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ANALYSIS

Globalization, firm-level characteristics and environmental management: A study of Japan

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ABSTRACT

Using Japanese firm-level data, we identify and quantify the factors that influence the environmental management of Japanese firms. We measure 14 different aspects of a firm's environmental management and investigate how firm-level characteristics and external pressures affect the quantity and effectiveness of environmental management systems and structures. Our results show that one consequence of the growth in international trade and FDI is that Japanese firms are increasingly aware of their environmental obligations and that both regulatory and non-regulatory factors play a role in a firm's decision to quantify and manage the impact their activities have on the environment.

1. Introduction

In recent years corporations over the world have become increasingly aware of the environmental damage associated with their activities and have, sometimes reluctantly, made efforts to lessen this damage. The pressure for firms to employ appropriate structures and systems to control pollution comes from both formal and informal sources (see Pargal and Wheeler, 1996). The former are those usually defined by law and enforced by regulators. The latter encompass the pressures exerted by, for example, non-governmental organisations, local communities and market agents such as consumers and investors.

In a developed country such as Japan these pressures have resulted in significant reductions in air pollution over the last 20–30 years (OECD, 1994) despite rapid economic growth over the same period. However, data provided by Nihon Keizai Shimbun (2000) together with the results of Nakamura et al. (2001), indicate that patterns of environmental management practices across Japanese firms demonstrate considerable differences. Some firms have incorporated environmental goals into the very heart of their decision-making processes while others appear to largely ignore environmental considerations or do the minimum required by legislation. For example, the adoption of voluntary practices such as ISO14001 certification and the promotion of employee awareness of environmental

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practices is relatively patchy. Furthermore, a growing body of literature suggests that this variation in environmental management practices is not limited to Japan (see e.g. Gunningham et al., 2003, 2004). A natural question to ask therefore is what causes these differences across firms.

This paper aims to answer this question by employing a Japanese firm-level dataset, previously unused for the purposes of economic analysis, to identify and quantify the factors that influence the environmental management practices of Japanese firms. Our dataset allows us to examine 14 different aspects of a firm's environmental management process, covering both the management of specific environmental issues and more general structure and systems management. We are therefore able to examine all aspects of a firm's environmental management processes and are not dependent on far narrower measures of environmental management as, for example, used by previous studies (e.g. Nakamura et al., 2001). Specifically, we make the following contributions to the literature. First, we examine the extent to which a range of firm-specific factors such as firm size, profitability and the average age of employees influences environmental management. Thus, we identify those firm-level characteristics that appear to encourage and discourage the adoption of a wide range of environmental management practices. Second we assess the extent to which factors external to the firm may influence its environmental management. Specifically we ask whether the 'forces of globalization', as captured by participation in export markets or undertaking foreign investment, stimulates environmental management. Anti-globalization protestors clearly see the environment as a victim of free market forces although globalization may encourage the absorption of innovative technology, expose the firm to greater international monitoring and generally, perhaps via the role of the media, increase the public visibility of a firm. By assessing whether exposure to globalization encourages or discourages the adoption of environmental management practices, we contribute to the wider globalization and the environment debate (see e.g. Antweiler et al., 2001; Neumayer, 2001; Cole and Elliott, 2003). Finally, we examine whether the inherent pollution intensity of the industry to which each firm belongs plays any role in determining the extent to which environmental management practices are adopted. We therefore assess whether firms in more pollution intensive industries are more or less likely to have sophisticated environmental management systems.

With regard to the previous literature, theoretically, Sinclair-Desgagné and Gabel (1997) demonstrate how firms can design environmental audits that can improve environmental management systems without adversely affecting other activities. Drawing on the organisational management literature, Aragon-Correa and Sharma (2003) argue that the extent to which a firm's resources and capabilities (which include technology, managerial skills and attitudes) will affect environmental management is contingent upon a number of factors including the complexity and uncertainty of the business environment and the munificence of the firm in question. Although more numerous, empirical studies that analyse the determinants of firm's environmental management decisions are limited. Henriques and Sadorsky (1996) examine the external pressure exerted by customers, shareholders and local communities on firms' environmental performance in Canada while Levy (1995) examines the relationship between consumers and community pressure groups on the environmental performance of transnational corporations (TNCs). Gunningham et al. (2003, 2004) continue this theme by arguing that firms are subject to a 'social license', enforced by stakeholders such as pressure groups and community action groups, which encourages firms to go beyond minimum standards, often with regard to reputational consequences. In a related study, Pargal and Wheeler (1996) examine the impact of informal factors such as education and income per capita on the emissions of a specific pollutant by Indonesian firms. In addition to external pressures, firm specific factors have also been shown to have an impact on a firm's environmental performance. DeCanio and Watkins (1998), in a study for the US, find that firm-specific factors such as size and shareholder structure affect the decision to participate in the Green Light program (a voluntary pollution prevention program). Also for the US, Arora and Cason (1995, 1996) show that firm size and industry effects are important determinants of a firm's participation decision in the Environmental Protection Agency's 33/50 program. In the closest study to our own, Nakamura et al. (2001) examine the relationship between ISO14001 certification and firm-level characteristics for Japanese firms. Finally, Gray and Deily (1996) examine firm-level characteristics and the decision of firms in the US Steel industry to comply with air pollution regulations while Cole et al. (2005b), examine the determinants of UK industry level emissions.

The remainder of the paper is organized as follows: Section 2 reviews the methodology and describes our data; Section 3 presents the results and Section 4 concludes.

2. Methodology and data

In this paper we merge two firm-level datasets, Nihon Keizai Shimbun (2000) and Toyo Keizai Shinpo (2000a,b). As far as we are aware these datasets have not previously been combined. In this section we outline our main hypotheses and discuss our dependent and independent variables.

