by a parent company that owns a substantial amount of the firm's voting stock. The decision to develop an EMS is thus also likely to be influenced by the parent company. The parent company may believe that its reputation is affected by the environmental performances of its subsidiaries. Furthermore, the subsidiary firms may find it easier to develop EMSs because they may be able to use the experience and technical knowledge of the parent company. Thus, we hypothesize that if a firm has a parent company that has a highly developed EMS, the subsidiary firm will also have a highly developed EMS. No previous studies have empirically tested this hypothesis.

(5) Market conditions

Spence (1984) argued that product development is often a cost-reducing innovation that provides more services to the customers with the same price or lower price. According to this view, an EMS can be thought of as an innovation that delivers more environmental services. There is a huge debate on how market conditions affect

innovation in the research and development literature. The debate dates back to Schumpeter (1942), who argued that monopolistic market conditions (greater market power and concentrated market structure) favor innovation. According to his claim, monopolistic conditions generate internal financial resources necessary to cover investment expenditures on innovation. Thus, we hypothesize that firms with greater market power develop more comprehensive EMSs. Schumpeter also argued that a more concentrated market structure reduces uncertainty associated with rival behavior and favors innovation (Schumpeter 1942; Cohen and Levin 1989). Despite the large amount of empirical studies on the effect of market concentration on innovation, the results of these studies are not robust (Cohen and Levin 1989). In this paper, the impact of concentration of market on EMSs is left as an empirical issue.

### 2.2. Measures and definitions

The following variables are used to represent the factors that are hypothesized to affect the development of EMSs: advertising expenditures, capital intensity, foreign ownership, pollution intensity, export ratio, current debt ratio, age of assets, R&D expenditures, parent company's quality of EMSs, market share, and the Herfindahl-Hirschman index. The list of variables and their definitions are summarized in table 1.

**Table 1: List of Variables and Definitions**

| Variable | Definition |
|---|---|
| Advertising expenditures (billion yen) | Annual expenditures on advertisement |
| Capital intensity | Fixed assets divided by number of employee |
| Foreign ownership (%) | Percentage of shares owned by foreign investors |
| Heavily-polluting industries | = 1 if firms are in the industries with large average emission of chemicals per firm; = 0 otherwise |
| Intermediate-polluting industries | = 1 if firms are in the industries with intermediate average emission of chemicals per firm; = 0 otherwise |
| Low-polluting industries | = 1 if firms are in the industries with small average emission of chemicals per firm; = 0 otherwise |
| Export ratio (%) | Ratio of export sales to the total sales |
| Current debt ratio | Current liabilities divided by total assets |
| Age of assets | Total assets divided by gross assets |

| | |
|---|---|
| R&D expenditures (billion yen) | Annual expenditures on research and development |
| Top 10 | = 1 if a firm has a parent company whose quality of EMS is in top 10; = 0 otherwise |
| Top 11-25 | =1 if a firm has a parent company whose quality of EMS is in top 11-25; = 0 otherwise |
| Market share (%) | Firm's sales divided by total industry sales |
| Herfindahl-Hirschman index | Sum of squared market share of firms in the industry |

Stakeholder pressures are represented by advertising expenditures, capital intensity, and foreign ownership. Although firms may differ in their motivations for setting advertising expenditure levels, firms are likely to be well known among consumers if they have large advertising expenditures. Thus, advertising expenditures can be considered as a measure of proximity to consumers. Firms with greater advertising expenditures are likely to have stronger contact with consumers and therefore these firms may receive stronger consumer pressures to develop comprehensive EMSs.[2] Similar to Khanna and Anton (2002) and Anton et al. (2004), we use capital intensity as a measure of pressures from general investors. Capital intensity is defined as the value of fixed assets per employee. Firms with higher capital intensity are more likely to rely on capital markets and hence receive stronger pressures from investors to develop EMSs (Khanna and Anton 2002). Pressures from foreign shareholders are measured by foreign ownership, where foreign ownership is defined as the percentage of stocks held by foreign owners. Firms with higher foreign ownership may receive stronger pressures from foreign investors.

Regulatory pressures are represented by industry pollution intensity and firm-level export ratios. Industry pollution intensity is represented by three dummy variables: high-polluting industries, intermediate-polluting industries, and low-polluting industries. These dummy variables are constructed based on the average total emissions per firm in each industry reported in Japan's Pollutant Release and Transfer Register (PRTR).[3] Henriques and Sadorsky (1996) used industry dummy variables to control for

[2] Among past studies, Nakamura et al. (2001) used advertising expenditures per sales as a measure of consumer goodwill. Khanna and Anton (2002) used a dummy variable indicating whether firms are mainly producing final goods or intermediate goods. Since many Japanese firms diversify their product mix and produce both final and intermediate goods, using such a dummy variable in our analysis is not enlightening.

