

**Determinants of the Firm to Acquire ISO14001 Certificate
and Market Valuation of the Certified Firm ***

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Abstract

This paper examines the incentives for a firm to acquire an ISO14001 certificate and the effect of such an acquisition on the market value of the firm. We show that the firms with a larger size, larger export ratio, higher profitability and higher R&D expenditure have more incentive to acquire the ISO14001 certificate. Further, firms in Medicaments, Metal, Transportation Equipment, Precision Machinery, and Other Manufacturing have less incentive for the acquisition. In addition, after controlling for sample selection bias, we found that the introduction of the ISO14001 certification system contributes to a statistically significant increase in the market value of the firms by 11% to 14%. Our results suggest that the stock market gives firms the incentive to acquire the ISO14001 certificate.

Keywords: ISO14001, Environmental Management System (EMS), Tobin's q, Market Valuation, Probit Model

1. INTRODUCTION

Although governments in many countries have traditionally relied mainly on mandatory environmental regulations, economic instruments such as environmental taxes and charges, economic supports and emission trading are drawing increasing attention. This is because these economic instruments are considered to minimize the cost to protect the environment and to be more efficient in reducing pollutant emission.

However, because of the difficulty of reaching a public consensus on introducing environmental taxes and emission trading systems, governments have given attention to a “voluntary” approach as an alternative or as a complement to the present system. Above all, there is a growing belief in the need to provide firms with the flexibility to set their own technical goals and to achieve environmental targets. These movements have led to reliance on policies promoting voluntary action by firms, such as voluntary programs, voluntary agreements between firms and the government on environmental targets, and certified environmental management systems.

The adoption of an environmental management system (EMS), one form of voluntary action contributing to environmental protection, is often expected to help firms identify their environmental goals and reduce energy consumption, polluting waste, and the risk of future environmental liability.

Recently, the number of facilities and firms that have introduced certified EMSs, such as ISO(the International Organization for Standardization) 14001 and EMAS(the Eco-Management and Audit Scheme), has been increasing. Corresponding to the promotion of self-regulating environmental behavior, increasing attention has been paid to the mechanisms underlying firms’ incentive.¹ Understanding why firms actively seek ISO14001 certificates is a very interesting topic. Because firms are expected to pursue profit maximization, voluntary actions to promote environmental achievement, such as the adoption of the ISO14001, seems inconsistent with the firms’ ultimate aim.

The ISO14001 is particularly interesting to analyze for several reasons. First, the number of ISO14001-certified facilities overwhelms that of EMAS-certified facilities and continues to grow very rapidly.² As of June 2003, the world total of certified facilities was 46,836 and the number of certified facilities in Japan was 12,392, nearly 25% of the world total, which far surpasses the world’s second most certified nation, Spain,

¹ Previous studies, such as Arora and Cason [2, 3], and DeCanio and Watkins [7], among others, have used logit models to analyze what determines firms’ decisions to undertake voluntary action to contribute to environmental protection. However, most of these studies focus on U.S. voluntary programs such as Green Lights’ 33/50 programs. DeCanio and Watkins [7] investigated what determined over 9000 U.S. firms to participate in the Green Lights Program. They found that firm-specific variables, such as firm size, earnings, and insider shareholding significantly affect the firm’s participation decision. Arora and Cason [2, 3] attempted to explain firms’ participation decisions in the EPA’s 33/50 program by their size, financial characteristics, and so on. They found that firm size and industry effects significantly affect the firms’ decisions, whereas financial variables, such as debt ratios, are insignificant in explaining firms’ decisions.

² For example, in the three years between December 1999 and June 2003, the number of ISO14001-certified facilities in Japan grew about fourfold, from 2881 to 12,392 (Japanese Standards Association [14]).

with 3960 certified facilities.³ (ISO World [12]). Second, the ISO14001 is a process standard, not a technical standard, and it can be applied to a broad category of industries, allowing us to analyze the behavior of firms in a more general sense.⁴

In spite of such rapid diffusion of the ISO14001, there are only a few studies analyzing its performance and adoption by firms or facilities (Nakamura, et al. [22] and Welch et al. [24]). Such studies usually focus on the motivation of the firm or facility to be certified. However, they pay little attention to issues such as the performance of the ISO14001, whether the acquisition of the ISO14001 certificate is rewarded in the marketplace, and whether the adoption of an ISO14001 certificate contributes to environmental improvements. Hence, the ISO14001s are still not well understood quantitatively.

From an environmental policy perspective, it is important to explore the performance of the stock market in the context of the ISO14001, that is, whether the stock market values certified firms. This is because the valuation of the market is related to the incentive of firms to voluntarily act to protect the environment. If investors expect that the certified firms have a positive effect in reducing current and future pollution and that the adoption of the ISO14001 will lead in the future to lower risk of environmental liability and higher profitability, then the firm's market value will appreciate in accordance with stock market prices. Then, firms are strongly motivated to adopt the ISO14001.

The purposes of this study are (1) to explore what factors determine whether Japanese manufacturing firms adopt the ISO14001, and (2) to explore whether the stock market values the acquisition of ISO14001 certificates and thus gives firms an incentive to adopt the ISO14001.

Section 2 gives a brief overview of theoretical considerations, and presents two models on the determinants of the decision and market valuation. Section 3 describes the dataset and analyzes the characteristics of variables. Section 4 presents new empirical evidence for the models. Section 5 draws some broad conclusions.

2. MODELS

We analyze two issues: first, the determinants of Japanese manufacturing firms adopting the ISO14001, and second, whether the stock market values the acquisition of the ISO14001.

2.1 A model for the decision of firms to acquire an ISO14001 certificate

With regard to the first issue, a firm's motivational analysis, there are a few empirical studies. Nakamura et al. [22] and Welch et al. [24], the pioneering studies in this field, explored the determinants of firms acquiring an ISO14001 certificate.

Nakamura et al. [22] used data collected from a questionnaire sent to randomly selected firms from the

³ Japan and Spain were followed by Germany, with 3820 certified facilities, the U.S with 3032, Sweden with 2961, and the U.K. with 2917.