The Nihon Keizai Shimbun (2000) dataset was constructed from the survey results of a questionnaire that was sent to all publicly quoted companies and a random selection of major non-public companies in the Japanese manufacturing sector and selected non-manufacturing industries (*construction* and *electricity and gas*).[1] The survey was conducted between the beginning of October and the middle of November 1999. The purpose of the questionnaire was to gather detailed information regarding the environmental management practices of Japanese firms.

In total, data were obtained from 875 firms representing a response rate of 44%. Of the 875 responses, we were able to match other firm-level data from Toyo Keizai Shinpo (2000a,b) to approximately half of them. The result is an overall sample of around 400 firms. Each of our environmental performance

[1] See Appendix 1 for a list of industries. Those in bold are those designated as "dirty" industries based on Mani and Wheeler's (1998) classification system where an industry is defined as *dirty* if it is ranked within the top ten in terms of overall emissions.

indicators is derived from the marks ascribed to the answers to one of thirteen multi-part questions. To allow comparison across indicators, each measure is standardised around a mean of fifty with a standard deviation of ten.[2]

Thirteen of our fourteen indicators are allocated to one of two distinct groups with the fourteenth being an overall summary statistic. The first six relate to the management, and control, of specific environmental problems. Examples include the management of total CO_2 emissions and the outsourcing of the treatment of industrial waste. The other seven are concerned with the quality of the general structure and systems that firms employ to handle environmental issues. Examples include the disclosure of environmental information (on products and on the treatment of chemicals) and the award of ISO 14001 certification. The overall environmental management performance measure is constructed from a principal components analysis of the other thirteen indices.

To help interpret the basic scores a firm receives for each variable it is useful to briefly clarify how the survey results were constructed. Each indicator is constructed from the answer to one of thirteen questions, each of which contains a number of parts, although our data do not allow us to distinguish between the answers or weightings that are given to the different parts of each question. However, with the exceptions of Total Industrial Waste Management, Total Treated Industrial Waste Management and Management of CO_2 emissions, each indicator is derived purely from questions relating to environmental management rather than actual environmental performance. Even for these exceptions, only one part in six of the question relates to changes in actual emissions or waste.[3]

Table 1 provides index numbers for our 14 indicators grouped by industry. Detailed descriptions of each variable can be found in Appendix 1. From Table 1 we can see that firms in the *Gas and Electricity* and *Iron and Steel* industries have the best record for overall management performance while those firms in *Construction*, *Machinery* and *Textiles* industries have the worst. What is interesting, however, is that there are significant differences across industry by indicator, so that an industry with a high score in one measure may have a relatively low score in another. For example *Gas and Electricity* has high scores across the board except for Industrial Waste Outsourcing. Likewise, *Iron and Steel* performs badly on the Land and Ground Water Pollution Control indicator.

Our additional firm-level characteristics were obtained from Toyo Keizai Shinpo (2000a,b). The term in brackets is the variable name used in the regression analysis.

To test the globalization hypothesis, we consider the variables that relate more generally to the openness of a firm and how they impact on environmental management. The first variable is Foreign Direct Investment (FDI). It is hypothesised that firms that embark on direct investment abroad are more likely to exhibit higher levels of environmental management. Possible explanations include (1) that such firms are likely to employ similar operational standards across countries (Levy, 1995) so that if a Japanese firm invested in a country with higher regulations then standards would subsequently be raised in Japan; (2) that overseas affiliates are more likely to employ advanced technological solutions in order to maintain a competitive edge and to thus compensate for any lack of local knowledge (Kindleberger, 1969; Hymer, 1976). This information, in turn, could then form the foundation for technological improvements at home; (3) firms may choose to centralize the environmental management systems of overseas affiliates in the source country giving the impression of strong domestic investment in environmental management systems; (4) multinational enterprises may be subject to closer national and international monitoring than domestically owned firms. FDI is measured as a dummy that equals one if the firm undertook overseas investment in 1999.

Our second globalization variable is exports (Exports). It is hypothesised that those firms that export a certain proportion of their output are more likely to be influenced by international competition and the pervasive forces of globalization and hence will be more receptive to innovative production technologies or goods. Similarly, firms that compete in the global marketplace come under closer international monitoring from the products markets, the capital markets and non-governmental organisations. The overall effect may be to encourage good environmental management. Exports are measured as a dummy that is equal to one if a firm exported some of its products in 1999.[4]

The wider globalization and environment literature has been subject to a number of endogeneity concerns. Specifically, the standard concern is that trade and FDI are endogenously related to environmental regulations at the national level i.e. rather than causality moving from FDI to regulations it may, instead, move in the opposite direction. This can occur if countries set their regulations artificially low in order to attract FDI. Moreover, it is possible that foreign owned firms may lobby governments for lower regulations (or slower increases) in the future (Damania et al., 2003). We believe this problem to be minimised in our dataset for the following reasons. First, firms undertake a large proportion of environmental management practices voluntarily and hence the link between formal government regulations and firm-level environmental management is likely to be limited.[5] Thus, if levels of FDI (or exports) influence regulations they may not influence environmental management. Secondly, we concentrate on firm-level data and it is unlikely that a firm's decision to invest abroad or to enter the export market is related to how well it chooses to manage its domestic environmental obligations.

[2] The standardisation procedure is $50+10^{*}(X-\bar{X}/\text{S.D.})$ where X is the initial value for each environmental management indicator. It should be noted that the standardisation applies to our matched sample of firms and not the 875 replies from the original survey. The result is that the means are generally greater than the standardised level of 50. This reflects the fact that the matching data was biased towards larger firms that, ceteris paribus, are more likely to have environmental management systems in place.

