Does green management pay? An empirical examination of the relationship between the environmental and financial performance of listed Japanese companies

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CONTENTS

Abbreviations & Acronyms

CEO	chief executive officer
CO_2	carbon dioxide
GDP	gross domestic product
ISO	International Organisation for Standardisation
JASDAQ	Japan Association of Securities Dealers Automated Quotations
METI	Ministry of Economy, Trade and Industry (of Japan)
MOE	Ministry of the Environment (of Japan)
NOx	nitrogen oxide
OECD	Organisation for Economic Co-operation and Development
PRTR	Pollutant Release and Transfer Register
ROA	return on assets
ROE	return on equity
ROS	return on sales
S&P	Standard & Poor's Corporation
SOx, SO2	sulphur oxide, sulphur dioxide
TRI	Toxic Release Inventory

Abstract

The notion that it ‘pays to be green’ is widely promoted by environmental commentators. Relatively few studies, however, have rigorously examined the empirical relationship between corporate environmental performance and firm profitability, particularly in the Japanese context. This thesis considers five carefully-defined quantitative hypotheses capturing the notion that it “pays to be green”. Multiple regression techniques are applied to a panel data set of 300 Japanese listed manufactures over a five year time frame, constructed using the comprehensive environmental performance measures from the Nikkei Environmental Management Survey and financial measures extracted from the Toyokeizai database. The analysis reveals that financial performance (measured by Tobin’s q) is strongly and significantly correlated with environmental performance. Although operating performance (measured by return on sales, assets and equity) is also positively correlated, this correlation is not always statistically significant. As might be expected, results show that there are ‘diminishing returns’ to being green: efforts to improve environmental performance by high-polluting industries and firms yield greater *operating* performance improvements than efforts by firms and industries that are already very green. Interestingly, however, the effect on *financial* performance is the opposite — environmental improvements by firms that are already green are more highly valued by the market than by firms which are struggling with low environmental performance. Finally, it is found that while environmental enhancements take time to produce improvement to operating performance, the market appears to anticipate these improvements and adjusts firms’ intangible-assets value immediately. Overall, subject to caveats about causation, the analysis in this thesis lends qualified support to the claim that it ‘pays to be green’.

1. Introduction

Being ‘green’ is rapidly becoming a mainstream objective of business management in Japan. The influential Nikkei Survey (2005) reports that 219 manufacturers (37% out of 590 responding companies) have already achieved ‘zero-emission’ operations in their domestic factories and another 82 Japanese manufacturers plan to achieve the same target by 2012. Moreover, 378 manufacturers (64%) have reduced chemical emissions beyond the legal requirement and 390 manufacturers (66%) have already introduced low-polluting vehicles such as compressed natural gas (CNG) and electric-powered vehicles for their product distribution. A sizeable 389 manufacturers (66%) have internal greenhouse gas emission reduction targets, in spite of the absence of regulations.

Why are firms so eager to be green in the face of competitive pressure from companies in other countries such as the U.S. and, more recently, China? Various theories have been advanced for this trend, including reduced costs from efficient material input usage, reduced costs due to less waste disposal, reduced regulatory scrutiny, less public and community pressure, and enhanced product value and firm competitiveness due to consumer demand for ‘green products’ (Porter and van der Linde 1995, Konar and Cohen 2001). But theories, of course, are of little value if they are never confirmed or rejected by the available evidence. Little advance in this literature is possible until a crucial set of empirical questions are answered. Does being green really improve profitability on average? Does the market value firms who invest in environmentally beneficial practices?

Unfortunately, although there are a multitude of case studies and qualitative papers reporting environmental improvements that also increased profits, there is a distinct paucity of rigorous

empirical studies on the relationship between corporate green management and financial performance, especially in relation to Japanese firms. This thesis seeks to rectify that lacuna by investigating the correlation between environmental and financial performance of publicly listed Japanese companies by using two reliable data sources. The Nikkei Survey (see Section 4 below) is employed as a measure of environmental performance and financial statements from Toyokeizai (2002 and 2004) are used to gauge corporate performance.