⁴ For a more detailed description of the ISO14001, see Welch et al. [24].

Japanese manufacturing firms listed in the First Section of the Tokyo Stock Exchange. Estimation results showed that firm size, the average age of firm employees, the export ratio, and the debt ratio affect the decision making of the firms to be certified. In addition, they concluded that polluting industries are keener than less-polluting industries to adopt the ISO14001. Further, advertising is statistically significant only under some specifications and thus has only limited effects on firms' decision making.

Welch et al. [24] focused on four industries in Japan: chemical, electronics, electric machinery, and electric power. They studied which of three broadly accepted reasons for the adoption of ISO14001 (regulation, competitive advantage, and social responsibility) plays a larger role in each type of industry. Using data collected from a questionnaire sent to the facilities, they showed that the early adopters tend to be larger, greener, and less driven by external pressure such as regulatory, competitive, or media pressures.

In these previous studies, only a limited dataset was available or used. For example, Welch et al. [24] focused on only the four most certified industries. Nakamura et al. [22] used only a part of samples available by randomly selecting firms from the original dataset to carry out the questionnaire survey. In addition, these analyses were based on data collected before the end of 1999 (1997 for Nakamura et al. [22] and 1999 for Welch et al. [24]). However, since that date, the number of certified facilities has quadrupled in Japan. Moreover, although it is positive that Welch et al. [24], unlike Nakamura et al. [22] and our study, explored the facility's incentive for the adoption, they did not use data on the business and financial performance of the firms, to which the facilities belong, because of data unavailability. Hence, they did not take into account the effect of firms' business and financial performance on the decision making.

To solve these problems, we use data from March 2002, including the financial and business performance data of all (rather than randomly selected) Japanese manufacturing firms listed in the First Section of the Tokyo Stock Exchange.

The firm is supposed to determine whether to acquire a certificate⁵ based on the net benefit, including economic and non-economic factors, from the acquisition of the certificate. The i th firm's net benefit from the acquisition, B_i , is specified as follows:

$$B_i = X_{1i}\theta_1 + \varepsilon_{1i} \quad (1)$$

where ε_{1i} is normally distributed with mean 0 and standard deviation of σ_1 , and we denote X_{1i} as a vector of exogenous variables for the i th firm, including firm attributes such as size and profitability.

In practice, B_i is unobservable and what we observe is the firm's choice decision:

$$DISO_i = 1 \text{ if } B_i > 0$$

⁵ In our study, following Nakamura et al. [22], we define a firm as "certified" if at least one of the facilities belonging to it acquires the ISO14001 certificate.

$$DISO_i = 0 \text{ otherwise} \quad (2)$$

where $DISO_i$ is a dummy variable, with $DISO_i = 1$ indicating that the firm has acquired the ISO14001 certificate and $DISO_i = 0$ indicating that it has not obtained it.

Given this specification, the probability of the acquisition decision of the firm is given by:

$$P_i = \Pr ob(DISO_i = 1 | X_{1i}) = \Pr ob(\varepsilon_{1i} > -X_{1i}\theta_1) = 1 - \Phi(-X_{1i}\theta_1) \quad (3)$$

where $\Phi(\cdot)$ denotes the cumulative normal function.⁶

2.2 A model for the valuation of the market

Although some previous studies analyzed the effect of the environmental performance of publicly traded firms on their market value, no previous study examined the effect of the adoption of ISO14001 on the market value of firms.

Earlier literature on the effect of environmental performance on market valuation found some evidence of a relationship between an indication of bad (good) environmental performance by a firm (e.g. oil spills, toxic release) and a lower (higher) market valuation. Klassen and McLaughlin [16] observed a statistically significant negative abnormal return when there was a media report involving bad environmental news on the firm, such as oil spills, and Hamilton [9] observed a similar phenomenon with respect to the toxic release inventory (TRI) announcement in 1989. Klassen and McLaughlin [16] also found a positive return when firms achieved environmental success.

Konar and Cohen [18], who went beyond the event studies and used a more objective measure of environmental performance, found that bad environmental performance has a significant negative effect on the intangible asset value of publicly traded firms and that a higher level of toxin emission results in a significant economic loss by the firm. In addition, they found that the trend is more conspicuous in heavily polluting industries.

In our study, we investigated the effect of acquiring the ISO14001 certificate on the market value of the firm. The firm's action in contributing to environmental protection is expected to affect the future profitability of the firm by reducing the future risk of environmental liability. Therefore, if the adoption of the ISO14001 can contribute to the establishment of a good image, so that firms are viewed as environmentally sound and at less risk of future environmental liability, the ISO14001 can be supposed to increase the firm's current market value. This is because, for the purpose of this study, we should pay attention to the stock price or the market value of the firm rather than the current financial performance over time, as in Hirsch and Seaks [10] and Konar and Cohen [18].

As in previous studies, we rely on the assumption of an efficient capital market (Fama [8]) and explore

⁶ Without loss of generality, we normalize $\sigma_1 = 1$.

the relation between Tobin's q as the market value of a firm and the ISO14001 certification status.⁷

The market value of a firm can be disaggregated into its tangible and intangible assets (Konar and Cohen [18]). We follow this approach because we believe that intangible assets are more directly influenced by environmental action and the image of a firm. Tangible assets consist of the replacement value of property, plant and equipment, cash, inventory, and so on. Intangible assets are valued based broadly on "reputation" and the "valued added" to a firm through its efforts at product differentiation (e.g. patents, trademarks, brand names, and the good image of a firm). These "reputation" factors can affect value both positively and negatively. For example, well-made commercials may contribute to the higher value of an intangible asset, whereas news of corruption by a firm can lower the value of the firm. Therefore, it is natural to think that the environmentally friendly image or action of a firm directly affects intangible assets. In this context, the market may view the adoption of an ISO14001 certificate as a sign that the risk of future liability due to pollution has been reduced. Thus, the adoption of the certificate improves the public image of a firm and results in an increase in investor confidence.