[3] Like the Toxics Release Inventory of the United States, Japan's PRTR is an inventory of emissions of a total of 354 potentially hazardous chemicals. We believe the average total emissions of the

differences in industry–wide regulatory environments. Firms operating in high-polluting industries are likely to have higher compliance costs and greater potential for government sanctions. Therefore, firms in higher-polluting industries are more likely to develop EMSs in order to reduce current and future costs associated with government regulations. As explained in the previous section, firms may also receive pressures from foreign governments. We measure exposure to foreign government pressures by the export ratio, which is defined as the ratio of export sales to total sales.[4] Firms with higher export ratios may receive stronger pressures from foreign governments.[5]

Ability is represented by current debt ratio, age of assets, and R&D expenditures. Current debt ratio is defined as current liabilities divided by total assets. It measures short-term financial flexibility. Firms with higher current debt ratios may have less financial flexibility to make investments in EMSs. Financial ability is also affected by the costs of investment. Firms with lower costs of investment are likely to have a higher ability to develop EMSs. For example, firms with older equipment may find it less costly to replace old equipment when making a start-up investment in new equipment (Khanna and Anton 2002). As in Khanna and Anton (2002), the costs of investment are represented by age of assets. Age of assets is defined as total assets divided by gross assets, where gross assets are defined as total assets plus accumulated depreciation on tangible fixed assets. A higher value indicates newer equipment. Technical ability is measured by R&D expenditures. Firms with higher R&D expenditures are likely to have a higher stock of technical knowledge.

The influence of a parent company on EMS comprehensiveness is represented by dummy variables "Top 10" and "Top 11-25." These variables indicate that the parent company is ranked among the top 10 or top 11-25 firms in terms of EMS comprehensiveness (see section 3.1 for our measure of comprehensiveness of EMSs).

Market conditions are measured by market share and the Herfindahl-Hirschman index. Market share is calculated by dividing sales of a firm by total industry sales.

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PRTR chemicals approximate the general pollution intensity of each industry.

[4] We did not find export data by regions (Europe, North America, etc.).

[5] We are aware that export ratio may also measure factors other than foreign government pressures, such as pressures from consumers in foreign countries. However, we could not find a better measure for which data exist.

Larger market share indicates larger market power for a given industry.[6] The Herfindahl-Hirschman index represents market concentration. The index is calculated as the sum of squared market share (measured in %) of each firm in the industry. Thus, the index takes values between 0 and 10,000, where the maximum is attained when the industry is characterized by monopoly.

For all variables constructed at the industry-level, we use the industry classification of the Japan Company Handbook (approximately the same as two-digit SIC codes in the U.S.).

## 3. DATA AND EMPIRICAL METHODS

### 3.1. Dependent variable

This section describes how the dependent variable, which represents comprehensiveness of firms' EMSs, is constructed. We obtained a dataset from the Fifth Environmental Survey of Japanese Manufacturers conducted by the Nikkei Newspaper.[7] The questionnaires were sent to a total of 2,040 firms, consisting of all manufacturing firms listed in the Tokyo Stock Exchange (these are major public firms) and a small number of other manufacturing firms in September 2001. The response rate was 40.2% (820 firms). The questionnaires had approximately 50 main questions, plus associated sub-questions. These questions covered eight aspects of environmental management practices that firms employ, such as degree of disclosure of environmental information about the firm, degree of establishment of monitoring and audit systems of pollutants that are generated through production processes, extent of employee training, comprehensiveness of firm's recycling practices, and so on. After the questionnaires were collected, the answers were summed for each practice, producing what the Nikkei Newspaper called a "score" for each environmental practice by individual firms. Since the numbers of associated questions were slightly different across practices, the Nikkei Newspaper standardized the scores so that the mean becomes 50 and the standard

[6] Strictly speaking, the Lerner Index is the theoretically valid measure of market power. In practice, however, market share is widely used, including in antitrust cases, because obtaining the necessary data to calculate the Lerner Index is difficult (Goldberg and Knetter 1999).

[7] The Nikkei Newspaper is Japan's equivalent of the Wall Street Journal. Although the Nikkei Newspaper has the copyright of the survey results, the survey itself was designed and conducted in cooperation with the Nikkei Research. The Nikkei Research is a well-known research institute in Japan specializing in corporate research, marketing research, and database development.

deviation becomes 10. The dataset we obtained consists of standardized scores of each of the eight environmental practices at the individual firm level. The description of these eight practices is summarized in table 2.

**Table 2: Summary of Eight Categories of Environmental Management Practices**

| Variable name | Description |
|---|---|
| $v_1$ | Degree of introduction of management systems related to ISO14000 series |
| $v_2$ | Degree of environmental information disclosed and ease of access to the disclosed information by the public |
| $v_3$ | Extent of employee training and environmental consideration in human resource management (such as whether there are incentive programs to promote environmental awareness among employees) |
| $v_4$ | Whether firms have various long-term environmental management plans |
| $v_5$ | Degree of monitoring and audit systems of pollutants that are generated through production processes |
| $v_6$ | Comprehensiveness of recycling practices |
| $v_7$ | Degree of monitoring of green-house gas emissions and energy use in production processes |
| $v_8$ | Comprehensiveness of life cycle assessment, or assessment of environmental impacts of firm's products at various stages of their production and consumption |

*Note:* This table is constructed based on Nihon Keizai Shimbun (2002).

