The Choice of Management Practices: What Determines the Design of an Environmental Management System?

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Abstract

This paper examines whether differential incentives exist in the adoption of environmental management practices (EMPs) with varying features that often make up the design of environmental management systems implemented by firms. Estimation of multivariate probit models reveals that greater consumer, regulatory and investor pressures are positively related to the adoption of EMPs that directly enhance a firm's green image. In addition, potential liability costs are positively associated with adopting broad-based EMPs while regulatory pressures are not generally found to have any significant relationship with environmental efforts that improve and address compliance issues. Results also reveal that competitive pressures arising from environmental efforts by rival firms creates stronger incentives for environmental self-regulation than any pressures arising from potential regulatory threats at the industry level.

1. Introduction

Higher costs associated with existing conventional command-and-control approaches to environmental regulation and the increasing levels of environmental consciousness among the public have led environmental policy makers to promote and encourage the adoption of self-regulatory measures that have the potential for achieving improvements in environmental performance. In addition, increased regulatory stringency and scrutiny as well as stakeholder and public pressures for greener approaches to production have heightened interest in considering the benefits of these self-motivated efforts. The evolution of this type of environmental responsiveness has led to the proliferation of voluntarily created environmental management systems (EMSs) that consist of practices that determine how firms will manage the potential impacts of their business strategies on the environment. The potential for EMSs to motivate firms to systematically minimize the impact of their actions on the natural environment and to attain competitive advantages is acknowledged by increased efforts at promoting these management tools in the public policy arena. In 1999, EPA issued a major report which committed the agency to encourage organizations to use EMSs that improve compliance, pollution prevention, and other measures of environmental performance.[1]

EMSs are composed of various environmental management practices (EMPs) that include the conduct of internal environmental audits to identify environmental problems, securing an organization-wide pledge for responsible environmental management, standardizing environmental codes of conduct, and releasing environmental reports to firm

[1] The importance of establishing systematic efforts at addressing environmental issues was further highlighted in 2000 with Executive Order 13148 that called for the implementation of EMSs within government agencies by following principles of continual improvements, flexibility and collaboration.

stakeholders, among other things. Because firms have the flexibility in their choice of what EMPs to adopt, the composition and design of an internally structured EMS and its potential effectiveness for achieving environmental goals can be expected to vary. The nature of the EMPs that can be implemented by firms varies considerably. Some require extensive modifications in production processes or adjustments in managerial approaches while others simply require increasing attention or resources devoted to environmental issues through information dissemination. This paper seeks to examine the incentives behind the adoption of different EMPs and determine the type of firm that adopts the types of EMSs that can be characterized by these practices. This study can provide insights on which firms are likely to participate in greater self-initiated environmental protection efforts.

This research contributes to the literature that examines the incentives behind voluntary environmental measures. Within the body of empirical work, studies have focused on the adoption of single practices or practices that are bundled into a single unit. Most studies disregard the interrelationships between the specific practices and other alternatives available to the firm at the time of adoption decision. When the adoption decisions of these practices are affected by the same unobserved factors, then ignoring these correlations in single equation models leads to inefficient estimates. Similarly, studies that treated practices as a set overlooked the possibility that the factors considered may influence the adoption of the individual practices differently as will be the focus of this study. This paper addresses the adoption of several EMPs in a multiple equation framework. The four EMPs to be examined are: (1) conducting environmental audits; (2) environmental reporting; (3) implementing total quality management standards; and (4) conducting environmental risk evaluations of suppliers. These EMPs represent varying degrees of commitment, resource requirements and reputation effects that determine the potential to capture strategic benefits for the firm. The empirical analysis is conducted for a sample of S&P 500 firms using data from 1994-96.

Results show new evidence that greater consumer, regulatory and investor pressures specifically induce the adoption of EMPs that have greater reputation effects through image enhancement. In addition, potential liability costs can increase the likelihood of adopting broad-based and risk-reducing environmental management strategies while threats of greater regulatory stringency encourage compliance-based EMPs. This study also finds that visible environmental efforts by rival firms within industries positively influence self-regulatory efforts. The insights derived in this paper has implications for the design and targeting of policy initiatives towards entities less likely to be self-motivated to demonstrate strong environmental stewardship in response to public policy and stakeholder concerns. Understanding the drivers of adoption of these EMPs as they relate to each other rather than as isolated dichotomous decisions would be useful in forecasting the adoption of a particular type of EMS. The remainder of the paper is organized as follows. Section 2 presents a brief review of the related literature. Section 3 discusses the conceptual framework and defines the variables to be included in the empirical analysis. The empirical framework is then presented in Section 4 while Sections 5 and 6 present the empirical findings and conclusions, respectively.

2. Previous Literature

Regulatory pressures as well as pressures from environmentally conscious consumers and investors are likely to raise the cost of doing business. As firms search for ways to maximize profits, they may voluntarily adopt management practices that could lower liability costs and risks of negative consumer and investor reactions. However, intensifying environmental efforts may result in even more stringent regulatory standards. There is limited theoretical evidence that has looked at the mechanisms for firm's voluntary environmental actions. Segerson and Miceli (1998) have shown that the threats of increased stringency of anticipated mandatory regulations as well as expected costs of compliance in the future create incentives for voluntary pollution abatement in order to preempt regulation. Lutz et al. (2000) show that firms can also attempt to influence the minimum quality standards set by the government by voluntarily producing goods with environmental attributes. Focusing on the impact of consumer pressures, Arora and Gangopadhyay's (1995) theoretical work shows that consumers' preference for quality and their willingness to pay premium prices for this quality create incentives for firms to produce environmentally friendly products to differentiate themselves and possibly gain market share. Maxwell et al. (2000) show that self-regulatory reaction can be a strategy to preempt consumer groups from lobbying more stringent regulations.

There has been greater empirical scrutiny of the incentives behind voluntary actions categorized into participation in public environmental programs (Videras and Alberini, 2000; Welch et al., 2000; Khanna and Damon, 1999; DeCanio and Watkins, 1998), adoption of a single practice such as writing an environmental plan (Henriques and Sadorsky, 1996), and adoption of industry-wide and international environmental standards (King and Lenox, 2000; King and Lenox, 2003; Nakamura et al, 2002; Dasgupta et al, 2000). These studies find that a mix of firm-specific characteristics as well as external factors such as regulatory, industry, investor and market pressures provide incentives for the adoption of specific components of a firm's EMS. Recognizing the potential interactions among individual strategies, Khanna and Anton (2002) and Anton et al. (2004) use the number of practices adopted by firms as a measure of the comprehensiveness of these EMSs, and Nakamura et al (2001) use factor analysis to identify common sets of characteristics that categorized the sets of practices considered. Synergies among different agricultural production practices have also been examined in several studies. Dorfman (1996) uses a multinomial probit framework to study the adoption of integrated pest management and irrigation techniques by apple producers. Wu and Babcock (1998), on the other hand, use a multinomial logit model to look at decisions to adopt conservation practices and their impact on input use, crop yield and soil erosion rates. More recently, Gillespie et al. (2004) apply the multivariate probit framework to study breeding technologies in the hog sector.

3. Model Specification and Data

EMSs provide a systematic and comprehensive strategy to address environmental issues (Florida and Davidson, 2001; Coglianese and Nash, 2001). The mechanism by which EMSs can provide benefits associated with improved efficiency, reduced compliance costs, greater innovation or the ability to capitalize on opportunities to improve competitiveness lies in the nature of the management strategies incorporated therein. When EMSs are characterized by practices that create opportunities for improvements in input use through organizational innovations such as better systems that track input flows and emissions generation, and improving product quality by minimizing defects, then such EMSs may be considered similar to production practices that increase the effectiveness by which pollution generating inputs are used (as in Khanna and Anton, 2002). On the other hand, when EMSs are characterized by practices that are more likely subject to public assessment, then these types of EMSs may be seen as signals of products that are differentiated by the way they are produced. A more visible demonstration of a firm's environmental concerns can allow the firm to capture competitive advantages by gaining market share from environmentally conscious consumers that are willing to pay for products that signify higher environmental quality (as suggested in Arora and Gangopadhyay's framework) or by generating more favorable investor reaction.