It is well known that during the rapid economic growth of the 1950s and 1960s Japan's private and public sectors both invested heavily without proper considerations for protecting the environment (Nakamura et. al., 2001). Consequently, high levels of pollution caused serious health problems, such as the Minamata disease from mercury poisoning and severe asthma due to polluted air in the cities of Kawasaki and Yokkaichi. These pollution-related health problems raised public attention to environmental protection in the late 1960s and this led the Japanese government to introduce the Basic Law for Environmental Pollution Control (1967) and other environmental measures including the enactment of the Air Pollution Control Law (1968), the Water Pollution Control Law (1970) and establishment of Environment Agency (1971) (see Table 1 for history of environmental problems and measures in Japan). Another important factor contributing to the Japanese companies' environmental efforts was the significant oil price increase due to the first and second oil shocks in the 1970s. In responding to the energy crises under the lack of domestic primary natural resources, Japanese industries invested enormously in less energy-consuming production equipment and pollution control devices with the support of governmental policy and financial schemes (Nakamura et. al., 2001). In fact in the 1970s and 1980s, Japan reduced SO_2 and NO_x emissions at the highest rate among the OECD members while achieving the highest economic growth rate among the G7 countries (OECD, 1994). Since

1990s, in response to new environmental policies against such as global warming and the creation of a closed-loop material society, Japanese companies have made further progress on environmental protection.

As of December 2003, the number of ISO 14001-certified plants in Japan was 13,416, surpassing second-placed UK's 5,460, third-placed China's 5,064 and the USA's 3,553 (ISO, 2004). The number of companies publishing environmental or CSR reports increased from 169 in 1997 to 743 in 2003 (MOE, 2004c). There are various kinds of other indications showing the rapid progress of environmental management in modern Japan (see Table 2 for recent environmental regulations and eco-friendly corporate behaviour). Consequently, Japan is now one of the most environmentally-economically efficient countries in the world (see Figure 1, 2 and 3). These high levels of eco-efficiency are attributed mainly to industry sector efforts (MOE, 2002a, see Figure 4).

Therefore, it should be noted that this paper examines the correlations between the environmental and financial performance in relatively, in general, low polluting Japanese current companies. It should be also taken into account that Hart and Ahuja (1996) demonstrated that emission reduction in the U.S. toxic release inventory (TRI) had no significant effect on financial performance for the low polluting U.S. firms during the period 1989-1992, but had a positive and significant effect on financial performance for the high polluting firms.

The paper proceeds as follows. Section 2 reviews the literature on the relations between environmental performance and profitability. In Section 3, the hypotheses to be tested are established based on theories. Section 4 describes this survey methodology and data. Section 5

presents empirical results and Section 6 discusses the results as concerns causality between environmental performance and profitability. Section 7 concludes with referring to contributions to the literature and future research.