[3] For reasons of space, an English translation of the original questionnaire can be found Cole et al. (2005a).

[4] We would ideally lag FDI and exports since their impact on environmental management is unlikely to be instantaneous. Unfortunately, data limitations prevent his and hence we are implicitly assuming that FDI and exports in 1999 were representative of FDI and exports in years immediately prior to 1999.

[5] Although, in principle, regulatory agencies may encourage firms to adopt certain management practices, as far as we are aware, Japanese firms are in no way forced to do this.

Table 1 – Mean of each environmental performance for each industry

Variable	Construction	Food and Beverages	Textile	Paper and Pulp	Chemicals and Chemical Products	Refined Petroleum Products	Rubber and Plastics Products	Clay and Glass	Iron and Steel	Non-Ferrous Metals and Metals Products	Machinery	Electrical Machinery	Motor Vehicle	Other Transport	Precision Instruments	Other Manufacturing	Gas and Electricity
Overall environmental management performance	48.05	54.91	50.54	55.04	54.93	53.83	57.18	55.63	61.29	51.47	50.36	58.58	54.68	52.97	53.59	52.26	70.25
Total industrial waste management	48.34	55.68	55.50	48.84	53.62	50.69	57.30	49.89	52.10	49.44	50.93	52.98	50.65	56.63	50.83	49.24	74.00
Total treated industrial waste	46.84	51.84	50.82	54.67	55.60	55.94	58.80	52.78	58.46	50.54	50.87	56.50	59.42	54.25	51.36	50.89	63.50
CO_2 emission management	44.80	52.00	50.91	50.00	53.62	55.32	57.50	53.56	56.55	51.90	49.51	54.91	56.07	53.13	51.42	53.59	66.50
Land and ground water pollution control	46.80	51.32	49.37	51.50	50.80	50.44	51.10	50.00	50.00	54.14	52.19	59.98	50.42	51.25	58.65	48.24	58.50
Industrial waste outsourcing	51.48	57.52	50.46	47.84	53.44	51.94	57.40	53.34	64.55	52.20	50.72	54.82	51.52	49.88	52.83	51.83	50.00
Management of global warming	47.03	53.92	50.23	65.50	52.07	56.13	56.70	53.67	62.19	50.00	50.25	56.13	54.36	53.13	52.24	54.24	76.00
Environmental accounting	47.19	54.60	51.69	59.34	51.10	49.19	52.20	54.67	59.28	48.84	49.55	57.88	53.23	49.50	51.65	53.12	66.50
Environmental management structure	54.55	56.32	49.28	54.67	54.38	54.69	52.20	54.45	60.28	51.07	50.84	55.76	53.07	58.00	55.00	50.65	65.00
Disclosure of environmental statement	50.07	55.00	51.05	53.67	56.60	52.75	50.10	58.12	58.46	49.57	48.51	56.00	53.04	46.88	49.53	51.48	72.00
Disclosure of chemical treatment	42.36	51.00	51.32	52.67	57.55	54.94	55.70	54.45	56.64	51.74	50.14	57.70	54.84	49.88	51.71	51.53	67.00
ISO 14001	50.90	51.24	50.19	53.84	53.52	54.19	56.60	58.45	59.28	51.77	51.84	58.12	54.49	54.13	57.42	50.95	61.50
Environmentally friendly products	48.17	53.84	47.78	50.50	51.91	51.32	54.30	55.23	60.73	50.47	50.40	58.50	49.81	50.38	52.48	53.42	78.50
Environmental cooperation	52.71	53.68	48.00	53.17	53.76	48.82	61.60	53.78	60.00	53.17	47.97	52.98	52.88	53.63	50.48	51.77	60.50

That said, we do acknowledge that a firm possessing a good environmental record may be more attractive to global partners or recipients of its exports. Although it is therefore not possible to state that endogeneity concerns have been removed we do, however, believe them to be less of a problem than industry and country level studies that examine the relationship between the environment and FDI and trade.

In addition to our openness variables we employ a range of regressors to measure formal and informal factors that may influence the environmental management practices of Japanese firms. To capture a firm's factor endowments we include physical capital intensity (PCI). It is hypothesised that the higher the physical capital intensity of a firm the more likely it is to have highly capital-intensive and complex production facilities. This, in turn, provides greater opportunities and scope for the introduction of clean technologies during the normal course of upgrading production facilities. Furthermore, there is an additional effect as a result of the established positive relationship between PCI and actual emission levels (see e.g. Antweiler et al., 2001; Cole and Elliott, 2003). Pollution intensive (and capital intensive) industries would be expected, therefore, to adopt more stringent environmental management practices due to the additional demands of regulators. The expected sign is therefore positive. We measure PCI as capital stock per worker.

A second endowment variable is human capital intensity (HCI). Following on from the argument above, it is supposed that those firms where a large proportion of the workforce is defined as skilled are more likely to have technologically advanced and complex production lines, larger R&D divisions and hence better environmental management systems. Moreover, if such a complex process results in greater emissions intensity, we may again expect to see a more comprehensive environmental management system in place. The expected sign is therefore positive. HCI is measured as total wages per worker.

The next group of variables is a set of firm specific controls. First, firm size (Size). Larger firms have a number of potential advantages over smaller firms when it comes to the introduction of environmental management systems. Larger firms are more likely to have the resources and infrastructure to enable them to dedicate staff to environmental management. Large firms are also more likely to appear 'on the radar' of monitoring organisations which may act as a disciplinary device (Zarsky, 1999). It is hypothesised that firm size will have a positive impact on environmental management (DeCanio and Watkins, 1998; Nakamura et al., 2001). Firm size is measured by total employment.