The adoption of EMSs is also likely to impose costs on firms, the magnitude of which depends on the extent of the resource requirements of the EMPs included in the system. EMPs that require broader organizational changes expectedly involve greater costs associated with employee training, modifications in production lines and information integration among other specialized tasks, as opposed to EMPs that are primarily adopted to signal information to the public. Because the different EMPs that compose an EMS vary in terms of their objectives and implementational requirements, it is assumed that the costs and benefits from adoption as perceived by firms vary. As such, EMS designs expectedly differ across firms as they structure them through the adoption of different types of practices. A discussion of the general nature of each of the EMPs included in this study and the features that distinguish them from each or that unify them are discussed below.

The EMPs

The dependent variables used in the jointly estimated equations are dummy variables of 1 if a firm adopts an EMP and 0, otherwise. Data on the EMP adoption decisions are obtained from 1994-1996 surveys of S&P 500 firms conducted by the Investor Research Responsibility Center (IRRC).[2] The four EMPs included in this analysis are described below:

Conducting environmental audits (AUDIT). The regular conduct of environmental audits allows firms to not only monitor compliance with a range of environmental statutes but go beyond standard regulatory compliance to improve compliance and to ensure that compliance procedures are occurring in the most cost-effective manner. An audit team that consists of internal employees or external consultants ensures that environmental requirements of federal law are met, that environmental programs are in accordance with environmental policy and that its environmental action plans are progressing. Beyond

[2] Survey firms are asked about whether they adopt specific types of EMPs. Unfortunately, there are no detailed descriptions of these EMPs in the survey forms other than one-line questions: e.g. whether a firm has adopted environmental audits; implemented TQM principles in environmental management; released environmental reports; and adopted risk evaluation criteria for suppliers. This section expands on the likely features of these EMPs based on standard descriptions that are accepted in the business arena and integrated from other information included in the survey and a variety of corporate resources found on the web.

meeting compliance measures, an environmental audit may also be used to evaluate the effectiveness of EMSs and assess the environmental impact of firm operations.[3]

Applying TQEM principles (TQEM). The total quality management philosophy is a multidimensional concept driven by goals of quality improvement. The application of TQM principles in environmental management (TQEM) assumes a systemic integration of waste minimization, risk reduction and overall environmental excellence across all stages of the production cycle. This management practice includes an ongoing process of discovering sources of poor quality performance and being able to address them in the most cost effective manner.

Evaluating environmental risks of suppliers (SRISK). Firms may also choose to adopt certain criteria at evaluating any environmental risks associated with their suppliers. Identifying and encouraging green-friendly suppliers can be achieved through a variety of means including environmental questionnaires suppliers have to fill out prior to contract negotiations, inspections of goods received, onsite environmental assessments, or requiring that the suppliers' environmental programs are certified by third-party audits. Often requiring cross-functional teams, this practice typically involves merging environmental policies and programs with supply chain management activities, including their design, procurement, and distribution processes. Business purchasers may, as a practice, offer greater preference to suppliers who are determined to carry the least environmental risks.[4]

Releasing environmental reports (REPORT). As a result of growing demands for corporate transparency and to address stake holder concerns about firms' corporate position

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[3] In 1986, the EPA issued the Environmental Auditing Policy which strongly encouraged the conduct of voluntary environmental audits. In 1995, this policy was updated to include incentives for the voluntary disclosure and correction of violations to environmental regulations during the conduct of audits in return for penalty reductions.

[4] E,g, General Motors requires all its suppliers to adopt certified EMSs by December 31, 2002. Ford requires to be ISO 14001 certified by July 2003

on environmental issues, firms are also increasingly choosing to improve communication with their stakeholders by releasing annual environmental reports or more broad reports covering the full spectrum of corporate responsibility performance. While the content and delivery of these reports vary greatly (Sinclair-Desgagne and Gozlan, 2003; Line et al., 2002), open and proactive environmental reporting is considered a cornerstone of strong stakeholder relationships.

The EMPs chosen to be included in this study may be distinguished from each other based on the level of environmental commitment as in Nakamura et al. (2001), whether they proactively focus on pollution prevention or are primarily reactive and compliance-based, the extent to which they might impact a firm's environmental reputation and potential resource requirements. TQEM and SRISK represent process-driven initiatives requiring the creative capabilities of employees and cross-functional teams to improve organizational processes to reduce waste and environmental risks; thus, creating greater opportunities for efficiency improvements. Driven by waste reduction goals, a TQEM strategy may encourage further innovations. The SRISK strategy can, on the other hand, protect firms from potential supply chain interruptions associated with their suppliers' environmental problems and could therefore lead to reduced waste output through enhanced sourcing and inventory management and implementing better materials tracking and reporting systems (EPA, 2000). These EMPs suggest a higher level of commitment that integrates environmental policy into general corporate policy and management practices. Because a TQEM-oriented policy may involve process improvements at all stages of production and because evaluating the risks in a firm's supply chain seeks to reduce environmental impacts, these EMPs are more likely to prevent pollution at the source rather than at the end-of-pipe. Because REPORT is not systematically integrated in the entire production process, it represents a more basic level of commitment for the firm relative to TQEM or SRISK. Similarly, conducting environmental audits is a more reactive type of management tool and hence may also imply a relatively lower level of environmental commitment than that suggested by TQEM or SRISK.

The level of visibility to the public and the resulting impact on the reputation of the firm can also distinguish these EMPs. Releasing environmental reports is expectedly a visible type of EMP that gives direct signals about a firm's environmental initiatives. This suggests that REPORT may be a management strategy specifically to have a more direct impact on protecting and enhancing a firm's environmental reputation and brand image. TQEM, AUDIT and SRISK, on the other hand are less likely to be known to the public as their operations involve only internal changes in production processes, monitoring and evaluation procedures, respectively. Thus, these EMPs are likely to have low visibility to stake holders and have a low reputation effect.

Finally, TQEM is a management tool that is likely to require higher capital requirements as part of the broader scope of changes in production processes. On the other hand, SRISK, AUDIT and REPORT are less resource intensive.

Khanna and Anton (2002b) differentiate EMPs based on the type of external pressures faced by the firm. They focus on whether the impact of regulatory and market based pressures on the adoption decision varies across EMPs and therefore categorize EMPs into two groups (each of which is likely to respond to each type of pressure). This study does not predetermine the strategic goals of the EMPs. Whether or not a particular type of EMP will more likely respond to regulatory or market-based pressures will be an outcome of this analysis. Instead, this study identifies differentiating features that could be responsive to a combination of external incentives as EMPs are not likely to be driven purely by either regulatory requirements or a desire to capitalize on opportunities to improve competitiveness.

There is no clear evidence that suggests that specific EMPs are adopted in a particular sequence; in fact, these EMPs are often adopted simultaneously as part of a firm's systematic efforts to address environmental issues. While EMPs may not be perfectly coordinated, there may still be possible iterations between EMPs since the implementation of one EMP may affect the costs of implementing the other. As such, the variables that are expected to influence the voluntary adoption of EMPs are closely based on the existing literature on environmental self-regulation discussed in the previous section.