The survey results reflect comprehensiveness of each firm's EMS in a sense that the eight environmental practices represent different aspects of firm's EMS, therefore reflecting breadth of the EMS. Furthermore, rather than simple binary information on whether or not firms adopt each environmental practice, the survey results contain richer information on intensity of each of the environmental practices firms employ because there were several questions associated with each of the practices. As an objective measure of the comprehensiveness of the EMS for each firm, we use the principal component score that is obtained from applying a principal component analysis (PCA) to the dataset.[8] Principal component analysis is a commonly used

[8] The Nikkei Newspaper also applied PCA and a portion of the results were published in a report

statistical technique used to reduce the dimensionality of possibly correlated variables without losing much of the information contained in the original data set.

Mathematically, PCA determines the optimal weights $w_{ik}$ for linear combinations of the p original variables $\mathbf{v}_j$'s (j = 1, 2, …, p). In our dataset, $\mathbf{v}_j$'s correspond to scores for the eight environmental practices and p = 8. The first principal component captures the largest proportion of data variation, and the second principal component captures the second largest variation subject to the constraint that the second principal component is orthogonal to the first principal component. Therefore, different principal components capture independent dimensions of the data. As is standard, we normalized $\mathbf{v}_j$ such that the mean becomes 0 and the standard deviation becomes 1, and then applied PCA in order to produce robust results.

The results of PCA are shown in table 3.[9] The eigenvalue associated with the $k^{th}$ principal component represents the proportion of the variance of the original variables explained by the $k^{th}$ principal component. The proportion of the variance explained, labeled as contribution ratio, is calculated as each eigenvalue divided by 8 (mathematically the sum of all eight eigenvalues must equal to 8). As is shown, the first principal component explains over 78% of the variance, while the second principal component explains only 4.9%. Thus, the first principal component captures most of the information contained in the original 8 variables and thus can reasonably be considered as a measure of the comprehensiveness of firms' EMSs (Nihon Keizai Shimbun 2002). Larger values of the first principal component score indicate that the firm has a more comprehensive EMS. Let $S_i$ be the degree of the comprehensiveness of the $i^{th}$ firm's EMS as measured by the first principal component score. Larger value indicates more comprehensive EMSs. We treat $S_i$ as a continuous variable because it takes sufficiently many values.[10]

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(Nihon Keizai Shimbun 2002). We conducted PCA by ourselves to investigate the validity of the measure of comprehensiveness in details. Although the dependent variable is based on the results of PCA conducted by ourselves, similar figures (the first principal component scores) are available in Nihon Keizai Shimbun (2002).

[9] The first two principal components are also shown in Nihon Keizai Shimbun (2002). Although there are slight differences, our results are consistent with their results.

[10] Principal component scores take different values for each firm. For all 820 samples, the score ranges from -3.79 to 6.73, with median -0.40. The score is not truncated from below because all firms have at least some environmental practices and therefore we do not use a Tobit model.

**Table 3: Results of Principal Component Analysis**

| Weight coefficients | First principal component | Second principal component | Third principal component |
|---|---|---|---|
| $w_1$ | 0.361 | 0.111 | -0.412 |
| $w_2$ | 0.358 | 0.283 | -0.391 |
| $w_3$ | 0.338 | 0.385 | 0.746 |
| $w_4$ | 0.358 | 0.018 | 0.031 |
| $w_5$ | 0.361 | -0.401 | -0.112 |
| $w_6$ | 0.344 | -0.537 | 0.314 |
| $w_7$ | 0.362 | -0.303 | -0.063 |
| $w_8$ | 0.346 | 0.468 | -0.056 |
| Eigenvalue | 6.267 | 0.392 | 0.328 |
| Contribution ratio (%)[a] | 78.33 | 4.90 | 4.09 |

*Note.* [a]Contribution ratio represents the proportion of the variance explained, and is calculated as each eigenvalue divided by 8.

### 3.2. Estimation methods

In this section, we explain the empirical methods used to evaluate the determinants of the comprehensiveness of EMSs developed by firms. In the previous section, we hypothesized that the comprehensiveness of a firm's EMS is determined by various firm characteristics. This relationship is represented by:

$$S_i = \mathbf{X_i}\boldsymbol{\beta} + u_i, \qquad [1]$$

where $\mathbf{X_i}$ is a vector of variables that are hypothesized to affect EMS comprehensiveness, and $u_i$ is an error term. Some of the firm characteristics might be endogenously (contemporaneously) affected by the comprehensiveness of EMS. In order to avoid endogeneity, firm characteristics are measured with a three-year lag. Thus, a vector of firm characteristics $\mathbf{X}_i$ is measured in 1998.[11]

The dependent variable is constructed from survey results, and thus is observed only for those firms that responded to the survey. This raises an econometric issue in the estimation of equation [1] because the non-response may be based on self-selection

[11] We find that our conclusions are largely unaffected by the choice of a three-year lag (versus, say, a five-year lag).

rather than random sampling. It is possible that the firms' decision to respond to the survey was dependent on the expected score the firm would receive. For example, firms with potentially lower scores are less likely to respond to the survey because a low score may lead to bad publicity.[12] Thus, the estimation of equation [1] by OLS may lead to biased coefficient estimates. Although self-selection by non-response is always an issue in surveys, controlling for it in the analysis is difficult because independent variables associated with non-respondents are not often available. In our dataset, we know to whom surveys were sent (all manufacturing firms listed in the Tokyo Stock Exchange) and the firm characteristics data are available from published data sources for both respondents and non-respondents.