Table 1 Transition of environmental problems of Japan

	Year	Social economy and science and technology	Environment status and international movement	Environmental measures of Japan
High-growth period when industrial pollution was generated (1st stage, around 1960's to 1972)	1955	- The "Economic White Paper" declared "it is no longer a post-war" material (1956) - Joined the United Nations. (1956) - Opening of metropolitan expressway (1959) Jimmu economy November 1954 to June 1957	- Itai Itai disease was detected (Jinzu River basin). (1955) - Minamata disease was detected. (1956) - Protest against factory effluent by the Tokyo Bay fishermen. (1958)	- Memorandum was exchanged with the local factory (Shimane Prefecture) * First Pollution Control Agreement by the local public bodies (1952) - Smoke Control ordinance was established (Tokyo) (1955) - Natural Parks Law was established. (1957) - Law regarding water quality conservation of public basins and law regarding factory effluent were established. (1958) - Factory Location Law was established. (1959)
	1960	- The Japan - U.S. Security Treaty was signed. (1960) - National income doubling plan (1960) - National total development plan (1962) - Joined OECD (1964) - Opening of Tokaido Shinkansen (1964) - Host the Tokyo Olympics. (1964) Iwato economy June 1958 to December 1961 Olympic economy October 1962 to October 1964	- Slime accumulation in Tagonoura, Shizuoka Prefecture (1960) Yokkaichi pollution became serious (asthma, etc.) - Smog was generated over one week. (Tokyo) (1962) - Rachel Carson, "Silent Spring" (1962) - The construction project of Mishima/Numazu industrial complex was canceled due to protest from the residents. (1964) - The second Minamata Disease was detected (Agano River basin). (1965)	- Law regarding smoke and soot emission control was established. (1962)
	1965	- The population in Japan exceeded 100 million. (1966) - European Community (EC) was established. (1967) - Japan's GNP ranked the 2nd in the world. (1968) - The first human landed on the moon. (1969)	Expansion of Red Tide - Niigata Minamata Disease lawsuit and Yokkaichi pollution lawsuit(1967)	- Basic Law for Environmental Pollution Control was established. (1967) - Air Pollution Control Law and Noise Regulation Law were established. (1968)
	1970	- Osaka EXPO was held. (1970) - Number of passenger vehicles owned exceeded 10 million. (1971) - The Okinawa Return Agreement was signed. (1972) - The "Plan for Remodeling the Japanese Archipelago" was announced. (1972) - Club of Roma "Limits to Growth" (1972) Izanagi economy October 1965 to July 1970 Remodeling the Japanese Archipelago December 1971 to November 1973	- Photochemical smog damage frequently occurred in Tokyo. (1970) Serious air pollution by smoke, soot, and SOx occurred. Environmental pollution problem caused by PCB - The policy of imposing the responsibility on those who caused pollution was accepted by OECD. (1972) - Declaration on the Human Environment was accepted by the United Nations Conference on the Human Environment. (1972) - The World Environment Day (June 5) was decided by the UN General Meeting. (1972) - The UN Environment Plan (UNEP) was established. (1972)	- Fourteen pollution related measures were established in the 64th Diet session. (1970) (Marine Pollution Prevention Law, Waste Management and Public Cleansing Law, Water Pollution Control Law, Law concerning Entrepreneurs' Bearing of the Cost of Public Pollution Control Works were established.) (1970) - The Environment Agency was established. (1971) - Construction of Oze automobile road was cancelled. (1971) - Nature Conservation Law was established. (1972)
Stable-growth period when urban type pollution become noticeable (2nd stage, 1973 to middle of 1980's)	1973	- Changed to the floating exchange rate system. (1973) - 1st oil crisis caused by the 4th Middle East wars (1973) - 2nd oil crisis occurred (1979) - Three-Mile Island nuclear power plant accident occurred (USA) (1979)	- Washington Convention was accepted (UN). (1973) - The possibility of ozone depletion by CFCs was indicated. (1974) - London Convention became effective. (1975) - Serious Red Tide occurred in Seto Inland Sea. (1976)	– Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea was established. (1973) - Chemical Substances Control Law was established. (1973) - Pollution-related Health Damage Compensation Law was established. (1973) - Notice of Japanese Version of Muskie Act (1974) - SOx emission control system was introduced. (1974) - Law Concerning the Rational Use of Energy was established. (1979) - Total pollutant load control of COD. (1979)
	1980	– Number of Japan's automobile production reached No.1 in the world. (1980) - Iran-Iraq War (1980) - The USA launched the first space shuttle. (1980)	- SOx environmental quality standard was almost accomplished. (1980) The occurrence of photochemical oxidants was decreasing. Ground subsidence expanded nationwide.	- NOx emission control system was introduced. (1981) - Law Concerning Special Measures for the Preservation of Lake Water Quality was established. (1984)
Period when global environmental problems were beginning to be recognized (3rd stage, from middle of 1980's)	1985	- Tsukuba Science EXPO was held. (1985) - Chernobyl nuclear power generation plant accident occurred. (1986) - The National Railways was divided and privatization was implemented. (1987) - World's share market collapsed (Black Monday). (1987) - The Seikan tunnel was opened and Seto Bridge was completed. (1988) Bubble Economy November 1986 to February 1991	- An ozone hole was discovered above Antarctic. (1985) - Vienna Convention for the Protection of the Ozone Layer was accepted. (1985) Continuously decrease in automobile traffic noise environmental quality standards accomplishment rate. Ground water pollution by trichloroethylene and so on spread more widely. The NO_2 environmental quality standard accomplishment rate (general bureau) deteriorated. - "Our Common Future" was announced (WCED). (1987) - The Montreal Protocol was accepted. (1987) - An Intergovernmental Panel on Climate Change (IPCC) was established. (1988) The household wastewater pollution problem became serious in the enclosed basins.	- Ozone Layer Protection Law was established. (1988)
	1989	- Tokyo Stock exchange price average reached the highest in its history (38,915 yen) (1989) - Consumption tax (3%) was introduced. (1989) - The Berlin Wall collapsed. (Integration of East Germany and West Germany) (1989) - Gulf War (1991) - Soviet Union collapsed and CIS was established. (1991) - The five-day working week system became stable and schools started to introduce the system. (1992)	- Valdez oil leakage accident (1989) The agricultural chemical problem of golf courses became evident. Automobile air pollution in metropolitan areas became serious. The dioxin problem became evident. - Basel Convention was implemented. (1992) - United Nations Framework Convention on Climate Change was accepted. (1992) - Acceptance of Biodiversity Convention (1992) - A Global Summit was held in Rio de Janeiro. (1992)	- Water Pollution Control Law was revised (prevention of groundwater pollution was regulated) (1989) - The global warming prevention activity plan was decided by the Cabinet. (enacted in1990) - Law for the Promotion of Utilisation of Recyclable Resources. (enacted in1991) - Automobile NOx Law was established. (1992) - Law for the Conservation of Endangered Species of Wild Fauna and Flora was established. (1992) - The Government development aid principle was decided by the Cabinet. - "Environmental conservation" as the basic principle. (1992)
	1993	- WTO was established. (1994) - The Product Liability Law (PL Law) was established. (1995) - Great Hanshin Earthquake (January), Underground Sarin incident (March) (1995) - The exchange rage of Japanese yen reached 1 dollar = 79 yen 75 sen (highest in the postwar history). (1995) - The consumption tax was increased to 5%. (1997) - Hong Kong was returned to China. (1997)	Pressure in the final landfill site - "Global Warming has already started" IPCC Secondary assessment report (1995) - Convention on Prevention of Desertification was accepted. (1996) - Nakhodka Oil Spill accident (1997) - Kyoto Protocol was accepted (COP3) and an emissions reduction commitment was set. (1997)	- Basic Environment Law was established. (1993) - The environment basic plan was decided by the Cabinet. (1994) - Law for Promotion of Sorted Collection and Recycling of Containers and Packaging. (enacted in 1995) - Keidanren Environment Appeal - declaration of Voluntary Action of business community (1996) - Environmental Impact Assessment Law was established. (1997)
	1998	- Single currency "Euro" was launched. (1999) - Number of people who are without jobs reached 3 million. (1999) - Reorganization of the central government ministries (2001) - Simultaneous terrorism occurred in the USA. (2001)	- Rotterdam Convention on PIC was adopted. (1998) - Tokorozawa Dioxin vegetable problem (1999) - "Climate change 2001" IPCC 3rd Assessment Report (2001) - Stockholm Convention on POPs was adopted. (2001) - COP7 (Marrakesh Agreement) (2001)	- Law for Recycling of Specified Kinds of Home Appliances was established. (1998) - Global Warming Measure Promotion Law was established. (1998) - Law Concerning the Rational Use of Energy was revised (introduction of top runner method, and so on). (1998) - Law Concerning Reporting,etc.of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management was established (PRTR Law). (1999) - Law Concerning Special Measures for Dioxins was established. (1999) - Law on Promoting Green Purchasing was established. (2000) - Basic Law for Establishing the Recycling-Based Society.(enacted in 2000) - Food Recycling Law. (enacted in 2000) - Construction Materials Recycling Act (enacted in 2000) - New environment basic plan was decided by the Cabinet. (2000) - Fluorocarbons Recovery and Destruction Law was established (2001) - Law Concerning Special Measure against PCB waste(enacted in 2001) - Automobile NOx Law was revised (PM was added). (2001)