The market value of the firm can be written as:

$$MV = V_T + V_I \quad (4)$$

where MV is the market value of the firm, and V_T and V_I are the portions of the firm value attributable to the tangible assets and the intangible assets of the firm respectively. We measure the value of the tangible assets as the replacement cost (RC) of the firm, which is estimated using accounting-based values for the assets of the firm. As subcomponents of V_T and V_I are not observable, we need to undertake some manipulations. From equation (4) and the definition of Tobin's q , Tobin's q can be expressed as:

$$q = \frac{MV}{RC} = 1 + \frac{V_I}{RC}$$

We hypothesize that the Tobin's q of the firm i is affected by the decision to acquire an ISO14001 certificate, as well as by the attributes of the firm, such as size and profitability. To estimate the effects of various factors on the Tobin's q of the firms, we postulate the model as follows:

$$q_i = X_{2i}\theta_2 + \alpha DISO_i + \varepsilon_{2i} \quad (5)$$

where we denote q_i as the Tobin's q of the firm i , ε_{2i} as a random error term following a normal distribution, X_{2i} as a vector of the firm i , containing the explanatory and control variables such as the attributes of the firm, and $DISO_i$ as the same dummy variable shown in (2).

We should note that the decision of the firm to acquire an ISO14001 certificate, $DISO_i$, cannot be

⁷ Under an efficient capital market, if the investors expect that more polluting firms with greater future risks of environmental liability will gain less profit in the future, their current stock price or their current market value will decrease.

treated as exogenous, because the decision is likely to be affected by the same observable and unobservable factors that determine q_i . For example, given an unpredicted positive technological shock, a firm may be more likely to obtain the certificate, simply because it will be easier for them to acquire the certificate. At the same time, the firm's market value will be positively affected by the improvement in productivity. To correct for a bias due to self-selection in the estimation of the equation (5), we use the two-step procedure suggested by Lee and Trost [19] and Barnow et al. [4]. First, we calculate the predicted probability \hat{P}_i of the i th firm, as indicated in equation (3), using the estimation results from the model for the decision of the firm to adopt the ISO14001 certificate. Then, after replacing $DISO_i$ in equation (5) with \hat{P}_i , we estimate equation (6) by linear least squares, regressing q_i on predicted probability as an explanatory variable, as well as X_{2i} . Thus, we obtain:

$$q_i = X_{2i}\tilde{\theta}_2 + \tilde{\gamma}\hat{P}_i(DISO_i = 1) + \tilde{\xi}_i \quad (6)$$

where we denote $\tilde{\xi}_i$ as an error term with $E(\tilde{\xi}_i | X_2) = 0$.

With regard to the specification of Tobin's q , Hirsch and Seaks [10] found it is more likely that market value determinants have multiplicative effect on q . Thus, the semi-log linear specification is preferable to the linear specification. Hence, for comparison, we estimate an alternative to equation (6), as follows:

$$\ln q_i = \mathbf{X}_{2i}\theta_2 + \gamma\hat{P}_i(DISO_i = 1) + \xi_i \quad (7)$$

where similarly we denote ξ_i as an error term with $E(\xi_i | X_2) = 0$.

3. DATA and VARIABLES

We focus on the publicly held firms in the manufacturing industry in the first section of the Tokyo Stock Exchange. After eliminating missing values from the samples, the total number of samples for the analysis was 573 on March 31, 2002.⁸ Most of the data were obtained from *Nikkei Needs*, whereas the information on the ISO14001 certificate status of facilities was obtained from the Japanese Standard Association [14].

3.1 Variables used in the model I, the effect of the decision behavior of the firm on the ISO14001 acquisition

We explore how current and future profitability, size, financial performance, product type, composition of shareholders, the degree of the contact with consumers, and some other factors affect the decision of the firm

⁸ On March 31, 2002, there were 1,511 firms in all industries and 673 firms in the manufacturing industry in the first section of the Tokyo Stock Exchange.

to be certified in the model.

The decision to adopt the ISO14001 is made primarily at the facility level. Therefore, all of the facilities that belong to a firm do not necessarily adopt the ISO14001. In our study, following Nakamura et al. [22], we define a firm that has at least one certified facility among all its facilities as “a certified firm”.⁹ The variables used in the estimations and the definitions are listed in Table 1.

Table 1: Variables and the Definitions

Variable	Name	Definition
<i>DISO</i>	Dummy variable of ISO14001 adoption	Equal to 1, if a firm has adopted ISO14001 and 0, otherwise
<i>PSR</i>	Current profit-sales ratio	Current profit divided by sales
<i>DR</i>	Debt ratio	Debt divided by capital
<i>S</i>	Annual Sales	—
<i>SG</i>	Sales growth	Growth rate of sales in a year
<i>C</i>	Capital	—
<i>CG</i>	Capital growth	Growth rate of capital in a year
<i>N</i>	Employee	The number of workers
<i>ER</i>	Export sales-gross sales ratio	Export sales divided by sales
<i>IS</i>	Share of stock held by individual stockholders	Stock held by individual investors divided by total stock
<i>GS</i>	Share of stock held by government	Stock held by government divided by total stock
<i>FS</i>	Share of stock held by foreign stockholders	Stock held by foreign investors divided by total stock
<i>AD</i>	Advertising	Sum of advertising expenditure in three consecutive years
<i>RD</i>	R&D	Sum of R&D expenditure in three consecutive years
<i>CTR</i>	Capital turnover ratio	Sales divided by capital

We use profitability (*PSR*), debt ratio (*DR*), capital growth (*CG*), sales growth (*SG*), and rate of capital turnover (*CTR*) as proxies of the current profitability of a firm, the financial soundness, the productivity of capital, the expected growth, and the potential productivity growth, respectively. The number of employees at a firm (*N*) is used to control for differences in the size of firms. Acquisition of the ISO14001 certificate involves some substantial fixed costs, which become less significant for larger facilities. Therefore, firm size may affect the firms’ decision regarding adoption.