By taking advantage of this feature, we address the self-selection problem using full information maximum likelihood estimation (FIML). FIML produces an asymptotically efficient estimator. Let $D_i$ be a binary variable representing whether or not a firm has responded to the survey, where $D_i = 1$ if a firm has responded and $D_i = 0$ if it has not responded. Therefore, $S_i$ is observed only when $D_i = 1$. Firms are assumed to respond to the survey only if doing so will give them higher profits. In order to model the decision to respond to the survey, we introduce a latent variable $D_i^*$. $D_i^*$ represents the i$^{th}$ firm's incentive to respond to the survey such that $D_i = 1$ if $D_i^* \geq 0$ and $D_i = 0$ if $D_i^* < 0$. We model the decision as:

$$D_i^* = \mathbf{Z_i}\boldsymbol{\gamma} + v_i . \qquad [2]$$

The vector $\mathbf{Z_i}$ contains all the variables in $\mathbf{X}_i$ (measured in 1998) because the decision to respond is likely to depend on the expected score $S_i$, which in turn is hypothesized to be affected by $\mathbf{X}_i$. $\mathbf{Z_i}$ also contains sales measured in 2001, which is not in $\mathbf{X}_i$. This variable serves as an exclusion restriction, although the model is identified through assumptions on the error terms even without such a restriction. The variable is included because the response rate is likely to be positively correlated with firm size. If a firm has a high-quality EMS, it is likely to respond to the survey regardless of firm size. If, however, a firm does not have a comprehensive EMS, it will likely to respond only if it is large. The rationale is that if large firms did not respond, people are likely to notice

[12] Firms do not need to know the exact scores they would receive in order for this conjecture to be plausible. Firms only need to know whether their EMSs are generally comprehensive or not.

and assume that the firms did not respond because they have low-quality EMSs. In contrast, people may not notice that small firms did not respond to the survey.

We make a standard assumption that $u_i$ and $v_i$ are jointly normally distributed with mean zero and covariance matrix $\begin{pmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{pmatrix}$. $Var(v_i)$ is normalized to be 1 for identification purpose because we observe only the sign of $D_i^*$. Both equations [1] and [2] are simultaneously estimated using full information maximum likelihood estimation. FIML incorporates information on the correlation of error terms in equations [1] and [2] and produces an asymptotically efficient estimator. The log-likelihood function to be maximized is given by (Davidson and MacKinnon 1993)

$$\sum_{D_i=0} \log(\Phi(-\mathbf{Z_i}\boldsymbol{\gamma})) + \sum_{D_i=1} \log\left(\frac{1}{\sigma}\phi((S_i - \mathbf{X_i}\boldsymbol{\beta})/\sigma)\right) + \sum_{D_i=1} \log\left(\Phi\left(\frac{\mathbf{Z_i}\boldsymbol{\gamma} + \rho((S_i - \mathbf{X_i}\boldsymbol{\beta})/\sigma)}{\sqrt{1-\rho^2}}\right)\right), \quad [3]$$

where $\phi$ and $\Phi$ are the density and the cdf of the standard normal distribution respectively.

### 3.3. Data

The independent variables, $\mathbf{X}_i$, are taken from published data books. All firm characteristics are taken from the *Japan Company Handbook* with the following exceptions. Advertising expenditures are taken from *Ad Spending of Leading Japanese Corporations*. Age of assets is calculated using data on accumulated depreciation from *Nikkei Annual Corporation Reports*. The dummy variables for pollution intensity are constructed based on the average emissions per firm in each industry reported in Japan's PRTR.[13]

The initial sample consisted of the 2,040 firms to which the questionnaires were sent. Of these, we excluded firms not listed in the Tokyo Stock Exchange because data on these firms are very limited. This first exclusion resulted in 1,575 firms. After

[13] These dummy variables are constructed based on emissions data during 2001 because prior years are not available (Japan's PRTR started in 2001). We thus implicitly assume that industry pollution intensities do not change over a short period.

selecting only the firms with complete data, we had the sample size of 1,154. We used these 1,154 firms to estimate equations [1] and [2]. Of these 1,154 firms, 536 firms responded to the survey and therefore have principal component scores.