The Explanatory Variables

Consistent with earlier studies (see survey in Khanna, 2001), the explanatory variables for the unilateral adoption of these EMPs proxy for factors that influence the perceived gains from and the costs of adoption. As in Khanna and Anton (2002a; 2002b) and Anton et al. (2004), pressures emanating from consumers, investors and regulators are expected to have an impact on firms' decisions to adopt EMSs. Since the adoption of the EMPs may have occurred prior to 1994-96, explanatory variables are measured with a lag of five years (1989-91). This takes into account any potential endogeneity issues with the adoption decision and some lag in firms' behavioral responses to external factors. In this framework, the same regressors are assumed for each EMP adoption equation to examine differential incentives for each EMP.[5] The variables and their definitions are described next.

Regulatory factors are measured by three variables. The number of Superfund sites for which a firm has been listed as potentially responsible (SUPERFUND SITES) is used as proxy for existing mandatory regulations. This information is obtained from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) of the USEPA. This database contains the names of potentially responsible

[5] The multivariate probit model does not require that explanatory variables be different since the derivatives of the log-likelihood function are not linearly dependent.

parties who have been issued notice letters pertaining to previous activities at identified Superfund sites as provided under provisions of Comprehensive Environmental Response, Compensation and Liability Act. Firms with a greater number of sites for which they might be liable under the Comprehensive Environmental Response, Compensation and Liability Act face greater threats of liability costs and might face greater incentives to improve their environmental image through the implementation of more publicly oriented EMPs such as REPORT. Similarly, when firms have a higher level of emissions of pollutants that are subject to regulation under the National Emissions Standards for Hazardous Air Pollutants (NESHAP)[6], then there is a greater threat of compliance costs in the future. This is measured by the ratio of the level of hazardous air pollutants to sales (HAP/SALES). The impact of mandatory regulations is also represented by the number of random inspections that a firm has received from the EPA (INSPECTIONS). Firms that have undergone a larger number of inspections face greater threats of more stringent regulations and may therefore lean towards the adoption of TQEM, SRISK or AUDIT that could reduce the firm's environmental impact and thereby reduce compliance costs. In addition to having a direct impact on abatement costs, increased monitoring activities may also be felt by firms in terms of loss of reputation or government contracts (Brunnermeier and Cohen, 2003). The empirical evidence for the impact of various measures of regulatory threats of liabilities and higher costs of compliance (e.g. number of Superfund sites; fines for violation of environmental statutes) on the participation in voluntary environmental programs has been mixed (Arora and Cason, 1996; Khanna and Damon, 1999; Videras and Alberini, 2000).

In order to measure the level of consumer pressures felt by firms, the variable FINAL GOOD is created where the dummy variable is equal to 1 if the firm is primarily selling final

[6] 189 chemicals were specified in 1990 as those that will be subject to Maximum Available Control Technology standards based on emission levels already achieved by the best-performing similar facilities.

products (e.g. pharmaceutical preparations, food products) and providing services (e.g. retail stores, restaurants, banks) directly to consumers. Classifying them into final goods and intermediate goods was based on the 4-digit level SIC code. Firms that produce final goods and are in closer contact with consumers are likely to benefit more from adopting EMPs that create a better green image to the public. Empirical evidence suggests that consumer pressures positively influence firms' voluntary participation in environmental programs (Arora and Cason, 1996; Khanna and Damon, 1999; Videras and Alberini, 2000) and adoption of environmental plans (Henriques and Sadorsky, 1996).

Other financial and firm-specific data are obtained from the publicly available Research Insight database which provides company specific information on all publicly traded firms that file 10-K forms with the Securities and Exchange Commission. A firm's ratio of sales to total assets (SALES/ASSET) is used to capture the influence of investor reactions to firms' proactive environmental efforts. A high value of capital stock per unit output (proxied by a low ratio) indicates greater dependence on capital markets and hence, vulnerability to investor sentiments. Firms adopt EMPs to signal to investors a greater potential for long-term profitability and a reduced risk of environmental liabilities and increased regulatory compliance costs. For firms that are more sensitive to investor pressures, the incentives are likely to be greater. It is hypothesized that such firms are more likely to adopt EMPs that would signify more sustainable environmental efforts such as TQEM and SRISK. Previous empirical work have shown that firms with a lower sales-assets ratio are more likely to be more environmentally proactive through the adoption of a more comprehensive EMS (Khanna and Anton, 2002; Anton et al., 2004) or adoption of an environmental plan (Henriques and Sadorsky, 1996).

A broader measure of the social pressures faced by firms may be suggested by their environmental performance. Data on toxic emissions are obtained from the Toxics Release Inventory (TRI) that contains facility-level information on media releases of chemical-specific toxic pollutants. These data are aggregated across chemicals and facilities of each parent company to obtain releases at the parent company level. Toxic emissions data are disaggregated into on-site toxic releases and off-site transfers for treatment, recovery and disposal. To control for firm size, the ratio of these variables to sales is used (ON-SITE/SALES and OFF-SITE/SALES). Firms that have a larger volume of on-site discharges are likely to face greater pressures from communities and stake holders to improve their environmental performance and therefore are more likely to adopt EMPs that could directly lead to reductions in waste through process changes in a TQEM or SRISK policy or through a compliance based policy as AUDIT even though there are no mandatory regulations to control toxic releases. While the visibility of off-site transfers could also generate the same pressures, high off-site transfers could also suggest low costs of disposal and treatment creating less incentives for adoption of these EMPs. In the context of this analysis, these two arguments leave the sign of the OFF-SITE/SALES coefficient unknown *a priori.*

Other firm-specific characteristics could influence the costs of adopting specific EMPs. Firms that have greater technical know-how are likely to be able to implement changes in production practices. The ratio of R&D expenditures to sales is used to proxy for this potential impact (RD/SALES).[7] It is expected that more innovative firms are more likely to face lower costs of making more integrated changes in production processes such as TQEM and SRISK. Empirical evidence suggests that higher levels of R&D expenditures positively influence the adoption of EMSs (Khanna and Anton, 2002) and the participation in

[7] Studies on environmental innovation have often used the number of successful patent applications as proxies for innovative activity. To be consistent with the existing literature in this area, R&D expenditures were used instead. Also, this model benefits more from an indicator of innovative activity rather than of successful outcomes from such activities as better measured by patent applications.

some voluntary environmental programs (Arora and Cason, 1996; Videras and Alberini, 2000).

The age of assets is used as a proxy for the cost of replacement equipment that could improve process and product design. The variable AGE is measured by dividing the total assets of a firm by its gross assets[8] (Khanna and Damon 1999) and takes on the value between 0 and 1, with higher values indicating newer plant and equipment, more current assets and smaller accumulated depreciation. Firms with older assets are expected to face lower costs of replacement than firms with newer assets and may thus be more likely to adopt more capital intensive EMPs such as TQEM and SRISK.

To control for possible differences in the firms' propensities to adopt that result from belonging to specific industries, industry-level variables at the two-digit SIC code level are also included.[9] Firms may be imposed penalties in violation of any of 10 environmental statutes (e.g. Clean Air Act, the Clean Water Act or the Toxic Substances Control Act). The average number of penalties received by firms in the industry to which a firm belongs (INDUSTRY-PENALTY) could suggest relatively higher costs of compliance where firms prefer a risk of being penalized rather than satisfying regulatory requirements. Firms that belong to such industries may also consider themselves as having a higher likelihood of receiving penalties in the future if they do not make efforts to improve their environmental performance. [10]

Competitive pressures are also expected to influence EMP adoption. To capture the degree of environmental efforts by rival firms, the average rates at which the various EMPs

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[8] Total assets are defined as current assets including net property plant and equipment plus other noncurrent assets. Gross assets are total assets plus accumulated depreciation.

[9] Because of missing data and to avoid problems of interpolation for the years considered, the Herfindahl index was not used as an industry control.