It is predicted that the lower the debt ratio (Debt) of a firm the freer that firm is to employ its capital for environmental related expenditure. The expected sign on debt ratio is therefore negative (Nakamura et al., 2001). The debt ratio is measured as both long and short-term debt relative to assets.

Related to the increasing public awareness of environmental issues encouraged by non-governmental organisations such as Greenpeace and Friends of the Earth, we attempt to investigate the relationship between public exposure and environmental performance. It is envisaged that the higher the marketing expenditure of a firm (Marketing), the stronger the relationships between the firm and consumers, the media, and other external stakeholders. An increase in the value of the firm's brand as a result of marketing activity means that a firm is more likely to internalize the environmental values held by the general public. The expected sign is therefore positive. Marketing intensity is measured as the cost of advertising as a proportion of sales.

It is generally assumed that R&D intensive firms (R&D) are more likely to be the most technologically advanced. If we imagine that a certain percentage of R&D expenditure is targeted specifically at the development of clean technologies then it is supposed that these firms are more able to adopt technological solutions to environmental problems. It could be argued that forward looking firms who engage in R&D generally, would also have environmental management systems in place to investigate the role of R&D in helping to avoid regulatory costs. The expected sign is therefore positive. R&D intensity is measured as the share of R&D expenditures relative to sales.

To control for the overall economic performance of a firm we include a measure of productivity (TFP). The more productive and hence efficient a firm is the more likely it is to have efficient environmental management systems and structures in place. The expected sign is positive. Our measure of productivity is calculated using a Cobb–Douglas production function.[6]

Similarly, the profitability of a firm (Profits) is included and is measured as the return on assets. More profitable firms are assumed to have access to the funds (via retained profits or capital markets) to make the necessary investments required to improve environmental management (Nakamura et al., 2001). The expected sign is therefore positive. Profitability is measured as a firm's ordinary profit relative to it total assets.

Our penultimate variable is a measure of the average age of employees (Age) under the premise that younger employees are generally more trainable, adaptable, less resistant to change and perhaps more environmentally aware. As a result, it is hypothesised that the lower the average age of a firm's employees, the more likely the firm will be to implement environmental policies and practices.[7] The expected sign is therefore negative.

Finally we include a Keiretsu dummy (Keiretsu) to capture the unique corporate structure of some Japanese firms known as the keiretsu and to see whether being a member of a Keiretsu has a systematic effect on a firm's environmental performance. One result of keiretsu membership is that the firm should have less rigid liquidity restrictions that should enable the firm to raise sufficient funds to undertake environmental improvements when required (Hoshi et al., 1991). There may also be positive technological and managerial spillover effects from other firms within the keiretsu so that member firms share information and make joint business and investment decisions including the decision to adopt greener policies and technologies. In contrast, however, there may be a competing effect where membership of a keiretsu adversely affects the efficiency and freedom with which a firm can operate. Moreover, the strength of the legal

[6] Estimation details are available from the authors upon request.

[7] A superior measure would perhaps be the average age of each firm's management, but such a variable is not available.

Table 2 – Mean of each economic variable for each industry

Variable	Construction	Food and Beverages	Textile	Paper and Pulp	Chemicals and Chemical Products	Refined Petroleum Products	Rubber and Plastics Products	Clay and Glass	Iron and Steel	Non-Ferrous Metals and Metals Products	Machinery	Electrical Machinery	Motor Vehicle	Other Transport	Precision Instruments	Other Manufacturing	Gas and Electricity
FDI	0.59	0.50	0.67	0.54	0.76	0.57	0.91	0.63	0.62	0.57	0.62	0.87	0.87	0.73	0.78	0.57	1.00
Exports	0.21	0.04	0.64	0.34	0.78	0.82	0.90	0.78	1.00	0.57	0.97	0.97	0.68	1.00	0.95	0.71	0.00
PCI	0.13	0.40	0.19	0.48	0.29	0.45	0.18	0.42	0.48	0.25	0.15	0.12	0.15	0.17	0.13	0.20	0.78
HCI	0.09	0.09	0.07	0.09	0.08	0.09	0.09	0.08	0.10	0.09	0.08	0.08	0.08	0.07	0.08	0.08	0.14
TFP	7.64	8.06	7.49	7.59	7.76	7.94	7.88	7.61	7.54	7.60	7.62	7.86	7.69	7.59	7.77	7.73	8.10
Profits	0.02	0.04	0.02	0.01	0.03	0.07	0.04	0.02	−0.01	0.01	0.02	0.03	0.02	0.02	0.03	0.04	0.04
Debt	0.08	0.12	0.13	0.12	0.12	0.20	0.09	0.13	0.11	0.11	0.15	0.20	0.12	0.12	0.16	0.13	0.05
Size	0.35	0.27	0.27	0.48	0.28	0.39	0.37	0.47	0.91	0.29	0.35	0.70	1.04	0.54	0.30	0.34	1.09
Marketing	0.05	0.33	0.08	0.01	0.07	0.25	0.10	0.05	0.01	0.02	0.04	0.10	0.05	0.05	0.15	0.18	0.00
R&D	0.01	0.06	0.20	0.05	0.30	1.04	0.03	0.25	0.10	0.11	0.16	0.26	0.05	0.12	0.36	0.08	0.28
Age	39.35	38.52	38.19	40.65	39.91	39.56	40.25	39.52	41.02	38.15	39.30	37.82	38.57	41.50	39.54	37.32	42.60
Keiretsu	0.75	0.68	0.55	0.67	0.62	0.69	1.00	0.45	0.82	0.67	0.65	0.50	0.55	0.50	0.53	0.48	1.00

teams and resources available to Keiretsu members may result in greater lobbying pressures on the Japanese government to keep regulations low and to fight any civil or government action to impose fines or reduce emissions in the industry of the Keiretsu firm. The expected sign of the coefficient is therefore undetermined. Following Fukao et al. (1994), if the largest percentage of a firm's loan is from the same main bank for over 3 years then it is considered a keiretsu of the bank and the firm is given a dummy variable of one.[8]