**Table 4: Descriptive Statistics**

| Variable | All firms | Respondents | Non-respondents |
|---|---|---|---|
| Principal component score | | 0.360 | |
| | | (2.410) | |
| Advertising expenditures | 1.453 | 2.695 | 0.376 |
| (billion yen) | (5.452)[a] | (7.667) | (1.441) |
| Capital intensity | 0.032 | 0.033 | 0.031 |
| | (0.049) | (0.027) | (0.061) |
| Foreign ownership (%) | 5.064 | 7.46 | 2.98 |
| | (7.829) | (9.30) | (5.49) |
| Heavily-polluting industries | 0.290 | 0.295 | 0.286 |
| | (0.454) | (0.456) | (0.452) |
| Intermediate-polluting | 0.491 | 0.481 | 0.500 |
| industries | (0.500) | (0.500) | (0.500) |
| Low-polluting industries | 0.218 | 0.224 | 0.214 |
| | (0.413) | (0.417) | (0.410) |
| Export ratio (%) | 13.34 | 16.45 | 10.64 |
| | (18.29) | (19.47) | (16.76) |
| Current debt ratio | 0.392 | 0.371 | 0.411 |
| | (0.185) | (0.171) | (0.195) |
| Age of assets | 0.746 | 0.736 | 0.754 |
| | (0.130) | (0.127) | (0.133) |
| R&D expenditures (billion | 7.22 | 14.47 | 0.94 |
| yen) | (33.69) | (48.41) | (2.08) |
| Top 10 | 0.022 | 0.041 | 0.0049 |
| | (0.146) | (0.199) | (0.070) |
| Top 11-25 | 0.025 | 0.028 | 0.023 |
| | (0.157) | (0.165) | (0.149) |
| Market share (%) | 1.14 | 1.94 | 0.449 |
| | (2.58) | (3.53) | (0.792) |
| Herfindahl-Hirschman | 526.63 | 527.45 | 525.92 |
| index | (307.39) | (323.09) | (293.34) |
| Sales (billion yen, 2001) | 221.94 | 418.65 | 51.34 |
| | (770.94) | (1,097.08) | (65.43) |
| N | 1,154 | 536 | 618 |

*Note.* All variables are measured in 1998 unless specified.

[a]Standard deviations are shown in parentheses.

Table 4 shows descriptive statistics for all firms (all 1,154 firms used for the estimation of equations [1] and [2]), for firms that responded to the survey, and for firms that did not respond to the survey. For some variables, the means of respondents and non-respondents differ substantially. For example, mean R&D expenditures for respondents and non-respondents are 14.47 billion yen and 0.94 billion yen

respectively. Similarly, mean advertising expenditures and sales for respondents are much larger than those for non-respondents. Such differences suggest that self-selection may exist due to both observable and unobservable factors.

## 4. RESULTS AND DISCUSSION

### 4.1. Results

This section presents our results and discusses their policy implications. Table 5 summarizes the underlying hypotheses, expected signs of explanatory variables, and empirical results. We estimated equation [1] using both OLS and FIML and the results are shown in table 6. The null hypothesis that $\rho = 0$ is rejected at the 1% level, indicating that self-selection is statistically significant. We can see how self-selection bias affects OLS estimates in table 6. Generally speaking, OLS estimates tend to be larger in magnitude and statistically more significant. For example, the coefficients on R&D expenditures and the Herfindahl-Hirschman index are strongly significant under OLS, but are insignificant under FIML. All other coefficients have smaller magnitudes under FIML as well with the exception of the dummy variables for pollution intensities, which represent regulatory pressures. Pollution intensities become larger in magnitude and statistically more significant under FIML. These observations are consistent with our original claim: Using information only on respondents tends to overstate the impact and significance of the independent variables because firms with more comprehensive EMSs are more likely to respond to the survey and these firms have characteristics that are associated with more comprehensive EMSs.

**Table 5: Summary of the Hypotheses and Results**

| Hypotheses (Factors expected to affect development of EMSs) | Variable | Expected sign | Results from OLS | Results from FIML | Joint significance under FIML, $\chi^2[J]$ {p-value}[d] |
|---|---|---|---|---|---|
| 1. Stakeholder pressures | Advertising expenditures<br>Capital intensity<br>Foreign ownership | +[a]<br>+<br>+ | +<br>N.S.[b]<br>+ | +<br>N.S.<br>+ | 8.75<br>{0.0328} |
| 2. Regulatory pressures | Heavily-polluting industries<br>Intermediate-polluting industries<br>Export ratio | +<br>+<br>+ | +<br>N.S.<br>+ | +<br>+<br>+ | 19.91<br>{0.0002} |
| 3. Ability | Current debt ratio<br>Age of assets<br>R&D expenditures | -<br>-<br>+ | N.S.<br>-<br>+ | N.S.<br>-<br>N.S. | 8.28<br>{0.0406} |
| 4. Parent company's influence | Top 10<br>Top 11-25 | +<br>+ | +<br>+ | +<br>+ | 20.39<br>{0.0000} |
| 5. Market conditions | Market share<br>Herfindahl-Hirschman index | +<br>?[c] | +<br>- | +<br>N.S. | 6.52<br>{0.0384} |

***Note.*** [a]The positive and negative signs indicate the direction of the impact of independent variables on dependent variable.
[b]N.S. stands for not statistically significant at the 10% level.
[c]"?" means the direction is ambiguous.
[d]Joint significance is a Wald test for slope coefficients jointly equal to zero. The degrees of freedom (J) is either 2 or 3, depending on the number of variables associated with the hypothesis.