[10] While a lot of empirical work have used data on pollution abatement cost and expenditures (Census Bureau) as proxies for industry level measures of regulatory burden, a new measure is used in this study to avoid problems with missing data.

are being adopted by rival firms (INDUSTRY EMP) are calculated.[11] In an industry where peer firms are demonstrating more proactive environmental initiatives, a firm is more likely to adopt the same in order to be competitive.

The Sample

Firms that did not respond to the 1994-96 IRRC surveys and that had missing TRI or financial data were excluded leaving an unbalanced panel of 172 parent companies with 135 observations for 1994, 158 for 1995 and 164 for 1996. The sample of firms represent 28 two-digit primary SIC codes, the biggest group represented being the chemical industry with about 15 percent of the sample.[12] Table 1 shows the variability in adoption of the EMPs. About 83 percent conduct environmental audits while only about 38 percent release environmental reports. About 67 percent adopted a TQEM philosophy and almost half of the sample conducted supplier risk evaluation procedures. Over the three-year period, only about 14.7 percent of the sample do not indicate adopting any of the EMPs studied while an average of about 75 percent of the firms say that they adopted at least two of the four EMPs suggesting that the simultaneous adoption of these EMPs is relatively widespread. Correlation analysis indicate positive correlations among the EMPs further suggesting that these practices are complementary to each other rather than substitutes for each other. Table 2 shows that there are significant differences in the mean values of some of the explanatory variables between adopters and non-adopters of these EMPs. Firms that have adopted any of these EMPs are seen to have a higher number of Superfund sites for which they are held potentially liable, a higher level of R&D expenditures and are more likely to sell final goods.

3. Empirical Framework

[11] INDUSTRY-EMP is the variable that indicates the average adoption rate of the specific EMPs within the industry (excluding the firm).

[12] Expectedly, a greater proportion of firms belonging to manufacturing SIC codes 20-39 is represented in the sample – about 87 percent compared to 50 percent in the original pooled sample. Because mandatory reporting is expected of firms meeting a minimum level of toxic emissions, the TRI sample excludes firms in generally low polluting industries.

Estimating unknown parameters of the model would be simple if the vector of random errors were independently and identically distributed using a series of independent binary probit or logit models. However, because the EMPs included in this analysis are not mutually exclusive and are assumed to be simultaneously adopted, then these errors are likely to exhibit stochastic dependence. Ignoring such dependency in multivariate choice models may lead to biased estimates of the choice probabilities and incorrect estimates of the standard errors of the parameters.

While a multinomial logit model may analyze the simultaneous decisions for multiple EMPs, the assumption of their mutual exclusivity as part of the independence of irrelevant alternatives restriction does not appear appropriate in this case. This restriction assumes that an additional choice comes at the expense of reducing the probabilities of the original choices, even when the added choice is no different from those already in the choice set. On the other hand, while the multinomial probit model relaxes the independence restrictions built into the multinomial logit model, the model is difficult to estimate when considering more than two alternatives requiring many additional restrictions on the standard deviations and correlations (Greene, 2003). In this study, a multivariate probit model is used. While the model does not allow for the computation of the probability of adoption of more than one EMP at a time, assuming contemporaneous correlation reduces bias. Because this model is, in principle, simply an extension of the bivariate probit model by adding equations, the difficulty of evaluating higher-order multivariate normal integrals has historically limited its use in more applications. More recently, better methods for simulating probabilities have been developed (e.g. Kimhi, 1999; Hyslop, 1999; Chib and Greenberg, 1998; Bock and Gibbons, 1996).

Consider a firm making the decision to adopt any or some combination of EMPs to form its EMS across a set of *m* categories. This model assumes binary indicator variables for the adoption of practices. This observed behavior is driven by an underlying system of unobservable latent variables such as the perceived discounted net benefits from adoption of the m^{th} EMP that is a function of a vector of observed measures representing external pressures as well as firm-specific characteristics, x as well as unobservable and random characteristics of the i^{th} firm. Assuming that the part of the latent variable which is functionally related to observable variables is linear, then:

$$EMP_{im}^{*} = X_{im}^{'}\beta_m + \varepsilon_{im}$$
$$EMP_{im} = 1 \text{ if } EMP_{im}^{*} > 0, \quad 0 \text{ otherwise}$$

where $m = 1..M$ EMP alternatives, X represents a 1xK vector of characteristics of the i^{th} firm, β is a Kx1 vector of coefficients to be estimated and ε is the stochastic term which captures all unobserved and random effects. These error terms are assumed to have a multivariate normal distribution with mean vector 0 and a covariance matrix R with diagonal elements equal to 1.

The probabilities that enter the likelihood and the derivatives are computed using the GHK simulator (Geweke-Hoajivassiliou-Keane). The log likelihood for the model is accumulated as the sum of the logs of the probabilities of the observed outcomes (see Greene, 2003). The marginal effects for continuous explanatory variables are derived by taking the derivative of the expected value of EMP_1 given that all other EMPs are equal to 1, with respect to the regressors in the model.[13] The signs and magnitudes of these marginal probabilities contain the policy-relevant information from the multivariate probit model.

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[13] The matrix computation of the marginal effects associated with the model is:

$$\frac{\partial EMP_1}{\partial x} = \frac{\partial(prob(EMP_1 = 1...EMP_M = 1 \mid prob(EMP_2 = 1,..., EMP_M)}{\partial x}$$

$$= \sum_{m=1}^{M} \left\{ \left[\frac{\partial(prob(EMP_1 = 1,..., EMP_M = 1 \mid prob(EMP_2 = 1,..., EMP_M)}{\partial Z_m} \right] c_m * \frac{1}{prob(EMP_2 = 1,..., EMP_M = 1)} \right\}$$

4. Results

Correlation analysis and variance inflation factors on the regressors do not suggest any serious multicollinearity. Correlation coefficients are found to be positive and statistically significant at the 1 percent level across all equations and models tested indicating that error terms are correlated across these EMPs (Table 3). This implies that the costs and benefits of adoption of these EMPs are interrelated and that efficiency gains are captured when the equations are estimated jointly rather than separately.[14] Positive signs suggest the complementarity of the adoption decisions and its role in how a firm defines its environmental strategy through an EMS. A relatively high absolute value of correlation coefficient is observed for TQEM and AUDIT. Results of several model specifications are shown in Table 4. Model results reflect the degree of correlation between the variables and choice of EMP. Key findings are qualitatively robust across models.[15]

Estimation results from Models 1-3 generally show that potential regulatory stringency arising from a greater number of regulatory inspections has a positive relationship with the adoption of REPORT but surprisingly a negative relationship with TQEM. Perhaps, a greater number of regulatory inspections indicates greater endurance to regulatory scrutiny and therefore less incentives for broader responses to environmental issues. On the other hand, to the extent that these inspections are more targeted towards firms that already face

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$$-EMP_1 * \sum_{m=2}^{M} \left\{ \left[\frac{\partial(prob(EMP_2 = 1,..., EMP_M = 1 \mid prob(EMP_2 = 1,..., EMP_M)}{\partial Z_m} \right] c_m * \frac{1}{prob(EMP_2 = 1,..., EMP_M = 1)} \right\}$$

where $EMP_1 = \frac{prob(EMP_1 = 1,..., EMP_M = 1)}{prob(EMP_2 = 1,..., EMP_M = 1)}$, x are all the regressors in the model, and

$Z_m = x' c_m = \beta_m ' x_m$

[14] All the models consistently show statistically significant positive correlation coefficients. Only the coefficients for Model 1 are presented here.