In our sensitivity analysis we replace industry dummies with a dummy variable to capture the inherent dirtiness of an industry. This allows us to investigate whether, over and above the effect of other variables, dirty industries tend to have better environmental management systems than non-dirty industries. As mentioned above in the context of physical capital intensity, there is the possibility that dirty industries face more stringent environmental regulations, are more visible to external agencies and generally require more developed environmental management practices due to the greater volumes of pollution and waste that are generated. Appendix 1 provides the list of dirty and clean industries while Fig. A1 provides the average value of each environmental management index for firms in both 'dirty' and 'clean' industries, offering some support for this argument.

Table 2 provides a table of means for each variable, grouped by industry. Table 2 reveals, for example, that the largest firms are in *Motor Vehicles* and *Gas and Electricity*. The largest debt levels are recorded for those firms in *Precision Instruments* and *Refined Petroleum Products* while marketing spend is highest for firms in the *Food and Beverages*, *Refined Petroleum Products* and *Other Manufacturing Industries*. Our average export variable ranges from a low of 0.04 for *Food and Beverages* to a high of 1 for *Iron and Steel* illustrating the variation in trade patterns across firms.

Our final estimating equation is therefore:

$$\begin{aligned}\mathrm{EnvPer_i} = {} & \alpha_1 + \alpha_{2i}\mathrm{Exports} + \alpha_{3i}\mathrm{FDI} + \alpha_{4i}\mathrm{PCI} + \alpha_{5i}\mathrm{HCI} \\ & + \alpha_{6i}(\mathrm{TFP\ or\ Profits}) + \alpha_{8i}\mathrm{Debt} + \alpha_{9i}\mathrm{Size} + \alpha_{10i}\mathrm{marketing} \\ & + \alpha_{11}\mathrm{R\&D} + \alpha_{12i}\mathrm{Age} + \alpha_{13i}\mathrm{Keiretsu} + \varepsilon_i \end{aligned} \quad (1)$$

Total factor productivity and profits were included separately to avoid possible co-linearity problems. All estimations employ OLS analysis with heteroskedastic-robust error terms. Industry dummies are included to control for industry specific effects. A correlation matrix is provided in Appendix 1. The nature of the relationships that we are investigating means that the endogeneity issues that plague the globalization and the environment literature are unlikely to be present. Subsequently we are able to run standard OLS analysis without recourse to instrumental variables or complicated lag structures. Finally, it should be noted that, due to data limitations, the FDI and export variables are dummy variables. Although it would be interesting to analyse how the

[8] The six main banks listed in the firms' '*keiretsu*' list of Toyo Keizai Shinpo (2000c) are Mitsui (now Sakura), Mitsubishi (now Tokyo-Mitsubishi), Sumitomo, Fuji, Sanwa and Ikkan.

Table 3 – Overall environmental management performance and environmental management for specific environmental issues

Variable	Overall environmental management performance (1)	Total industrial waste management (2)	Total treated industrial waste management (3)	CO_2 emission management (4)	Land and ground water pollution control (5)	Industrial waste outsourcing and recycling (6)	Management of global warming and energy saving (7)
FDI	3.73**	−1.91	3.47**	−0.24	1.80	2.38	−1.30
Exports	5.49***	0.68	6.19***	3.55***	2.43**	5.00***	4.89***
PCI	3.67**	−5.47**	1.83**	−3.54	−4.43*	2.90	8.62***
HCI	12.83	−0.14	12.24	14.05	23.46*	−15.50	−1.59
TFP	1.84**	1.68**	1.73***	0.85	0.31	0.22	1.00
Debt	−8.27***	−11.78***	−14.25***	−14.92***	−8.71**	−12.65***	−8.60***
Size	5.60***	0.96	3.42***	4.45***	2.06***	3.88***	4.89***
Marketing	2.06***	−0.90	−1.28	−1.75	0.07	3.08	−1.20
R&D	5.21***	2.05	4.57**	3.53	2.24	2.12	0.31
Age	−0.14	−0.29*	−0.23	−0.38**	−0.08	0.02	−0.17*
Keiretsu	−1.40*	0.05	−1.20	−2.09**	−0.92	−0.77	−1.54**
Constant	29.90***	47.06***	37.42***	52.95***	44.97***	45.67**	43.85***
R^2	0.53	0.19	0.39	0.30	0.33	0.30	0.50
Obs	397	399	392	398	395	394	399

Standard errors are excluded due to space considerations although *, ** and *** denote statistical significance at the 10%, 5% and 1%, respectively.

growth in trade and FDI has affected environmental management activity, data limitations mean it is beyond the scope of this paper.

3. Results

3.1. *Estimation results*

Our results are split into three distinct sections. The first considers the overall environmental management variable that also provides the basis for our sensitivity analysis. Our remaining thirteen environmental management indicators are split into two groups, those that measure the management of specific environmental problems and those that consider each firm's general systems and structure for dealing with environmental issues.

Table 3 reports the result of an OLS analysis for our overall environmental management indicator and our six problem specific variables.[9]

For our overall environmental management variable reported as regression (1) in Table 3, the significance of our explanatory variables is high with the majority of variables exhibiting significance at the 5% level or better. The results reveal that the coefficient on FDI is positive and significant, confirming the expectation that firms that undertake FDI are more likely to have higher standards of environmental management. The coefficient on exports is also positive and significant reflecting, we believe, the effects of international competition on the adoption of innovative technologies or products and the possibilities of greater international monitoring.