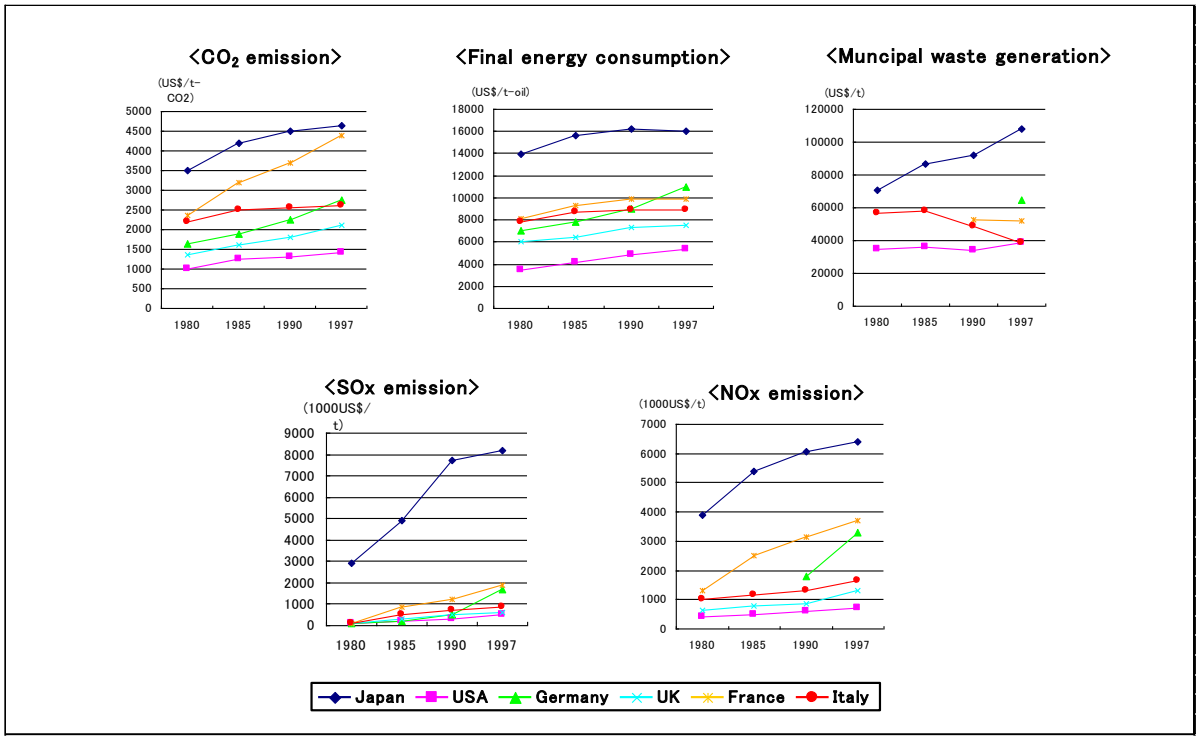
Source: MOE(2002a)