[15] These basic results are robust to several variations in the model specifications such as: the inclusion of a proxy for size such as sales, the use of absolute, scaled and normalized levels of R&D and the emissions variables, aggregate levels of toxic emissions, another industry level indicator of regulatory stringency in the form of industry HAP emissions.

compliance problems, firms are not likely to respond by implementing a more sweeping change of environmental strategy because of issues of time and uncertainty, and instead implement more immediate measures such as REPORT. The relationship between INSPECTIONS and a compliance-based EMP such as AUDIT is also found to be statistically insignificant at conventional probability levels. If increased targeted inspections indeed reflect a lack of compliance history, then this result should not be surprising. Results further show that liability threats from more identified Superfund sites are directly associated with adoption of TQEM and REPORT. A positive relationship between consumer pressures (FINAL) and self-regulation is consistently robust across all EMP equations. On the other hand, investor pressures (SALES/ASSETS) appear to not have a strong relationship with TQEM adoption. Another differentiated set of directional relationships between the emissions variables and EMP adoption is revealed by the models. Results show that ON-SITE/SALES is positively related to the adoption of risk reduction types of EMPs that directly address the environmental impact of other agents related to the production process such as the supply chain (SRISK). The relationship between past emissions and REPORT becomes insignificant when future mandatory control (HAP/SALES) is included (Model 2). OFF-SITE/SALES, on the other hand, is negatively correlated with all EMPs except TQEM; however this correlation is not statistically significant. The model results also indicate that older equipment (higher AGE) and higher levels of innovativeness are positively associated with EMP adoption. The inclusion of HAP/SALES does not generally alter basic results and does not indicate any significant association with the adoption of any of the EMPs. One explanation may be that HAP emissions are correlated with either of ONSITE/SALES and OFF-SITE/SALES variables. However, Pearson correlation coefficients between HAP/SALES and these two variables are only 0.38 and 0.23. Furthermore, HAP/SALES coefficient remains insignificant even when the model is re-estimated without the emissions variables. Model 3 accounts for industry attributes and behavior. The environmental stringency faced by the industry to which a firm belongs (INDUSTRY PENALTY)[16] does not have any statistically significant relationship with EMP adoption. Meanwhile, a more extensive adoption rate of EMPs by rival firms is positively related to self-initiated environmental strategies. The impact of some variables may be inflated by their interactions with other regressors. The impact of the level of on-site emissions of a firm may be magnified by the number of inspections received. Model 4 results show that firms with greater on-site emissions in the past and that received a greater number of inspections (ON-SITE/SALES*INSPECTIONS) have some positive likelihood of releasing environmental reports.

Because of the nonlinearity feature of probit analysis, the magnitude of the marginal effect of an explanatory variable cannot be directly explained by the magnitude of the estimated coefficients. A quantitative interpretation of the relationships described above necessitates calculating the marginal effects of the explanatory variables on the probability of adopting the EMPs.[17] The directional relationships suggested by the coefficient estimates were not supported by statistically insignificant marginal effects. As shown in Section 3, the marginal effects are calculated as the derivative of the probability of the adoption of each EMP given that all other EMPs are adopted, with respect to the explanatory variable.[18] Perhaps these effects may be negligible in the adoption of these EMPs when the gains from adopting another EMP are offset by those obtained from other EMPs. In addition, the absence of more significant marginal effects could indicate that perhaps some endogeneity

[16] Other measures of industry-level environmental stringency such as the average toxic emissions or the average HAP/SALES were also added to the models but they did not affect results and were also statistically insignificant.
[17] Note that for continuous variables, marginal effects are calculated at the means may therefore appear smaller than what the true impact may suggest.
[18] Estimated using LIMDEP version 8.0

issues remain. The decision to adopt specific types of EMPs can conceivably be affected by unobservable exogenous factors such as management capabilities or the extent to which a firm's management philosophy is governed by social corporate responsibility to the environment. These differences might be particularly important in deciding between EMPs that require relatively more comprehensive changes in production or management structure and those that do not. Firms with greater management capacity and readiness to handle broader changes are more likely to be driven towards the adoption of TQEM-types of EMPs or EMPs that more immediately address the reduction of environmental risks such as SRISK. Managerial interpretations of environmental issues (i.e. whether they are viewed as opportunities or threats) may also play a role. In addition to these firm-specific factors, industry factors such as the industry's propensity for advancements in environmental technology may determine a firm's inclination towards particular types of EMPs to form its EMS. Firms belonging to industries with particular access to such technology may be more likely to address environmental concerns through EMSs that focus on pollution reduction that is achieved through technological improvements. Finally, because data are panel in nature, then potential fixed and random effects may not be captured. However, the methods for incorporating fixed or random effects into the likelihood function are at best difficult or not well-developed at this time[19]

Despite these issues that generate statistically insignificant coefficients from the multivariate probit framework, quantitative insights may still be gleaned from marginal effects generated from the univariate setting as these will show the impact of the regressors

[19] As of writing, a software that addresses the longitudinal nature of multivariate binary data is currently being developed at the University of Illinois at Chicago under a grant from the National Institutes of Health. Models that included a time trend variable were estimated to account for a firm's tendency to continue to adopt an EMP or to never adopt an EMP. Results did not show that the time trend variable was robust to any specification.

on individual EMP adoption independent of the other EMPs.[20] The marginal choice probabilities are presented in Tables 5a and 5b. Note that for continuous variables, marginal effects are calculated at the means may therefore appear smaller than what the true impact may suggest. Results prove to be generally qualitatively similar to those obtained from the joint estimations.

An additional regulatory inspection faced by a firm increases the likelihood of adoption of publicly visible EMPs but only by a very negligible amount. This implies that whether a firm targets improvements in its green image does not necessarily strongly depend on perceived probabilities of being targeted by regulatory authorities. The magnitude of the impact is similarly small and still negative for TQEM adoption, and consistent with the directional results of the multivariate probit models. Khanna and Anton's (2002a) earlier findings show that regulatory inspections have a positive relationship but that this does not significantly impact EMS adoption. Looking at a summated measure of the EMPs adopted by firms, their study was not able to generate insights on these differentiated impacts on specific EMPs. A higher number of Superfund sites for which firms are listed as potentially liable positively influences the adoption of TQEM and REPORT. A statistically insignificant impact on compliance audits might be explained by the fact that these EMPs seek to minimize the occurrence of future environmental liabilities from monitoring current emissions rather than correcting past hazardous waste emissions for which firms have already been identified as potentially liable in the future.[21]

[20] Marginal probabilities for a probit model are given by the formula: $\frac{\partial p}{\partial x_j} = \phi(x\beta)\beta$ where p = prob(EMP=1), x is the vector of independent variables, β are the associated coefficients (normalized by the standard deviation), and j indexes the variable whose effect is being measured.

[21] Whether a firm is ultimately held responsible for clean up costs to an identified hazardous waste site is to be determine in a process involving site assessments and investigations.

Results reveal that close consumer proximity (FINAL) directly impact self-regulation regardless of the type of EMP adopted. Being a final goods producer increases the probability of adopting these different EMPs by 10 to 23 percent. Meanwhile, a lower SALES-ASSETS ratio increases adoption probabilities (including of TQEM) by 8 to 21 percent. Combined social and stake holder pressures represented by the ON-SITE/SALES and OFF-SITE/SALES variables, still show that firms with inferior past environmental records measured by both variables are not likely to be adopters of TQEM. By contrast, while onsite emissions positively influence the adoption of REPORT and SRISK (increasing adoption probabilities by 9-12 percent), higher volumes of off-site transfers seem to imply less costly ways to address waste output rather than as components of total waste generated. As such, a higher value for OFF-SITE/SALES has a negative relationship with the adoption of AUDIT, REPORT and SRISK. This impact is found to be quite significant increasing likelihood of adoption by 30 to 100 percent.