We now consider our other explanatory variables. Physical capital intensity (PCI) is a significant and positive determinant of overall management, implying that firms with more physical capital intensity have more advanced environmental management systems. This concords with prior expectations and reflects, we believe, the positive correlation found to exist between pollution intensity and emissions intensity (Antweiler et al., 2001; Cole and Elliott, 2003). Human capital intensity (HCI) generally has no significant effect. Firm size is strongly significant and positive as expected. This implies that larger firms have a greater capacity to invest in mechanisms to handle environmental concerns. The results also show that total factor productivity (TFP) has a significantly positive impact on overall environmental management, suggesting that efficient firms make greater efforts to lessen their environmental impact. The ratio of debt to assets, Debt, is negative and significant as expected under the premise that distressed companies are less likely to have environmental concerns as a top priority.

Of the other variables in regression (1), marketing intensity (marketing) is positive and significant suggesting that firms with higher marketing intensity are reacting to pressures from consumers and NGOs to be environmentally friendly or risk damaging the brand and corporate reputation of the company. The coefficient on R&D also has the expected positive and significant sign.

The average age of employees (Age) seems to have little effect. Finally, our Keiretsu dummy variable is negative and significant (at the 10% level). The sign on the relationship between Keiretsu membership and environmental management was undetermined although it now seems that such membership may represent a hindrance to environmental management perhaps via an inherent inflexibility, or the bureaucracy, of internal procedures. A second explanation may be that members of a Keiretsu will have greater access to legal teams and resources to enable them to fight civil and government actions to increase regulations or demand lower

[9] The results for our industry dummies are not included for reasons of space. In our sensitivity analysis we report the results of a regression with no industry dummies and others that include a 'dirty' industry dummy.

Table 4 – Structure and systems environmental management

Variable	Environmental accounting (8)	Environmental management structure (9)	Disclosure of environmental statement (10)	Disclosure of chemical treatment (11)	ISO 14001 (12)	Environmentally friendly products (13)	Environmental cooperation (14)
FDI	0.65	6.00***	1.82	1.44	6.84***	4.31***	3.85***
Exports	1.20	5.65***	4.68***	4.39***	5.48***	1.33	1.65*
PCI	1.34*	2.10	4.95*	5.03***	2.92*	−1.31	3.72
HCI	18.39*	−12.60	−15.02	2.39	−9.29	12.30	7.22
TFP	1.76***	1.35**	2.04***	0.12	2.49***	1.49**	−0.66
Debt	−4.55	−12.72***	−6.25**	−6.08	−8.60**	−4.91*	−1.80
Size	7.00***	3.22***	6.95***	4.45***	2.62***	5.47***	5.91**
Marketing	1.62	−2.63**	4.24***	3.93***	2.92	6.39**	−1.71*
R&D	3.65**	2.01*	3.76**	4.28***	0.89	4.24**	4.11***
Age	−0.16	−0.29***	−0.10	−0.07	−0.10	−0.10	−0.08
Keiretsu	−2.17***	−0.73	−1.35	−0.98	−1.16	−1.35	0.38
Constant	35.77**	52.75***	33.51***	40.40***	30.74***	35.69***	53.21***
R^2	0.46	0.42	0.49	0.52	0.36	0.39	0.32
Obs	402	395	397	386	394	397	409

Standard errors are excluded due to space considerations although *, ** and *** denote statistical significance at the 10%, 5% and 1% respectively.

emissions. This supports the findings of DeCanio and Watkins (1998) for US firms while Nakamura et al. (2001) find mixed results with their Keiretsu dummy largely insignificant.

Of interest in this paper is whether our determinants vary across indicators. Regressions (2)–(7) consider the environmental management of specific environmental problems. In terms of openness, only Total Industrial Waste Management (2) appears unaffected by a firm's entry into export markets or by the firm's decision to invest abroad. Other interesting results include the finding that CO_2 Emissions Management (4) and Management of Global Warming (7) are both negatively related to Keiretsu membership (the two indicators that are given the highest profile by NGOs and consumer pressure groups outside Japan).

The sign on PCI is also inconsistent across regressions with unexpected negative coefficients on Total Industrial Waste Management (2) and Land and Ground Water Pollution Control (5). Finally, contrary to regression (1), it is interesting to note that marketing intensity (marketing) is not significant in any of the other six regressions. Interestingly, Age is significantly negative in regressions (2), (4) and (7) giving some support for the hypothesis that 'younger' firms are more environmentally aware and quick to adapt to specific environmental problems.

We now turn to Table 4 that considers the determinants of a firm's environmental system and structures. In most cases the evidence is supportive of the overall management results (1). Of particular note is that, like our overall environmental management indicator (1), for three indicators (10), (11) and (13), we find marketing to be a positive and significant determinant of environmental management. This suggests that those firms most concerned about their external image are those most likely to disclose an environmental statement (10), disclose a statement relating to chemical treatment (11) and claim to produce environmental friendly products (13). The fact that we find the marketing effect to be more significant for these 'structure and systems' variables compared to those in Table 3, presumably reflects the fact that the systems and structures indicators in Table 4 are more general and more publicly visible. A firm that is keen to present a positive public image is therefore more likely to ensure that their environmental systems and structures are suitably stringent. It is also worth noting that the R&D variable is generally more significant in Table 4 than Table 3, suggesting that those firms with the highest levels of R&D tend to have more developed environmental systems and structures in place.

3.2. *Sensitivity analysis*

In Table 5 we undertake a range of sensitivity estimations to test for robustness across our variables concentrating, for reason of space, on the overall environmental management variable.[10]

In regression (15) we replace TFP with a measure of profits (measured as the return on assets). The results seem to suggest that profits have no significant effect on overall performance.[11] Regressions (16) and (17) drop FDI and exports alternately. Both remain positive and significant suggesting that the openness effect is robust.