The adoption of the ISO14001 may depend on how much of the firm’s products are exported (*ER*), as more export-oriented firms might obtain greater benefits from adoption if their trade partners are keen on environmental protection. Thus, they would be more interested in obtaining an internationally recognized certificate that would act as a visible sign for their foreign partners. Therefore, we use *ER* to control for the

⁹ The analysis of facilities’ motivations by Welch et al. [24], among others, could be more realistic if the business and financial performance data of their “parent” firm were available. However, we apply this assumption to this analysis because of the data limitation and the linkage of this model with the analysis on Tobin’s q.

degree of the firms' export-orientation.

The composition of shareholders may also affect the decision making of a firm, because different types of shareholders have different perspectives and information. There are four types of shareholders, individual investors (*IS*), government (*GS*), financial institutions, and foreign investors (*FS*). We use proportions of shareholding by individual investors, by government, and by foreign investors as proxy variables representing a composition of shareholders.

We use advertisement expenditure (*AD*) as a proxy for the degree of contact with consumers. Firms with larger *AD* expenditure are more likely to retain close contact with final consumers and the public, and thus are more likely to internalize environmental values held by the public.

We use R&D expenditure (*R&D*) as a proxy representing the future perspective of a firm, which means that firms with a larger *R&D* have a longer-term perspective. Hence, the firms with larger *R&D* are supposed to be more interested in becoming certified to avoid the future risk of environmental liability and to increase their expected longer-term profit.

Ideally, *AD* and *R&D* should be stock measures. However, because of data limitation and our inability to obtain comparable data in most of the cases, we measure the *AD* (*R&D*) variable by summing the *AD* (*R&D*) expenditure of a firm in three consecutive years between 1999 and 2002.¹⁰

We use industry dummies as proxy variables representing the industry-wide effects. For example, these dummies control for the possibility that firms in a heavy-polluting industry might have more incentive to be certified to avoid future environmental liability and to obtain public acceptance for their production and their location.^{11 12}

3.2 Variables used for the model of market valuation

In this model, we explore how the current and potential profitability of the firm, the market type, the acquisition of the ISO14001, and so on, affect the market valuation of the firm. The data and variables used in this model are explained above and as follows.

We should note here that some of the data used in both estimations retain different interpretations. For example, as we mentioned before, *R&D* represents forward-looking behavior by a firm in the context of

¹⁰ We use the fiscal year, taking data from April 1999 to March 2002. We sum *R&D* and *AD* over three years and the variables are discounted using a GDP deflator relating to these three years.

¹¹ We have 15 categories of industries, as indicated in Table 4, and we set electronic machinery as a base industry when defining industry dummy variables.

¹² We could use one year lagged variables for all explanatory variables as it is more reasonable to assume that the firm's ISO14001 acquisition decision depends on the characteristics of the firm in the previous years. However, as each firm has been certified in a different year, such an assumption regarding the decision timing is artificial. We are simply presenting a snapshot view of the diffusion process. Using panel data analysis, we could take into consideration the fact that firms obtained ISO14001 certificates at different points of time. This topic is left for future research.

adopting the ISO14001 (equation (6)), whereas it measures the future profitability of the firms in the determination of Tobin's q (equation (7)). Such variables are listed in Table 2.

Table 2: Variables with Different Interpretations

Variables	Equation (6)	Equation (7)
<i>R&D</i>	Foresightedness	Future profitability
<i>AD</i>	Degree of contact with the final consumer (public pressure)	Degree of product differentiation and brand value.

The Market Value of the Firm

The value of the stock is calculated using the account-end stock market price multiplied by the number of shares outstanding (*MSV*) on March 31, 2002. The values of long-term debt and short-term debt (*DV*) for the firm are obtained from *Nikkei Needs*. Therefore, the market value of the firm is calculated as follows:

$$MV = MSV + DV$$

The Replacement Cost of the Firm

The replacement cost of the firm is calculated as the sum of liquid assets (*LA*), property, plant and equipment (*PPE*), and investment (*I*), as follows:

$$RC = LA + PPE + I$$

In addition, we use current profit ratio, sales growth, capital growth, capital turnover ratio, the number of workers at a firm, export sales–gross sales ratio, advertising expenditure, R&D expenditure, and industry dummies as independent variables.

Comanor and Wilson [6] showed that firms in more concentrated industries have a higher Tobin's q. Because of the unavailability of consistent concentration data, we use the industry dummies as the proxy for the market condition. Industry dummies also represent the other industry-wide effects. For example, these dummies control for the possibilities that a lower Tobin's q in a heavy-polluting industry might be due to more investment on pollution-control equipment.

Tables 3 shows the basic statistics of the samples, whereas Table 4 reports the total number of samples and the number of certified firms in each industry in the total samples. The number of total samples and the number of certified firms are 573 and 345, respectively, and the share of certified firms is 60.2%.¹³ The shares of certified firms in paper and pulp, rubber, non-ferrous metal and electric machinery are higher, whereas their shares in metal and other manufacturing industries are relatively lower.

¹³ The share of certified firms is 31.6% in Nakamura et al. [22] and the share of the certified facilities is 48% in Welch et al. [24].

Table 3: Descriptive Statistics (Means and Standard Deviations)