Ownership of older equipment (higher AGE) is likely to influence selective EMP adoption. Results suggest that firms with older equipment and hence, lower replacement costs are 44 percent more likely to be adopters of relatively more resource-intensive EMPs that target efficiency improvements as required in a TQEM management strategy. In addition, the greater likelihood of replacement and potential for organizational innovation are likely to indicate environmental efforts that could be publicized through environmental reports. Firms that have the current technical abilities and know-how to implement organizational changes (implied by higher R&D/SALES) are more likely to find it less costly to search for ways to improve environmental performance through process modifications, enhancing public environmental image or improving compliance. The positive coefficient was not statistically significant for SRISK. An increase in the sales-assets ratio of 1 percent increases the adoption probabilities between 3-6 percent.

In contrast to the joint estimation framework, Model 2 shows that a greater HAP/SALES ratio increases the likelihood of AUDIT adoption by 68 percent indicating that greater threats of mandatory control in the future influence the adoption of a more proactive form of compliance strategy. Jointly estimating the adoption decisions in fact, shows that there is no significant relationship between these variables.

Model 3 takes into account industry-level factors in firms' individual EMP adoption decisions. Industry-wide environmental stringency faced by the firm (INDUSTRY PENALTY)[22] is not found to be statistically significant in any of the equations. On the other hand, it appears that competitive pressures represented by an increase the average rate of EMP adoption of rival firms (INDUSTRY-EMP) increase the probability of adoption of these EMPs by 50-78 percent. Controlling for these industry effects seems to offset the impact of innovative capacity and investor pressures on TQEM adoption. The same pattern is observed in the multivariate setting.

While the general results of the multivariate and univariate analyses are fairly in agreement, differences do exist. The multivariate estimation framework suggests that as opposed to results from a univariate model, future mandatory control (HAP/SALES) as well as potential liabilities (SUPERFUND) do not have any significant association with the adoption of compliance-based EMPs (AUDIT). In addition, joint estimation results indicate that vulnerability to investor sentiments is not significantly related to TQEM adoption at conventional probability levels or that the relationship between innovativeness and TQEM becomes evident only when the threats of mandatory control are taken into account (Model 2). Also the models generate interesting evidence that past environmental performance (ON-SITE/SALES) is not significantly related to REPORT at conventional probability levels.

[22] Other measures of industry-level environmental stringency such as the average toxic emissions or the average HAP/SALES were also added to the models but they did not affect results and were also statistically insignificant.

These specific insights on differential incentives could not have been possibly addressed in previous studies that studied individual EMP adoption decisions separately.

5. Conclusions

This paper investigates whether differential incentives exist in the choice of management practices that determine the design of firms' environmental management systems. Because firms have the flexibility in choosing several types of practices in various combinations, an extension of the current set of empirical literature that examines the adoption of unilateral environmental initiatives requires a more appropriate framework that estimates adoption decisions simultaneously. Results may provide insights on how firms choose the designs of their EMSs through the adoption of different types of EMPs.

While the multivariate probit model did not generate useful marginal effects, empirical results that indicate which factors are correlated with increased adoption rates could still be used to target policies and information dissemination efforts. While the magnitude of the impact of the variables on simultaneously determined EMP adoption decisions can only be speculated at this point, the basic correlations revealed by the multivariate probit models are generally confirmed by the probit estimation and quite robust to several variations in the model specifications. They suggest that image-enhancing visible EMPs are likely to substitute for efficiency-enhancing strategies at least in the short-run and that their adoption seems to be a stronger response to a mix of external pressures coming from a firm's consumer base and investors, and the regulatory environment. Quite interestingly, the model also shows that there is no significant correlation between past emissions and more visible EMPs indicating that a firm's vulnerability to consumer or investor response (e.g. through boycotts or negative stock market valuations, respectively) and regulatory pressures potentially provide a stronger incentive for EMSs that primarily green corporate image. Firms are likely to perceive net benefits associated with the adoption of EMSs that include a publicity aspect to it. Across different EMPs, the potential outcomes of proximity to consumers (i.e. through collective actions as boycotts and greater demands for regulatory stringency) appear to be an important incentive for environmental self-regulation. Firms may be able to capture market share benefits from being able to differentiate themselves and products from their competitors.

The analyses also show that regulatory pressures themselves can affect EMP adoption differently. Greater liability threats arising from existing environmental records encourage the adoption of EMPs that are more encompassing or that primarily enhance public image rather than more compliance-based strategies. The lack of relationship between the different regulatory pressures and compliance-based EMPs suggests that more proactive efforts that are based on but are not limited to regulatory compliance are similarly influenced by external pressures emanating from firm stake holders. In addition, results also reveal that the prospect of future mandatory control does not appear to hold any significant relationship with EMP adoption implying perhaps that the risks from the possible negative repercussions of a poor environmental record or image provide stronger incentives for adoption. This study also finds that industry effects play a role when pressures arise from a degree of competition created by visible environmental efforts by rival firms. This impact is stronger than regulatory threats at the industry level.

Finally, the adoption of a more integrated type of EMP that could include process modifications is not found to be directly related to higher costs of abatement (e.g. waste disposal and treatment) and is instead likely to be driven more by a firm's innovativeness, and consumer and competitive pressures.

These findings suggest that firms do face differential incentives in choosing the type of management practices to adopt and hence, the general nature of their EMSs. The results of this analysis may still provide some additional insights even if usefulness in the policy arena may be limited due to the conceptual and empirical difficulties of calculating marginal probabilities in the multivariate setting. Treating the EMP adoption decision in joint-decision framework does lead to new information although these differences, by no means, generally invalidate the results from univariate models. Results suggest that when the adoption of more integrated and organizational types of EMPs that could promote efficiency improvements are targeted, then efforts could be geared towards firms that possess greater technical know-how and/or whose environmental record may have made future liability costs more likely. Where general stake holder pressures are more likely given high past emissions, EMPs that more immediately reduce environmental impact of certain aspects of production (such as of the supply chain) may be encouraged. Note, however, that in industries where there are visible proactive environmental efforts, firms are likely to face competitive pressures to be similarly proactive and hence, policy efforts perhaps need not be as intensive. The true benefits from these unilateral environmental initiatives remain to be assessed in terms of improvements in environmental performance resulting from their implementation. Whether differential impacts on environmental performance are observed when EMS designs vary while taking into account the endogenous nature of these EMP adoption decisions is the natural next step to this research. As methods for the joint estimation of these decisions are developed for panel data, then additional information on the implications of quantitative results may also be obtained.

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Table 1. Description and Adoption of Environmental Management Practices

Variable	Mean Values				Description of the Variable (1=yes; 0=no)
	Sample	**1994**	**1995**	**1996**	
TQEM	0.67 (0.47)	0.70 (0.46)	0.67 (0.47)	0.65 (0.48)	Firm applies principles of total quality management to environmental problems
AUDIT	0.83 (0.38)	0.889 (0.32)	0.79 (0.41)	0.811 (0.39)	Firm conducts audits to assess compliance with environmental regulations
SRISK	0.495 (0.50)	0.39 (0.49)	0.49 (0.50)	0.59 (0.49)	Firm evaluates its environmental risks when selecting its suppliers
REPORT	0.38 (10.49)	0.38 (0.49)	0.35 (0.48)	0.39 (0.49)	Firm regularly releases reports about its environmental performance and activities
N	457	135	158	165	

Standard deviations are presented in parentheses

Table 2. Mean Values of Explanatory Variables for Adopters and Non-adopters of EMPs