To examine the relationship between the dirtiness of an industry and its environmental performance, regressions (18)

[10] Similar tables for other performance indicators are available from the authors upon request. It is notable that exports generally have a larger, more significant, effect on environmental management than FDI, perhaps reflecting the greater exposure to overseas competition faced by exporters. A firm that competes in global markets may have to meet minimum environmental standards in order to enter certain export markets or may choose to develop environmental management systems in order to enhance its reputation. Compared to this mechanism, the manner in which FDI may influence environmental management may be less direct and perhaps weaker in magnitude.

[11] When profits and TFP are included jointly, profits are usually negative and significant suggesting that, over and above TFP, a firm with high profitability has little regard for environmental related issues.

Table 5 – Sensitivity analysis on overall environmental management performance

Variable	Full (15)	Full (16)	Full (17)	DIRTY (18)	Clean (19)	Full No dummies (20)	Full (21)
FDI	3.10**		4.23**	6.95***	4.29***	4.31***	3.73***
Exports	5.35***	5.59***		3.52***	6.35***	5.09***	5.49***
PCI	3.84**	3.85**	2.81	2.31	8.38***	5.31***	3.67**
HCI	20.42**	13.71	12.41	103.87**	4.71	16.95	12.83
TFP		1.60**	1.55**	0.87	2.40***	1.59***	1.84***
Profits	−4.41						
Debt	6.34***	−7.61***	−5.98**	−20.91***	−12.63**	−8.05***	−8.27***
Size	5.64***	5.68***	5.92***	10.36***	5.19***	6.14***	5.60***
Marketing	2.32***	2.15**	2.13**	9.36***	1.89	2.47***	2.06***
R&D	4.58***	5.06***	6.76***	7.91***	4.20**	2.97***	5.21***
Age	−0.15	−0.16	−0.11	−0.21	−0.08	0.10	−0.14
Keiretsu	−1.68**	−1.27*	−0.92	−1.14*	−1.92**	−1.00	−1.40**
Dirty							13.58***
Constant	48.32***	38.56***	35.34***	38.46***	27.28***	33.14***	33.90***
R^2	0.46	0.52	0.49	0.77	0.58	0.45	0.53
Obs	397	397	397	146	254	397	397

Standard errors are excluded due to space considerations although *, ** and *** denotes statistical significance at the 10%, 5% and 1%, respectively.

and (19) split the sample into firms from clean and dirty industries. It is notable that marketing intensity is only significant for firms in dirty industries suggesting that firms that pollute and have a strong corporate identity spend more trying to give the impression of caring for the environment. Less clear is why human capital intensity is positive and significant for dirty firms only. This explanation may be linked to the findings of Cole et al. (2005b) who demonstrate, for US industries, that HCI and pollution intensity are positively related.

Finally, regression (20) presents the results with no dummies for the full sample, while (21) includes a 'dirty' dummy instead of industry dummies. Regression (20) demonstrates the robustness of our general results. Regression (21) is generally supportive of our previous results but does exhibit a positive and significant coefficient for the dirty industry dummy. This suggests that, as expected, over and above the effect of our other explanatory variables, those firms that pollute the most also have the best overall environmental management. That dirty firms have some of the best environmental management systems may not be that surprising as it would appear to be rational behaviour in the face of increasing environmental regulations and ever-closer scrutiny from a range of governmental and non-governmental organisations.

4. Discussion and conclusions

The results in this paper go some way towards explaining the differences in environmental management behaviour across Japanese firms. One of the main results of this paper is the seemingly positive relationship between our measures of globalization and environmental management. Perhaps one consequence of the growth in multinational activity is that such firms are becoming increasingly aware of their environmental obligations. In an information and media-led world, the repercussions for a company that obtains a reputation as an abuser of the environment can be severe for future profits and even for the survival of the firm. This is reflected, for example, in the fact that a firm's expenditure on advertising and brand building is a positive determinant of environmental management.

Another inference we can draw from this study is that governments need to consider two aspects of a firm's environmental performance. A distinction can be made between managing a firm's pollution and managing how the general public perceive the firm's management of pollution. Measures to encourage a greater take up of ISO 4001 would, for example, more closely align a firm's aims with its actual environmental outcomes.

A final point of interest is the generally negative sign on the 'Keiretsu' variable that suggests that the traditional corporate structure of the Japanese economy may act to hinder improvements in the environmental management of Japanese firms. They may reflect an inherent lack of flexibility and inability of 'Keiretsu' members to adapt quickly to changing public and governmental perceptions on the importance of environmental issues. The other possible explanation is that the financial and legal resources available to Keiretsu members may enable them to fight civil and government actions aimed at increasing regulations or reducing emissions in the firm's area of business.

There is a considerable scope for future research in this area. Measures of firm-level emissions and more direct measures of regulations would enable us to examine more closely the relationship between environmental management and actual performance.

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Appendix A
Data definitions

Each of our firms falls into one of the following industries: Food and Beverages, Textiles, **Paper and Pulp**, **Chemicals and Chemical Products**, Refined Petroleum Products, **Rubber and Plastics Products**, **Clay and Glass**, **Iron and Steel**, **Non-Ferrous Metals** and **Metal Products**, Machinery, Electrical Machinery, Motor Vehicle, Other Transport Equipment, Precision Instruments, Other Manufacturing, **Gas and Electrical** and Construction. Industries in bold are those defined as 'dirty' by Mani and Wheeler (1998). The exception is the Gas and Electrical industry that is classified as dirty based on UK emission data.