Table 2 Recent laws and regulations regarding the environment and examples of corporate eco-friendly movements

Year	Laws and regulations regarding the environment	Examples of corporate eco-friendly movements
1992	Revision of Montreal Protocol (advancing CFC reduction) Establishment of Automobile NOx Law	Technical development of CFC avoidance advanced such as ozone depletion coefficient "zero" refrigerator Spread of development of lean-burn engine that satisfied both low fuel cost and low NOx emission and three-way catalyst
1994	Effectuation of the United Nations Framework Convention on Climate Change Ideal of zero emission by the United Nations University	Acceleration of development of energy conservation technology such as for electrical appliance manufacturers and automobile manufacturers Zero emission measures started in automobile, electrical appliances, and beer manufacturers.
1996	ISO14001 certification system	The ISO14001 certification acquisition support service, LCA support business, and environmental report creation support business were started.
1997	Revision of Waste Management and Public Cleansing Law (Review of the Manifest system)	Recycling and waste disposal support businesses are accelerated.
1998	Announcement of bioremediation environment influence assessment guideline	Promotion of bioremediation technology development
1999	Revision of Law Concerning the Rational Use of Energy and execution of Bill for the Promotion of Measures to Tackle Global Warming Announcement of Law Concerning Reporting, etc, of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management	Progress of technology development related to solar batteries and fuel cell batteries Development of chemical control systems such as for manufacturers of electrical appliances Establishment of the first ecological fund (SRI) by Nikko Asset Management
2000	Execution of Law Concerning Special Measures for Dioxins Execution of Law for Promotion of Sorted Collection and Recycling of Containers and Packaging Announcement of Law on Promoting of Green Purchasing Announcement of Construction Materials Recycling Act Announcement of Food Recycling Law	Progress in modification (and new installation) of dioxin countermeasure waste incineration facility Development of business supporting Container and Packaging Recycling Law Acceleration of market availability of environmently-friendly products Effort for zero-emission was started mainly by major general contractors. Raw garbage processing business accelerated.
2001	Execution of Law for Recycling of Specified Kinds of Home Appliances Fluorocarbons Recovery and Destruction Law was established Enactment of Law Concerning Special Measure against PCB waste Revision of Automobile NOx Law (added PM)	Consultancy business related to waste processing and recycling prospered. Technical development in recovery and destruction of Fluorocarbons Technical development of low polluting vehicle accelerated
2002	Announcement of Soil Contamination Countermeasures Law Revision of Law Concerning the Promotion of the Measures to Cope with Global Warming Ratification of Kyoto Protocol of UNFCCC Execution of Law for the Promotion of Nature Restoration Law for the Recycling of End-of-Life Vehicles was established (executed April 2005)	Consultancy business related to soil contamination countermeasures prospered. Consultancy business related to global warming such as market transaction of CO2, prospered. Progress in financial support for nature conservation activities by the private sector Technical development of reusing end-of-life vehicles promoted
2003	Disclosure of the first aggregate results of the Pollutant Release and Transfer Register (RPTR) Execution of revised Waste Management and Public Cleansing Law (regarding illegal dumping)	Spread of CSR measures in leading companies Enhancement of 3R (reduce, reuse, recycling) movement
2004	Execution of Partial Amendment of the Chemical Substances Control Law Execution of Law Concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms Announcement of Law Concerning the Promotion of Business Activities with Environmental Consideration by Specified Corporations, etc, by Facilitating Access to Environmental Information, and Other Measures	Start of environmental-rating finance by governmental financial institution (DBJ) Establishment of the first carbon fund in Japan Enhancement of disclosure of environmental information such as environmental reports and environmental accounting.