	SAMPLE	AUDIT		TQEM		REPORT		SRISK	
		Adopters	**Non-adopters**	**Adopters**	**Non-adopters**	**Adopters**	**Non-adopters**	**Adopters**	**Non-adopters**
Superfund Sites **(SUPERFUND)**	9.13 (14.41)	6.69 (15.45)	6.44 (7.34)	11.21 (16.69)	4.87 (6.15)	13.32 (17.38)	6.5965 (11.62)	10.41 (15.08)	7.78 (13.67)
Number of Inspections **(INSPECTIONS)**	1749.46 (4257.46)	1871.81 (4532.47)	1164.06 (2546.97)	1578.93 (3888.97)	2098.5 (4934.73)	2527.55 (5472.66)	1279.88 (3247.50)	1776.14 (4579.66)	1723.36 (3936.59)
On-Site Release Intensity (M pounds/$ M) **(ONSITE/SALES)**	1795.22 (5212.08)	1793.35 (5362.43)	1804.16 (4491.98)	1920.26 (5790.91)	1539.30 (3788.48)	1974.38 (6092.45)	1687.09 (4618.83)	1961.61 (5901.87)	1632.43 (4455.17)
Off-Site Transfer Intensity (M pounds/$ M) **(OFFSITE/SALES)**	411.59 (1086.54)	368.47 (901.61)	617.91 (1713.40)	420.23 (985.63)	393.90 (1274.89)	260.45 (505.01)	502.80 (1313.00)	324.25 (804.86)	497.03 (1302.76)
Final Good **(FINAL)**	0.565 (0.50)	0.61 (0.49)	0.37 (0.49)	0.58 (0.49)	0.53 (0.50)	0.663 (0.474)	0.51 (0.50)	0.62 (0.49)	0.51 (0.50)
Age of Assets **(AGE)**	0.77 (0.10)	0.77 (0.09)	0.75 (0.12)	0.76 (0.10)	0.78 (0.10)	0.76 (0.09)	0.77 (0.10)	0.77 (0.09)	0.76 (0.10)
R&D Expenditures Intensity ($ 10 M) **(R&D/SALES)**	0.03 (0.04)	0.03 (0.04)	0.02 (0.04)	0.03 (0.04)	0.03 (0.04)	0.04 (0.04)	0.03 (0.04)	0.03 (0.03)	0.03 (0.04)
Average industry penalties **(IND-PENALTY)**	26.82 (20.62)	27.15 (21.25)	25.25 (17.52)	25.54 (18.96)	29.45 (23.58)	25.10 (19.53)	27.86 (21.26)	24.31 (18.87)	29.29 (22.01)

Table 3. Correlation Coefficients between EMPs

	AUDIT	TQEM	REPORT
TQEM	0.88 (0.06)***		
REPORT	0.65 (0.14)***	0.46 (0.09)***	
SRISK	0.70 (0.07)***	0.63 (0.06)***	0.55 (0.07)***

Standard errors are in parentheses. ***Statistically significant at the 1% level.

Table 4a . Factors affecting EMP Adoption (Multivariate Probit Joint Estimation Model)

	Model 1				Model 2			
	AUDIT	**TQEM**	**REPORT**	**SRISK**	**AUDIT**	**TQEM**	**REPORT**	**SRISK**
Constant	0.99 (0.59)*	1.32 (0.57)**	0.94 (0.64)$^{+}$	-0.24 (0.60)	0.88 (0.61)$^{+}$	1.27 (0.58)**	0.91 (0.66)$^{+}$	-0.17 (0.61)
SUPERFUND SITES	0.01 (0.01)	0.04 (0.01)***	0.02 (0.00)***	0.01 (0.01)$^{+}$	0.01 (0.01)	0.04 (0.01)***	0.02 (0.01)***	0.01 (0.01)
INSPECTIONS	3.88E-04 (0.00)$^{+}$	-0.51E-04 (0.00)***	0.38E-04 (0.00)**	0.47E-05 (0.00)	0.30E-04 (0.00)	-0.47E-04 (0.00)**	0.35E-04 (0.00)*	-0.19E-05 (0.00)
ON-SITE/SALES	0.18 (0.21)	0.09 (0.23)	0.32 (0.18)*	0.23 (0.15)$^{+}$	0.09 (0.24)	0.09 (0.30)	0.26 (0.17)$^{+}$	0.27 (0.15)*
OFF-SITE/SALES	-1.41 (0.86)*	0.03 (0.63)	-3.85 (1.74)**	-2.04 (0.73)***	-1.67 (0.80)**	0.03 (0.67)	-4.21 (1.73)**	-1.92 (0.75)**
FINAL GOOD	0.62 (0.18)***	0.33 (0.15)**	0.70 (0.15)***	0.27 (0.14)*	0.65 (0.18)***	0.32 (0.15)**	0.71 (0.15)***	0.24 (0.14)*
AGE OF ASSETS	0.07 (0.80)	-1.39 (0.71)*	-1.84 (0.80)**	0.84 (0.77)	0.02 (0.81)	-1.35 (0.71)*	-1.84 (0.81)**	0.81 (0.77)
R&D/SALES	3.54 (2.26)$^{+}$	2.68 (1.77)$^{+}$	3.92 (1.71)**	0.04 (1.78)	4.08 (2.27)*	3.13 (1.86)*	4.31 (1.73)**	-0.10 (1.78)
SALES/ASSETS	-0.48 (0.17)***	-0.23 (0.13)*	-0.47 (0.18)***	-0.51 (0.11)***	-0.44 (0.17)***	-0.22 (0.14)$^{+}$	-0.47 (0.19)**	-0.52 (0.11)***
HAP/SALES					2.14 (2.14)	0.14 (0.89)	0.98 (1.04)	-0.78 (1.04)

Standard errors are in parentheses. ***Statistically significant at the 1% level. **Statistically significant at the 5% level;

*Statistically significant at the 10% level; $^{+}$Statistically significant at the 20% level

Table 4b . Factors affecting EMP Adoption (Multivariate Probit Joint Estimation Model)

	Model 3				Model 4			
	AUDIT	**TQEM**	**REPORT**	**SRISK**	**AUDIT**	**TQEM**	**REPORT**	**SRISK**
Constant	-0.07 (0.69)	-0.29 (0.68)	-0.05 (0.72)	-1.01 (0.63)+	-0.14 (0.69)	-0.098 (0.64)	0.0145 (0.7212)	-1.10 (0.62)*
SUPERFUND SITES	0.01 (0.01)	0.03 (0.01)**	0.02 (0.01)*	0.01 (0.01)	0.0055 (0.012)	0.026 (0.011)***	0.0165 (0.0050)***	0.01 (0.01)
INSPECTIONS	0.40E-04 (0.00)	-0.40E-04 (0.00)**	0.39E-04 (0.00)*	0.65E-05 (0.00)	2.92E-05 (3.76E-05)	-3.72E-05 (1.70E-05)**	0.11E-04 (0.0000)	-0.25E-05 (0.00)
ON-SITE/SALES	0.12 (0.26)	0.11 (0.29)	0.27 (0.18)+	0.30 (0.14)**	0.084 (0.35)	0.062 (0.33)	-0.2088 (0.2853)	0.16 (0.17)
OFF-SITE/SALES	-1.36 (0.98)+	0.05 (0.79)	-3.82 (1.81)**	-2.01 (0.78)***	-0.93 (0.99)	0.18 (0.88)	-4.1188 (1.7038)**	-2.16 (0.84)**
FINAL GOOD	0.70 (0.22)***	0.52 (0.17)***	0.65 (0.16)***	0.35 (0.15)**	0.68 (0.20)***	0.49 (0.17)***	0.6289 (0.1625)***	0.34 (0.14)**
AGE OF ASSETS	-0.18 (0.87)	-1.18 (0.78)+	-1.64 (0.88)*	0.90 (0.77)	-0.15 (0.86)	-1.23 (0.77)+	-1.6382 (0.8955)*	0.82 (0.74)
R&D/SALES	2.45 (2.43)	0.21 (1.94)	3.37 (1.80)*	-1.11 (1.68)	2.09 (2.28)	0.035 (1.99)	3.1953 (1.8108)*	-0.82 (1.72)
SALES/ASSETS	-0.41 (0.16)**	-0.14 (0.12)	-0.28 (0.20)+	-0.46 (0.13)***	-0.42 (0.15)***	-0.17 (0.12)+	-0.3280 (0.1920)*	-0.48 (0.13)***
HAP/SALES	2.23 (2.28)	0.48 (0.84)	0.80 (1.13)	-0.75 (1.00)				
INDUSTRY PENALTY	-0.002 (0.01)	7.2E-04 (0.00)	-0.002 (0.00)	-0.004 (0.00)				
INDUSTRY EMP	1.41 (0.43)***	1.97 (0.37)***	1.79 (0.53)***	1.52 (0.35)***	1.54 (0.47)***	1.91 (0.36)***	1.8593 (0.4804)***	1.64 (0.32)***
INSPECTION*ON-SITE					7.64E-05 (0.000171)	1.76E-05 (3.70E-05)	0.0003 (0.0001)**	0.00003 (0.00006)