Table A1 – Definitions of dependent variables (source: Nihon Keizai Shimbun, 2000)

Variable	Definition/source
Total industrial waste management	Management to control total industrial waste. The variable uses progress in setting targets for managing total industrial waste, the value of the targets and actual reduction of total industrial waste in percentage terms. The results for each part of the question are then summed.
Total treated industrial waste management	Management of total amount of industrial waste.
CO_2 emission management	Management of CO_2 emissions.
Land and ground water pollution control	Management of land and ground water pollution and the activities concerning environmental pollution prevention. The value evaluated a firms understanding of their land and ground water pollution and the implications of dioxin reducing practices.
Industrial waste outsourcing and recycling	The variable uses the degree of control firms have over the outsourced treatment of industrial waste.
Management of global warming and energy saving	The variable uses the amount of effort put into, for example, for tree planting and energy saving.
Environmental accounting	Measures the structure of the costs associated with managing environmental programs. The variable uses the amount of effort applied to environmental accounting.
Disclosure of environmental statement	The variable evaluates whether environmental statements are provided to shareholders and the level of content.
Environmental management structure	Records whether a firm has a department designed to focus on environmental affairs, who is in charge and whether there are methods of imparting environmental information to employees.
Environmental friendly products	The variable measures the progress in the implementation of Life Cycle Assessment (LCA) and the level of parts and materials that are bought from green sources.
Environmental cooperation	Measures how a firm cooperates and partners with external agencies such as other firms or research organisations concerning environmental issues.
Disclosure of chemical treatment	Disclosure of information concerning chemicals and their treatment. The value measures the understanding of the situation concerning the amount of usage and emission of chemicals, and the degree of disclosure of information.
ISO 14001	Acquirement of the ISO 14001 certification. A firm with ISO 14001 certification has an environmental management programme that is recognised to meet a range of internationally agreed standards.
Overall environmental management performance	The overall environmental management performance is calculated by using principle component analysis on the 13 indices listed above.

Table A2 – Correlation matrix of economic variables and overall environmental management performance

	Overall environmental management performance	FDI	Exports	PCI	HCI	TFP	Debt	Size	Marketing	R&D	Age	Keiretsu
Overall environmental management performance	1.00											
FDI	0.20	1.00										
Exports	0.25	0.24	1.00									
PCI	0.16	0.09	−0.20	1.00								
HCI	0.10	−0.02	−0.07	0.27	1.00							
TFP	0.15	−0.06	−0.09	0.18	0.19	1.00						
Debt	−0.01	0.13	0.21	−0.16	−0.08	0.21	1.00					
Size	0.53	0.09	0.14	−0.01	0.05	−0.02	−0.11	1.00				
Marketing	0.07	0.05	−0.06	0.02	−0.10	0.04	0.05	0.01	1.00			
R&D	0.20	0.12	0.28	−0.04	−0.05	−0.02	0.19	0.13	0.08	1.00		
Age	0.06	−0.04	0.05	0.08	0.16	−0.01	−0.16	0.04	−0.11	0.03	1.00	
Keiretsu	−0.02	0.02	0.04	0.05	0.05	−0.19	−0.36	0.06	−0.03	0.05	0.23	1.00

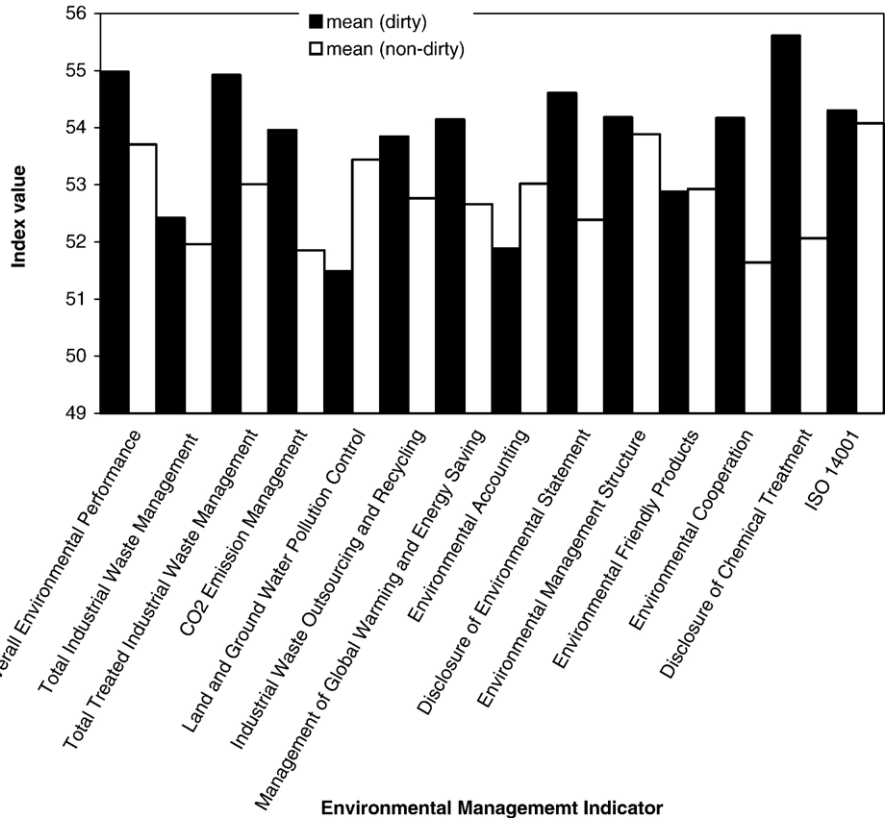

Fig. A1 – Mean environmental management indicators for 'dirty' and 'non-dirty' industries.

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