**Table 6: Estimates of Motivations behind Development of EMSs**

| Independent variables | OLS | FIML |
|---|---|---|
| Constant | 1.850 | 1.701 |
| | (0.733)** | (0.729)** |
| *1. Stakeholder pressures* | | |
| Advertising expenditures | 0.0415 | 0.0394 |
| | (0.0159)*** | (0.0174)** |
| Capital intensity | 1.338 | 0.205 |
| | (3.352) | (3.291) |
| Foreign ownership | 0.0450 | 0.0195 |
| | (0.0103)*** | (0.0109)* |
| *2. Regulatory pressures* | | |
| Heavily-polluting industries | 0.600 | 0.956 |
| | (0.274)** | (0.276)*** |
| Intermediate-polluting industries | 0.251 | 0.606 |
| | (0.239) | (0.241)** |
| Export ratio | 0.0192 | 0.0117 |
| | (0.00455)*** | (0.00467)** |
| *3. Ability* | | |
| Current debt ratio | -0.389 | -0.258 |
| | (0.530) | (0.521) |
| Age of assets | -3.332 | -1.837 |
| | (0.794)*** | (0.788)** |
| R&D expenditures | 0.00538 | 0.00443 |
| | (0.00257)** | (0.00283) |
| *4. Parent company's influence* | | |
| Top 10 | 2.729 | 1.899 |
| | (0.425)*** | (0.459)*** |
| Top 11-25 | 1.127 | 0.986 |
| | (0.496)** | (0.502)* |
| *5. Market conditions* | | |
| Market share | 0.167 | 0.0856 |
| | (0.0309)*** | (0.0338)** |
| Herfindahl-Hirschman index | -0.00103 | -0.000393 |
| | (0.000298)*** | (0.000303) |
| *Selection equation (equation [2])* | | |
| Constant | | 0.172 |
| | | (0.350) |
| Advertising expenditures | | -0.0178 |
| | | (0.0224) |
| Capital intensity | | -1.491 |
| | | (1.517) |

| | | |
|---|---|---|
| Foreign ownership | | 0.0000917 |
| | | (0.00656) |
| Heavily-polluting industries | | -0.133 |
| | | (0.137) |
| Intermediate-polluting industries | | 0.0158 |
| | | (0.121) |
| Export ratio | | 0.000245 |
| | | (0.00251) |
| Current debt ratio | | -0.606 |
| | | (0.247)** |
| Age of assets | | -0.928 |
| | | (0.371)** |
| R&D expenditures | | 0.0826 |
| | | (0.0187)*** |
| Top 10 | | 0.582 |
| | | (0.321)* |
| Top 11-25 | | 0.0622 |
| | | (0.259) |
| Market share | | 0.0588 |
| | | (0.0517) |
| Herfindahl-Hirschman index | | -0.0000514 |
| | | (0.000161) |
| Sales | | 0.00505 |
| | | (0.000696)*** |
| Number of observations | 536 | Respondents = 536<br>Non-respondents = 618 |
| ρ (standard error) {p-value}[a] | | -0.818 (0.029) {0.000} |
| Adjusted $R^2$ | 0.390 | |
| Log likelihood | | -1627.01 |
| F[13,522]{p-value}[b] | 27.33{0.000} | |
| $\chi^2$[13] {p-value}[c] | | 146.67{0.000} |

*Note*. The dependent variable is the first principal component score. Standard errors are shown in parentheses. Low-polluting industries are the excluded industries.

*** Statistically significant at the 1% level.

** Statistically significant at the 5% level.

* Statistically significant at the 10% level.

[a] ρ is the correlation coefficient between $u_i$ and $v_i$. P-value shown in curly brackets is the probability that ρ = 0.

[b] F[13,522] is an F-test for all slope coefficients jointly equal to zero.

[c] $\chi^2$[13] is a Wald test for all slope coefficients jointly equal to zero.

The estimates by FIML are consistent with the expected signs and generally support the hypotheses. The far-right column of table 5 shows the joint significance of the coefficients of the independent variables associated with each hypothesis. For all hypotheses, the coefficients are jointly statistically significant at the 5% level. Regulatory pressures and parent company's influence are particularly highly statistically significant.

The hypothesis that firms with stronger stakeholder pressures develop more comprehensive EMSs is partially supported. Firms with larger advertising expenditures and thus in stronger contact with consumers are likely to develop more comprehensive EMSs. Firms that receive stronger pressures from foreign investors, as measured by a higher percentage of foreign ownership, are also likely to develop more comprehensive EMSs. However, there is no evidence that stronger pressures from the general investor population, as measured by larger capital intensity, lead to more comprehensive EMSs.

The hypothesis that stronger regulatory pressures motivate firms to develop more comprehensive EMSs is strongly supported. Firms operating in high-polluting industries are likely to develop more comprehensive EMSs. Furthermore, the magnitude of the coefficient on high-polluting industries is larger than that of intermediate-polluting industries. This result is consistent with our hypothesis: firms operating in high-polluting industries are likely to receive stronger regulatory pressures than those in intermediate-polluting industries. Regulatory pressures from foreign governments, as measured by the export ratio, also have a significantly positive effect on the comprehensiveness of EMSs.[14]

The hypothesis that firms with higher technical and financial abilities are likely to develop more comprehensive EMSs is weakly supported. The effect of financial constraints as measured by a higher current debt ratio is, as expected, negative, but is not statistically significant. Technical knowledge as measured by R&D expenditures is not statistically significant either, after controlling for self-selection (the R&D coefficient in the selection equation implies that firms with larger R&D expenditures were more likely

[14] As we mentioned in the previous section, export ratio may also measure factors other than foreign government pressures, such as pressures from consumers in foreign countries. We are aware of this limitation, and we leave it as future research to investigate the effect of various pressures from foreign countries.

to respond to the survey). While financial flexibility and technical knowledge are statistically insignificant, investment costs do have a significant effect. Firms with newer facilities, and thus with higher costs of replacing the existing assets, have significantly less comprehensive EMSs.