Standard errors are in parentheses.***Statistically significant at the 1% level. **Statistically significant at the 5% level; +Statistically significant at the 20% level

Table 5a . Marginal Effects of Factors on EMP Adoption (Probit Estimation Model)

	Model 1				Model 2			
	AUDIT	**TQEM**	**REPORT**	**SRISK**	**AUDIT**	**TQEM**	**REPORT**	**SRISK**
Constant	0.22 (0.14)$^{+}$	0.43 (0.19)**	0.38 (0.21)*	-0.079 (0.21)	0.17 (0.14)	0.42 (0.19)**	0.34 (0.21)*	-0.043 (0.21)
SUPERFUND SITES	.002 (0.002)$^{+}$	0.012 (0.002)***	0.0059 (0.002)***	0.0029 (0.0018)$^{+}$	0.003 (0.002)$^{+}$	0.012 (0.002)***	0.006 (0.002)***	0.002 (0.0019)$^{+}$
INSPECTIONS	0.79E-05 (0.55E-05)$^{+}$	-0.15E-04 (0.60E-05)***	0.14E-04 (0.60E-05)**	-0.24E-05 (0.62E-05)	0.51E-05 (0.54E-05)	-0.15E-04 (0.60E-05)***	0.13E-04 (0.60E-05)***	-0.12E-05 (0.63E-05)
ON-SITE/SALES	0.030 (0.039)	0.030 (0.053)	0.13 (0.06)**	0.091 (0.055)*	0.001 (0.047)	0.022 (0.06)	0.11 (0.06)*	0.11 (0.06)*
OFF-SITE/SALES	-0.27 (0.16)*	0.003 (0.21)	-1.69 (0.51)***	-0.79 (0.33)**	-0.32 (0.18)*	-0.0008 (0.22)	-1.79 (0.52)*	-0.74 (0.33)**
FINAL GOOD	0.16 (.040)***	0.11 (0.05)**	0.23 (0.049)***	0.10 (0.05)**	0.17 (0.04)***	0.11 (0.05)**	0.24 (0.05)***	0.095 (0.053)**
AGE OF ASSETS	-0.017 (0.18)	-0.44 (0.25)*	-0.64 (0.26)***	0.33 (0.27)	-0.007 (0.18)	-0.44 (0.25)*	-0.63 (0.26)**	0.31 (0.27)
R&D/SALES	0.74 (0.49)$^{+}$	1.09 (0.61)*	1.53 (0.62)***	-0.019 (0.65)	0.85 (0.49)*	1.11 (0.62)*	1.60 (0.62)***	-0.079 (0.65)
SALES/ASSETS	-0.086 (0.03)*	-0.078 (0.043)*	-0.21 (0.063)***	-0.21 (0.053)***	-0.08 (0.03)***	-0.08 (0.043)*	-0.20 (0.063)***	-0.21 (0.053)***
HAP/SALES					0.68 (0.32)**	0.10 (0.26)	0.32 (0.28)	-0.35 (0.30)

Standard errors are in parentheses. ***Statistically significant at the 1% level. **Statistically significant at the 5% level;

*Statistically significant at the 10% level; $^{+}$Statistically significant at the 20% level

Table 5b . Marginal Effects of Factors on EMP Adoption (Probit Estimation Model)

	Model 3				Model 4			
	AUDIT	**TQEM**	**REPORT**	**SRISK**	**AUDIT**	**TQEM**	**REPORT**	**SRISK**
Constant	-0.16 (0.16)	-0.23 (0.22)	-0.005 (0.23)	-0.40 (0.24)*	-0.14 (0.16)	-0.22 (0.22)	0.005 (0.24)	-1.07 (0.59)*
SUPERFUND SITES	0.003 (0.002)*	0.01 (0.003)***	0.006 (0.002)***	0.003 (0.002)+	0.0028 (0.0017)*	0.01 (0.002)***	0.006 (0.002)***	0.008 (0.005)*
INSPECTIONS	0.63E-05 (0.57E-05)	-0.11E-04 (0.60E-05)	0.15E-04 (0.62E-05)***	0.29E-05 (0.64E-05)	0.69E-05 (0.64E-05)	-0.13E-04 (0.66E-05)**	0.43E-05 (0.74E-05)	-0.43E-05 (0.17E-04)
ON-SITE/SALES	0.02 (0.04)	0.039 (0.06)	0.11 (0.06)*	0.12 (0.06)**	0.035 (0.05)	0.013 (0.07)	-0.08 (0.10)	0.14 (0.17)
OFF-SITE/SALES	-0.24 (0.17)+	-0.02 (0.23)	-1.69 (0.53)***	-0.74 (0.34)**	-0.19 (0.16)	0.016 (0.23)	-1.70 (0.56)***	-1.84 (0.86)**
FINAL GOOD	0.17 (0.04)***	0.18 (0.05)***	0.21 (0.05)***	0.13 (0.05)**	0.17 (0.04)***	0.17 (0.05)***	0.21 (0.05)***	0.35 (0.14)***
AGE OF ASSETS	-0.09 (0.18)	-0.32 (0.26)	-0.52 (0.27)**	0.35 (0.28)	-0.11 (0.18)	-0.33 (0.26)+	-0.52 (0.28)*	0.96 (0.70)+
R&D/SALES	0.51 (0.48)	-0.11 (0.65)	1.26 (0.63)**	-0.62 (0.67)	0.40 (0.48)	-0.16 (0.65)	1.19 (0.64)*	-1.50 (1.67)
SALES/ASSETS	-0.059 (0.03)**	-0.048 (0.04)	-0.13 (0.062)**	-0.18 (0.05)***	-0.06 (0.029)**	-0.05 (0.04)	-0.15 (0.06)**	-0.46 (0.14)***
HAP/SALES	0.46 (0.30)+	0.12 (0.26)	0.28 (0.28)	-0.35 (0.30)				
INDUSTRY PENALTY	0.16E-03 (0.88E-03)	0.47E-03 (0.001)	-0.62E-03 (0.0013)	-0.0015 (0.0013)				
INDUSTRY EMP	0.45 (0.12)***	0.78 (0.13)***	0.60 (0.15)***	0.62 (0.16)***	0.47 (0.12)***	0.78 (0.13)***	0.62 (0.15)***	1.53 (0.40)***
INSPECTION* ON-SITE					0.55E-05 (0.14E-04)	0.77E-05 (0.99E-05)	0.91E-04 (0.41E-04)**	0.36E-04 (0.34E-04)