Variable	Unit	All firms	Certified firms	Non-certified firms
<i>MV</i>	billion yen	350.700 (1,032.000)*	510.342 (1,290.730)	109,059 (244.247)
<i>RC</i>	billion yen	236.400 (540.500)	338,553 (672.797)	81.740 (100.904)
<i>q</i>	***	1.231 (0.717)	1.27087 (0.662)	1.17095 (0.791)
<i>DISO</i>	***	0.602 (0.5)	1 —	0 —
<i>PSR</i>	***	0.06314 (0.074)	0.064195 (0.065)	0.061545 (0.087)
<i>DR</i>	***	1.585 (2.135)	1.57369 (1.763)	1.60158 (2.603)
<i>SG</i>	***	1.052 (0.200)	1.04982 (0.124)	1.05632 (0.278)
<i>N</i>	Thousand	2.797 (5.684)	3.904 (7.022)	1.123 (1.420)
<i>ER</i>	***	0.152 (0.197)	0.1789 (0.200)	0.11209 (0.186)
<i>FS</i>	***	0.0819 (0.100)	0.099081 (0.108)	0.056025 (0.080)
<i>IS</i>		0.3256 (0.157)	0.27982 (0.146)	0.39478 (0.147)
<i>GS</i>	***	0.00003 (0.00042)	0.000010714 (0.00010)	0.000066141 (0.00066)
<i>RD</i>	billion yen	26.272 (97.561)	40.316 (123.608)	5.022 (8.773)
<i>AD</i>	billion yen	5.939 (17.103)	8.198 (21.098)	2.520 (6.558)
<i>C</i>	billion yen	113.819 (299.180)	161.068 (374.669)	42.324 (65.500)
<i>CG</i>	***	1.037 (0.204)	1.04436 (0.177)	1.0247 (0.239)
<i>SL</i>	billion yen	195.845 (502.165)	279.835 (625.935)	68,755 (121,429)
<i>CTR</i>	***	2.199 (2.129)	2.18807 (1.958)	2.2153 (2.369)

* Standard deviations are reported in parentheses

Table 4: Number of All Firms and of Certified Firms in Each Industry

Industry	Variable	Number of firms	Number of certified firms
Food	<i>D_FOOD</i>	53	30
Textile	<i>D_TXT</i>	24	13
Paper and Pulp	<i>D_P&P</i>	10	7
Chemical, oil and coal products	<i>D_CHEM</i>	80	50
Medicaments	<i>D_MEDI</i>	32	20
Rubber	<i>D_RUB</i>	8	7
Glass and Clay	<i>D_G&C</i>	18	12
Steel	<i>D_STL</i>	23	11
Non-ferrous Metals	<i>D_NFM</i>	14	10
Metal	<i>D_MTL</i>	26	9
General Machinery	<i>D_GMN</i>	88	47
Electric Machinery	—	118	86
Transportation Equipment	<i>D_TE</i>	31	21
Precision Machinery	<i>D_PM</i>	17	9
Other Manufacturing	<i>D_OMF</i>	31	13
Total	—	573	345

4. ESTIMATION RESULTS

4.1 A model for the Acquisition of the ISO14001 certificate

The estimation results for the discrete choice model articulated in equations (1) and (2) are shown in Table 5. The parameters for *DR*, *SG*, *FS*, *GS*, *AD*, *CTR* and some industry dummies are insignificant even at 10%, but the other parameters are significant. The proportion correctly classified is 75.4%.¹⁴

The positive coefficient on *PSR* and the negative one on its square mean that more profitable firms have more incentive to be certified. Likewise, the positive coefficient on *N* and the negative one on its square mean that larger firms have more incentive to be certified. Again, the positive coefficient on *ER* and the negative one on its square mean that more export-oriented firms have more incentive to be certified. However, in all cases, as profitability, firm size, and the share of exports increase, the likelihood of the firm voluntarily acquiring the certificate increases at a decreasing rate.

By contrast, the parameter for the debt ratio is insignificant and we find that financial soundness does not affect the firm's decision to be certified. This same result was reported in previous studies – for example, Arora and Cason [2] found that financial soundness does not affect firms' self-regulating behavior in regard to participation in voluntary environmental protection programs, such as the EPA's 33/50 program.

With regard to the variables relating to the stockholder's share, the coefficient on *IS* is significantly negative, whereas the coefficients on *GS* and *FS* are insignificant. This means that for firms where a greater proportion of shares is held by an individual investor, there is less incentive to be certified than for those firms

¹⁴ We conducted a Likelihood Ratio Test and rejected the null hypothesis that all coefficients are zero at the 1% significance level ($\chi^2 = 219.0447$).

that have a range of financial, government, and foreign investors.

The positive coefficient on *R&D* indicates that firms with larger R&D expenditure have more incentive to be certified. However, the parameter on advertising expenditure is insignificant, indicating that consumer pressure does not necessarily affect the decision of the firm.¹⁵

The signs of the coefficients on industry dummies for Medicaments, Metal, Transportation Equipment, Precision Machinery and Other Manufacturing are significantly negative, whereas the coefficients on the other industry dummies are insignificant. This indicates that firms in the specified industries have less incentive to be certified than firms in the other industries. The firms with the least incentive to be certified are in Other Manufacturing, followed, in order, by firms in Precision Machinery, Medicaments, Transportation Equipment, and Metal.

Table 5: Estimation Results for the ISO14001 Certificate Acquisition Model

Variable	Estimated Coefficient	Standard Error		P-value	Variable	Estimated Coefficient	Standard Error		P-value
<i>PSR</i>	4.122	1.843	**	[.025]	<i>D_FOOD</i>	-0.306	0.303		[.312]
<i>PSR</i> ²	-16.816	5.807	***	[.004]	<i>D_TXT</i>	-0.219	0.332		[.509]
<i>DR</i>	0.052	0.053		[.323]	<i>D_P&P</i>	-0.161	0.475		[.736]
<i>SG</i>	-0.222	0.364		[.542]	<i>D_CHEM</i>	-0.177	0.225		[.431]
<i>N</i>	0.220	0.069	***	[.002]	<i>D_MEDI</i>	-0.692	0.354	**	[.050]
<i>N</i> ²	-0.007	0.002	***	[.000]	<i>D_RUB</i>	0.382	0.697		[.584]
<i>ER</i>	3.267	1.028	***	[.001]	<i>D_G&C</i>	0.127	0.372		[.733]
<i>ER</i> ²	-3.918	1.517	***	[.010]	<i>D_STL</i>	-0.530	0.349		[.130]
<i>FS</i>	-1.436	0.914		[.116]	<i>D_NFM</i>	-0.038	0.433		[.930]
<i>IS</i>	-2.043	0.512	***	[.000]	<i>D_MTL</i>	-0.563	0.331	*	[.089]
<i>GS</i>	-478.610	392.258		[.222]	<i>D_GMN</i>	-0.318	0.212		[.133]
<i>RD</i>	0.023	0.008	***	[.004]	<i>D_TE</i>	-0.654	0.337	*	[.053]
<i>AD</i>	0.012	0.011		[.269]	<i>D_PM</i>	-0.725	0.371	*	[.051]
<i>CTR</i>	-0.045	0.054		[.405]	<i>D_OMF</i>	-0.858	0.301	***	[.004]
CONSTANT	0.678	0.514		[.187]	Percent Correctly Classified				0.754