The hypothesis that a parent company influences the comprehensiveness of the subsidiary company's EMS is strongly supported. Firms that have parent companies in the top 10 in terms of the comprehensiveness of EMSs are likely to develop more comprehensive EMSs. The coefficient of "Top 11-25" is also positive and significant, but the magnitude is smaller than that of Top 10. Therefore, the influence of parent company is larger if the parent company's EMS is more comprehensive.

The hypothesis that market conditions affect firms' EMSs is partially supported. Firms with larger market share and thus with larger market power have significantly more comprehensive EMSs. Firms with a larger Herfindahl-Hirschman index, implying that are operating in more concentrated industries, are significantly less likely to develop comprehensive EMSs under OLS. After controlling for self-selection, however, the effect is not statistically significant.

### 4.2. Comparisons with previous studies

Our broad findings generally support previous findings (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Nakamura et al. 2001; Welch et al. 2002; Khanna and Anton 2002; Anton et al. 2004). For example, these studies also found regulatory pressures to be significant in explaining firms' voluntary adoption of environmental practices. In addition, the effects of stakeholders, such as consumers, are generally found to be significant (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Khanna and Anton 2002; Anton et al. 2004). However, there are several important differences.

First, previous studies on firm adoption of environmental practices (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Nakamura et al. 2001; Welch et al. 2002; Khanna and Anton 2002; Anton et al. 2004) used survey data but did not control for self-selection. We found that after controlling for self-selection, the effects of regulatory pressures tend to become more significant and larger in magnitude while the effects of other variables

tend to become less significant and smaller in magnitude. This finding does not alter the previous findings that regulatory pressures are important, but rather our finding reinforces the importance of regulatory pressures because previous studies may have underestimated the significance and magnitude of regulatory pressures.

Second, our results indicate the factors that motivate EMS comprehensiveness by Japanese firms may not be exactly the same as those motivating firms in other countries, especially in U.S. and Canada. For example, Henriques and Sadorsky (1996) and Khanna and Anton (2002) found that pressures from general shareholders are important in motivating firms to take proactive actions in U.S. and Canada. We found that firms that receive stronger pressures from foreign investors, as measured by a higher percentage of foreign ownership, are likely to develop more comprehensive EMSs. However, there is no evidence that stronger pressures from the general investor population, as measured by larger capital intensity, lead to more comprehensive EMSs. This result might indicate that Japanese investors are not as concerned with the environmental performance of firms as foreign investors are (alternatively, firms may not receive stronger pressures from Japanese investors compared to foreign investors). We also found that R&D expenditures and Herfindahl-Hirschman index become insignificant when self-selection is controlled for, implying that technical knowledge and the market structure may not be major factors that affect EMS development among Japanese firms. Khanna and Anton (2002) found both of these factors statistically significant in firm adoption of environmental practices in the United States, but our results do not support their finding after controlling for self-selection. We cannot conclude whether these findings are due to the methodological differences (self-selection) or the true differences in the behaviors of Japanese firms and firms in other countries, but our results indicate more careful studies are needed in order to accurately quantify the relative importance of various motivations.

Third, there are some important differences between our results and those of previous studies on Japanese firms. For example, Nakamura et al. (2001) found that R&D expenditures negatively affect adoption of ISO 14001 among Japanese firms (meaning firms with large R&D expenditures are less likely to adopt ISO 14001), but we found the effect of R&D expenditures positive and significant under OLS and insignificant under

FIML. In addition, consumers pressures were found to explain only some aspects of ISO 14001 adoption among Japanese firms (Nakamura et al. 2001; Welch et al. 2002), but our results suggest that Japanese firms do receive strong pressures from consumers to be environmentally proactive. Furthermore, contrary to Nakamura et al. (2001), we found financial health does not affect EMS development.

### 4.3. Policy implications

In order to assess policy implications of the results, we examine how comprehensiveness of firms' EMSs changes when firm characteristics are changed. Table 7 calculates the changes in the principal component score (our dependent variable) when the independent variables that are statistically significant under FIML are changed from their minimum values to their maximum values. The result is shown in the column labeled "Changes in predicted score".[15] We can see that consumer pressures as measured by advertising expenditures have the largest impact, and market power as measured by market share has the second largest impact. Regulatory pressures, as measured by the industry's pollution intensity and the firm's export ratio, also have large combined effects. In the far right column, we calculate how changes in the predicted principal component score translate into changes in the relative position of the firms' comprehensiveness of EMSs. These figures are derived by first adding the predicted change in the principal component score to the principal component score at the median ($50^{th}$ percentile) and then finding the percentile that corresponds to this score. A change in the percentile is then calculated by subtracting 50 from this percentile. Thus, these figures represent changes in the relative position from the median when one of the independent variables is changed holding others fixed. As can be seen, changes in the percentiles are generally quite large. Advertising expenditures have a potential to change comprehensiveness of a firm's EMS by nearly 40%. These observations have several policy implications.

[15] We chose to change independent variables from minimum to maximum rather than for one standard deviation (or two standard deviations) because changing dummy variables for a fraction does not make sense. Changing dummy variables from 0 to 1 while changing all other variables for one standard deviation may not be a good strategy either in this context because it makes the impact of these variables difficult to compare with each other.