*** significantly different from 0 at 1%; ** significantly different from 0 at 5%; * significantly different from 0 at 10%

4.2 A model for Tobin's *q*

The estimation results for equations (6) and (7) are shown in Table 6. As for equation (6), the parameters for predicted probability of ISO14001 acquisition, *PSR* square and *ER* are significant at the 5%, 1%, and 10% significance level, respectively. The sign on the predicted probability of ISO14001 acquisition is positive. This implies that the market values environmentally friendly behavior by firms and that the acquisition of the ISO14001 certificate increases the valuation of the firm. The sign on *PSR* square is positive, as expected, although the parameter for *PSR* is insignificant. The sign on *ER* is also positive. These results indicate that higher profitability and higher *ER* increase the valuation of the firm. It is likely that the market expects that the

¹⁵ This finding coincides with the finding by Arora and Cason [2]

recession, which has been affecting the Japanese economy for a long time, does not affect firms with a higher *ER* so adversely as it does less export-oriented firms.

The parameters for *SG*, *CG*, and *CTR* are significant at the 10%, 1%, and 5% significance levels, respectively, with positive signs. These variables, which are proxies for current and expected growth and productivity, are positively correlated with the valuation of the firm, as is expected.

The parameters for *N* and *AD* are insignificant, indicating that the size of the firm and the closeness of the firm's product to the consumer do not affect the market value of the firm. In addition, the parameter for *R&D* is insignificant, which means the market values that R&D is not necessarily linked to the future profitability.

Industry dummies represent the market condition and the industry effects. The parameters for dummies of non-ferrous metal and of precision machinery are significant at the 1% and 5% levels, respectively, with positive signs. All other significant dummies, for steel, general machinery, and transportation equipment, are significant at the 10% level with negative signs. The parameters for the other dummies are insignificant.

Table 6: Estimation Results for the Tobin's q Model

Equation (6)				Equation (7)			
Variable	Estimated Coefficient	Standard Error	P-value	Variable	Estimated Coefficient	Standard Error	P-value
<i>P(DISO=1)</i>	0.268	0.127	** [.035]	<i>P(DISO=1)</i>	0.303	0.066	*** [.000]
<i>PSR</i>	0.660	0.670	[.325]	<i>PSR</i>	0.886	0.346	** [.011]
<i>PSR</i> ²	14.090	2.043	*** [.000]	<i>PSR</i> ²	6.155	1.055	*** [.000]
<i>SG</i>	0.245	0.126	* [.053]	<i>SG</i>	0.138	0.065	** [.034]
<i>ER</i>	0.281	0.146	* [.055]	<i>ER</i>	0.136	0.075	* [.072]
<i>N</i>	-0.005	0.010	[.612]	<i>N</i>	-0.001	0.005	[.892]
<i>R&D</i>	0.0007	0.0006	[.264]	<i>R&D</i>	0.0003	0.0003	[.329]
<i>AD</i>	0.0023	0.0022	[.288]	<i>AD</i>	0.0016	0.0011	[.150]
<i>CG</i>	0.330	0.127	*** [.010]	<i>CG</i>	0.238	0.066	*** [.000]
<i>CTR</i>	0.027	0.012	** [.030]	<i>CTR</i>	0.031	0.006	*** [.000]
<i>D_FOOD</i>	-0.045	0.113	[.692]	<i>D_FOOD</i>	-0.009	0.058	[.877]
<i>D_TXT</i>	-0.143	0.133	[.282]	<i>D_TXT</i>	-0.098	0.068	[.152]
<i>D_P&P</i>	-0.220	0.191	[.249]	<i>D_P&P</i>	-0.157	0.098	[.111]
<i>D_CHEM</i>	-0.104	0.088	[.236]	<i>D_CHEM</i>	-0.090	0.045	** [.046]
<i>D_MEDI</i>	0.063	0.125	[.616]	<i>D_MEDI</i>	0.128	0.065	** [.047]
<i>D_RUB</i>	-0.287	0.211	[.174]	<i>D_RUB</i>	-0.202	0.109	* [.065]
<i>D_G&C</i>	-0.212	0.149	[.155]	<i>D_G&C</i>	-0.137	0.077	* [.075]
<i>D_STL</i>	-0.232	0.136	* [.089]	<i>D_STL</i>	-0.174	0.070	** [.014]
<i>D_NFM</i>	0.483	0.164	*** [.003]	<i>D_NFM</i>	0.155	0.085	* [.068]
<i>D_MTL</i>	-0.245	0.135	* [.071]	<i>D_MTL</i>	-0.181	0.070	*** [.010]
<i>D_GMN</i>	-0.191	0.084	** [.024]	<i>D_GMN</i>	-0.097	0.044	** [.027]
<i>D_TE</i>	-0.231	0.120	* [.056]	<i>D_TE</i>	-0.175	0.062	*** [.005]
<i>D_PM</i>	0.293	0.150	* [.051]	<i>D_PM</i>	0.135	0.077	* [.083]
<i>D_OMF</i>	-0.133	0.124	[.285]	<i>D_OMF</i>	-0.061	0.064	[.344]
CONSTANT	0.260	0.206	[.208]	CONSTANT	-0.628	0.106	*** [.000]
Adjusted R²	0.373			Adjusted R²	0.455		

*** significantly different from 0 at 1%; ** significantly different from 0 at 5%; * significantly different from 0 at 10%

With regard to the estimation results for the alternative specification, equation (7), as are reported in Table 6, the parameter for predicted probability of ISO14001 acquisition is significant at the 1% with a positive sign again. Hence, the result in the alternative specification also shows that the market values environmentally friendly behavior by firms.