**Table 7: Economic Significance of Independent Variables**

| Variable | Coefficients | Minimum | Maximum | Changes in predicted score[a] | Changes in percentiles[b] |
|---|---|---|---|---|---|
| Advertising expenditures | 0.0394 | 0.001 | 99.5 | 3.919 | 39.1 |
| Foreign ownership | 0.0195 | 0 | 77.9 | 1.519 | 17.2 |
| Heavily-polluting industries | 0.956 | 0 | 1 | 0.956 | 11.8 |
| Intermediate-polluting industries | 0.606 | 0 | 1 | 0.606 | 8.3 |
| Export ratio | 0.0117 | 0 | 99 | 1.157 | 13.4 |
| Age of assets | -1.837 | 0.32 | 0.99 | -1.231 | -18.0 |
| Top 10 | 1.899 | 0 | 1 | 1.899 | 21.1 |
| Top 11-25 | 0.986 | 0 | 1 | 0.986 | 12.1 |
| Market share | 0.0856 | 0.0004 | 36.5 | 3.098 | 31.2 |

*Note*. [a]Changes in predicted principal component score are calculated by changing each variable from minimum to maximum holding other variables fixed.
[b]Changes in percentiles are derived by first adding the predicted change in the principal component score to the principal component score at the median ($50^{th}$ percentile) and then finding the percentile that corresponds to this score. A change in the percentile is then calculated by subtracting 50 from this percentile.

First, because consumer pressures have the largest impact, policy makers can encourage firms to develop more comprehensive EMSs by increasing public awareness. The Japanese government has started to disclose firms' emissions of PRTR chemicals (the Pollutant Release and Transfer Register, which is similar to the Toxics Release Inventory of the United States) since 2003, and this is one policy tool that can increase availability of information to consumers.

Second, regulators can use these empirical results to target future incentive programs aimed at encouraging EMS development. We identified firm characteristics that are likely to lead to comprehensive EMSs. Lack of these characteristics may deter firms' development of EMSs. Therefore, policy makers can target firms that lack these characteristics and provide assistance through incentive programs. For example, public recognition seems an effective tool since consumer pressures have the largest impact. A subsidy on EMS-related investment may work as well since investment costs were found significant. On the other hand, technical assistance may not be effective because technical

knowledge was found insignificant.

Third, despite the seemingly "voluntary" nature of EMS development, regulations play an important role in motivating firms to develop comprehensive EMSs. They can play such a role directly, as proxied by the industry's pollution intensity, or indirectly by allowing other stakeholders to pressure firms to develop EMSs. For example, we found that consumer pressures have a substantial effect on inducing firms to develop comprehensive EMSs. The effectiveness of consumer pressures, however, hinges on the availability of accurate information on firms' environmental performance, and accurate and reliable information disclosure typically requires regulatory tools such as Pollutant Release and Transfer Registers. Therefore, although encouraging the development of comprehensive EMSs has the potential to augment existing regulations, regulatory tools are fundamental to the success of these voluntary approaches.

## 5. CONCLUSIONS

In this study, we investigated the factors that motivate firms to develop comprehensive environmental management systems. Our broad findings generally support the previous analyses (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Nakamura et al. 2001; Welch et al. 2002; Khanna and Anton 2002; Anton et al. 2004). For example, we found regulatory pressures are important as previous studies empirically found. In addition, the effects of stakeholders such as consumers are found to be significant as was generally supported in previous analyses (Henriques and Sadorsky 1996; Dasgupta et al. 2000; Khanna and Anton 2002; Anton et al. 2004). We found that after controlling for self-selection in survey response, the effect of regulatory pressures tend to become more significant and larger in magnitude, while the effect of other variables tend to become less significant and smaller in magnitude. For example, we found that R&D expenditures and Herfindahl-Hirschman index are insignificant when self-selection is controlled for, implying that technical knowledge and the market structure may not be major factors that affect EMS development. We also found that consumer pressures, regulatory pressures, and market power are most important in determining the comprehensiveness of a firm's EMS.

We believe our results are important not because we found a few results that differ from previous analyses (such as the effects of market conditions, technical knowledge, and financial health), but because our results reinforce the importance of regulatory and stakeholder pressures. Despite using different data, controlling for self-selection bias, and considering the comprehensiveness of EMSs rather than the adoption of a single environmental practice, our results affirm the importance of regulatory and stakeholder pressures. This consistency provides an important foundation for turning academic research into effective policy implementations.

Our results suggest that Georgia's efforts to encourage firms to develop EMSs, if well targeted, have the potential to augment existing regulatory tools. At the same time, regulations are important not only for directly motivating firms to develop EMSs but for indirectly allowing other stakeholders to pressure firms to develop EMSs. For example, we found that consumer pressures have a substantial effect on inducing firms to develop comprehensive EMSs. The effectiveness of consumer pressures, however, hinges on the availability of accurate information on firms' environmental performance, and accurate and reliable information disclosure typically requires regulatory tools such as Pollutant Release and Transfer Registers (e.g., the U.S. Toxics Release Inventory).

Thus, although we believe our empirical results suggest that an official policy of encouraging development of EMSs has the potential to augment existing regulations, regulatory tools are fundamental to the success of such voluntary approaches.

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