The parameters for *CG* and *CTR* are also significant at 1%, while the parameters for *SG* and *ER* are significant at 5% and 10%, respectively. The signs on these parameters are positive, which is the same result as in the estimation for equation (6). We found a convex relation between Tobin's *q* and profitability, as the result shows that the coefficients on the linear and quadratic terms of *PSR* are both positive and significant. The specifications of equations (6) and (7) produce similar results except for some industry dummies.

A larger number of industry dummies are significant in equation (7), including all those that were significant in the specification of equation (6). Only food, textile, pulp, and other manufacturing were insignificant. The parameters for dummies of non-ferrous metal, precision machinery, and medicaments are positive. All the other significant dummies retain negative signs.

Finally, to estimate the economic value of the certified environmental management system for the market, we calculated the increase in expected market value of the firms due to introduction of the ISO14001 to the current system, using the estimation results. The increase in the expected market value is estimated to be 11% from the specification of equation (6) and 13.5% from the specification of equation (7), as indicated in Table 7.

Table 7: The Contribution of the ISO14001 to Market Valuation

From Equation (6)		Tobin's <i>q</i>	From Equation (7)	
Average of Estimated <i>q</i> when ISO14001 is present (A)	Average of Estimated <i>q</i> when ISO14001 is absent (B)		Average of Estimated <i>q</i> when ISO14001 is present (A)'	Average of Estimated <i>q</i> when ISO14001 is absent (B) '
0.978	0.808	1.231	1.17	0.97
The contribution of the ISO14001 measured by <i>q</i> $= (A)-(B) = 0.17$ (D)			The contribution of the ISO14001 measured by <i>q</i> $= (A)-(B) = 0.17$ (D)	
The contribution of the ISO14001 measured by MV $= \text{Average RC}*(D)/\text{Average MV}$ =0.1099			The contribution of the ISO14001 measured by MV $= \text{Average RC}*(D)'/\text{Average MV}$ =0.1349	

Table 8 shows differences across industries in the extent to which the ISO14001 contributes to market value. The advantage of introduction of the ISO14001 is relatively small in metal, transportation equipment, and precision machinery, which is consistent with the estimation of industrial dummies obtained in the probit estimation. Significantly, all these industries retain larger negative coefficients on their dummy variables (Table 5), which implies that the probability of adopting the ISO14001 certificate is relatively small in these three

industries.

Table 8: The Contribution of the ISO14001 by Industry

	Contribution of ISO measured by MV Equation (6)	Contribution of ISO measured by MV Equation (7)
Food	0.119	0.141
Textile	0.135	0.137
Paper and Pulp	0.181	0.182
Chemical, oil and coal products	0.140	0.155
Medicaments	0.076	0.147
Rubber	0.220	0.226
Glass and Clay	0.134	0.144
Steel	0.126	0.119
Non-ferrous Metals	0.135	0.115
Metal	0.105	0.099
General Machinery	0.118	0.134
Electric Machinery	0.112	0.124
Transportation Equipment	0.077	0.118
Precision Machinery	0.078	0.089
Other Manufacturing	0.112	0.151

5. CONCLUSIONS

The introduction of the certified environmental management system, ISO14001, is expected to play an important role in environmental protection. Despite this, few empirical studies have been conducted on the factors that determine the adoption of the ISO14001 certificate. In this paper, we explore the impact of adopting the ISO14001 on the financial market, as well as analyzing firms' incentives to adopt ISO14001.

In previous studies on this topic, limited datasets were available or used. For example, Welch et al. [24] focused on only the four most certified industries. Unlike Nakamura et al. [22] and this study, Welch et al. [24] explored the certified facilities' incentives for adopting the ISO14001. However, as data were unavailable, they were not able to analyze the effect on the decision-making process of the business and financial performance of the firms to which the certified facilities belong. Nakamura et al. [22] randomly selected firms from a dataset to carry out questionnaire surveys, and thus use only part of the samples available. Even more significantly, both these analyses were based on data collected before the end 1999, but since that date, the number of certified facilities in Japan has been rapidly increasing.

To solve these problems, we used more recent data, dating from March 2002, which includes financial and business performance data for all (rather than randomly selected) Japanese manufacturing firms listed in the First Section of the Tokyo Stock Exchange. In our study, using these data for a large sample of firms, we explored the characteristics of the firms that determine the acquisition of the ISO14001 certificate. In addition,

we examined whether the stock market values such voluntary action by the firm to contribute towards environmental protection.

From the estimation results, we found that the firms with a larger size, larger export ratio, higher profitability and higher R&D expenditure have more incentive to acquire the ISO14001 certificate. Further, firms in Medicaments, Metal, Transportation Equipment, Precision Machinery, and Other Manufacturing have less incentive for the acquisition.

In addition, we observed, after controlling for sample selection bias, that the stock market values voluntary action that contributes to environmental protection. Thus, the acquisition of the ISO14001 certificate increases the market value of a firm, reflecting an expected reduction in the potential risk of environmental liabilities. We also found that the introduction of the ISO14001 certification system contributes to an increase in the market value of the firms of between 11% and 14%, depending on specifications.

Our results suggest that the stock market gives firms the incentive to voluntarily acquire the ISO14001 certificate because it gives firms better access to credit markets. There are several possible reasons why the ISO14001 certificate status of a firm has been positively incorporated in market valuation. One of the biggest factors is that possession of the certificate is a simple and obvious proof of “environmentalist” firms, which will have a lower risk of environmental liabilities and lower adjustment costs if environmental policy is tightened in the future.

Finally, we should note that these estimations might be overestimated. The adoption of the ISO14001 is one of the tools contributing to the protection of the environment. Certified firms might adopt different environmental management tools at the same time and be aggressive in reducing pollution. Hence, adoption of the ISO14001 might become a proxy of such behavior. Thus, in this study, the effects of the ISO14001 on Tobin’s q , which indicates the market valuation of the firm, might also include the effects of adopting different tools and undertaking pollution reducing practices. Nevertheless, we believe that our results remain valid in exploring the motivations for firms to self-regulate their behavior to ensure environmental protection and in analyzing whether the Japanese stock market values such environmentally sound behavior.

We consider that our results provide evidence in support of the voluntary approach as an effective environmental policy instrument that can take advantage of the market incentive mechanism. Our results are important, because voluntary approaches, such as the certified environmental management system, the voluntary environmental protection program, can offer certain advantages over mandatory regulations that impose technology restrictions or environmental taxes. First, the voluntary approach allows flexibility in reaching the firm’s environmental goals, and thus may be more efficient in minimizing the cost of environmental protection. Second, it may reduce information costs and the administrative burden on environmental authorities. Finally, it avoids a lengthy political process that would be necessary for public acceptance of mandatory regulations and environmental taxes.

We propose that policies such as information disclosure of firms’ pollution emissions, or the introduction of a ranking system of firms and their products, based on their pollution and environmental soundness, will play an important role in enabling the market to value firms. Thus, it will motivate firms to actively self-regulate to ensure environmental protection.

From the environmental policy perspective, it is important to understand fully several issues related to the ISO14001. We believe that the following important questions should form the basis for future research: first,

what properties of the ISO14001 make it possible to reward firms in the marketplace; second, will the ISO14001 fulfill its promise as an instrument of environmental policy and contribute to pollution reduction; and finally, why is the ISO14001 far more prevalent in Japan than in the rest of the world.

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References

- [1] W. R. Q. Anton, G. Deltas and M. Khanna, Environmental Management Systems: Do They Improve Environmental Performance?, *J. Environ. Econom. Management*, forthcoming.
- [2] S. Arora and T. N. Cason, An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program, *J. Environ. Econom. Management*, 28(2), (1995) 271-286.
- [3] S. Arora and T. N. Cason, Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA's 33/50 Program, *Land Econom.*, 72(4), (1996) 413-432.
- [4] B. S. Barnow, G. C. Cain, and A. S. Goldberger, Issue in the analysis of selectivity bias, in W. Stromdorfer and G. Farkas (Eds.) *Evaluation Studies Review Annual*, Sage Press, Beverly Hills, 1981, pp. 43-59.
- [5] I. Cockburn and Z. Griliches, Industry Effects and the Appropriability Measures in the Stock Markets Valuation of R&D and Patents, *Amer. Econom. Rev.*, 78(2), (1988) 419-423.
- [6] W. S. Comanor and T. A. Wilson, Advertising, Market Structure and Performance, *Rev. Econom. Statist.*, 49, (1967) 423-440.
- [7] S. J. DeCanio, and W. E. Watkins, Investment in Energy Efficiency: Do the Characteristics of Firms Matter?, *Rev. Econom. Statist.*, 80, (1998) 95-107.
- [8] E. Fama, Efficient Capital Markets: Review of Theory and Empirical Evidence, *J. Finance*, 25, (1970) 383-417.
- [9] J. T. Hamilton, Pollution as News: Media and Stock Market Reactions to Toxics Release Inventory Data, *J. Environ. Econom. Management*, 28(1), (1995) 98-113.
- [10] B. T. Hirsch and T. G. Seaks, Functional Form in Regression Models of Tobin's q, *Rev. Econom. Statist.*, 75(2), (1993) 381-385.
- [11] M. A. Hirschery and J. J. Weygandt, Amortization Policy for Advertising and Research and Development Expenditures, *J. Accounting Res.*, 23(1), (1985) 326-335.
- [12] ISO World, "The number of ISO 14001/EMAS Registration of the World," available at <<http://www.ecology.or.jp/isoworld/english/analy14k.htm>> (2003).
- [13] A. B. Jaffe, Technological Opportunity and Spillovers of R&D: Evidence from Firm Patents, Profits and Market Value, *Amer. Econom. Rev.*, 76(5), (1986) 984-1001.
- [14] Japanese Standard Association, "ISO9000s/ISO14000s," available at <http://www.jsa.or.jp/iso/iso14000_05.asp> (2003) (in Japanese)
- [15] M. Khana and L. A. Damon, EPA's Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms, *J. Environ. Econom. Management*, 37, (1999) 1-25.
- [16] R. D. Klassen and C. P. McLaughlin, The Impact Environmental Management on Firm Performance, *Management Sci.*, 42(8), (1996) 1199-1214.
- [17] S. Konar and M. A. Cohen, Information as Regulation: The Effect of Community Right to Know Laws on Toxic Release, *J. Environ. Econom. Management*, 32(1), (1997) 109-124.
- [18] S. Konar and M. A. Cohen, Does the Market Value Environmental Performance?, *Rev. Econom. Statist.*, 83(2), (2001) 281-289.
- [19] L. Lee and R. P. Trost, Estimation of Some Limited Dependent Variable Models with Application to

- Housing Demand, *J. Econometrics*, 8, (1978) 357-382.
- [20] E. B. Lindenberg and S. A. Ross, Tobin's q Ratio and Industrial Organization, *J. Bus.*, 54(1), (1981) 1-32.
- [21] P. Megna and D. C. Mueller, Profit Rates and Intangible Capital, *Rev. Econom. Statist.*, 73(4), (1991) 632-642.
- [22] M. Nakamura, T. Takahashi and I. Vertinsky, Why Japanese Firms Choose to Certify: A Study of Managerial Responses to Environmental Issues, *J. Environ. Econom. Management*, 42 (1), (2001) 23-52/
- [23] C. J. Simon and M. W. Sullivan, The Measurement and Determinants of Brand Equity: a Financial Approach, *Marketing Sci.*, 12(1), (1993) 28-52.
- [24] E. W. Welch, Y. Mori and M. Aoyagi-Usui, Voluntary Adoption of ISO14001 in Japan: Mechanism, Stages and Effects, *Bus. Strat. Env.*, 11, (2002) 43-62.
- [25] E. W. Welch, A. Rana, and Y. Mori, The Promises and Pitfalls of ISO14001 for Competitiveness and Sustainability: A Comparison of Japan and the United States, *Greener Management International: J. Corporate Environ. Strat. Pract.*, forthcoming.