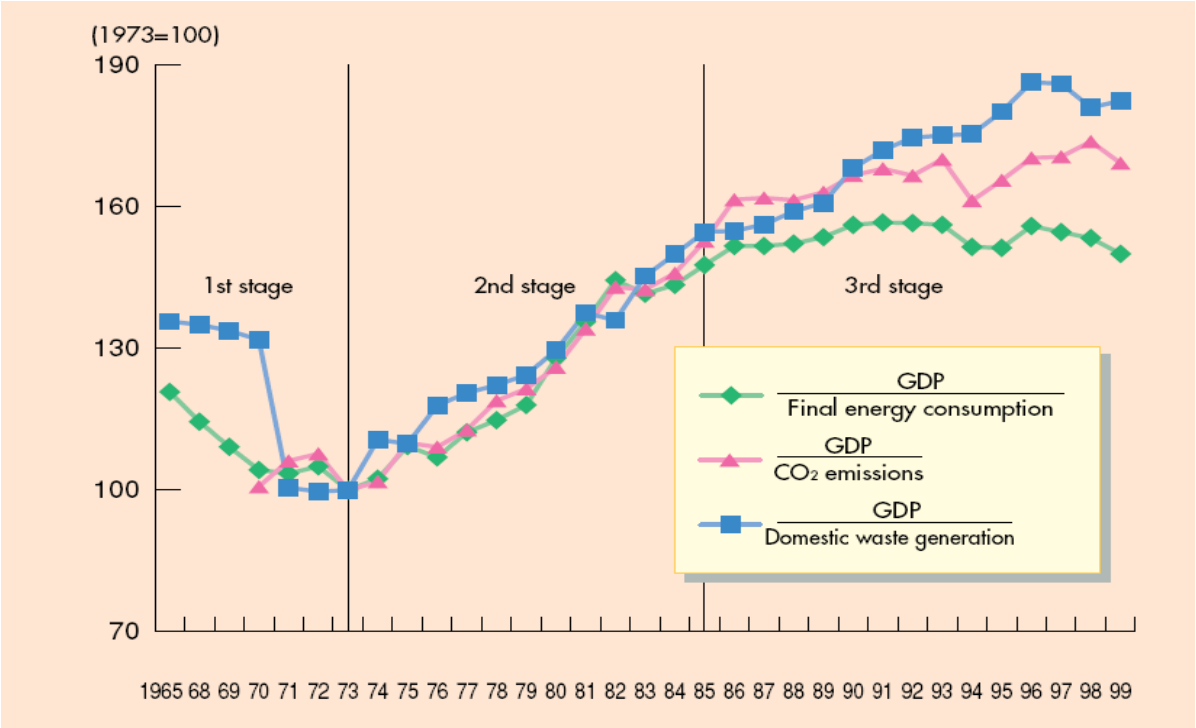
Source: Adapted by the author based from MOE (2002a, 2002b, 2004a, 2004b, 2005a, and 2005b)

Figure 1 International comparison of transition of eco-efficiency (GDP/environmental indicators)



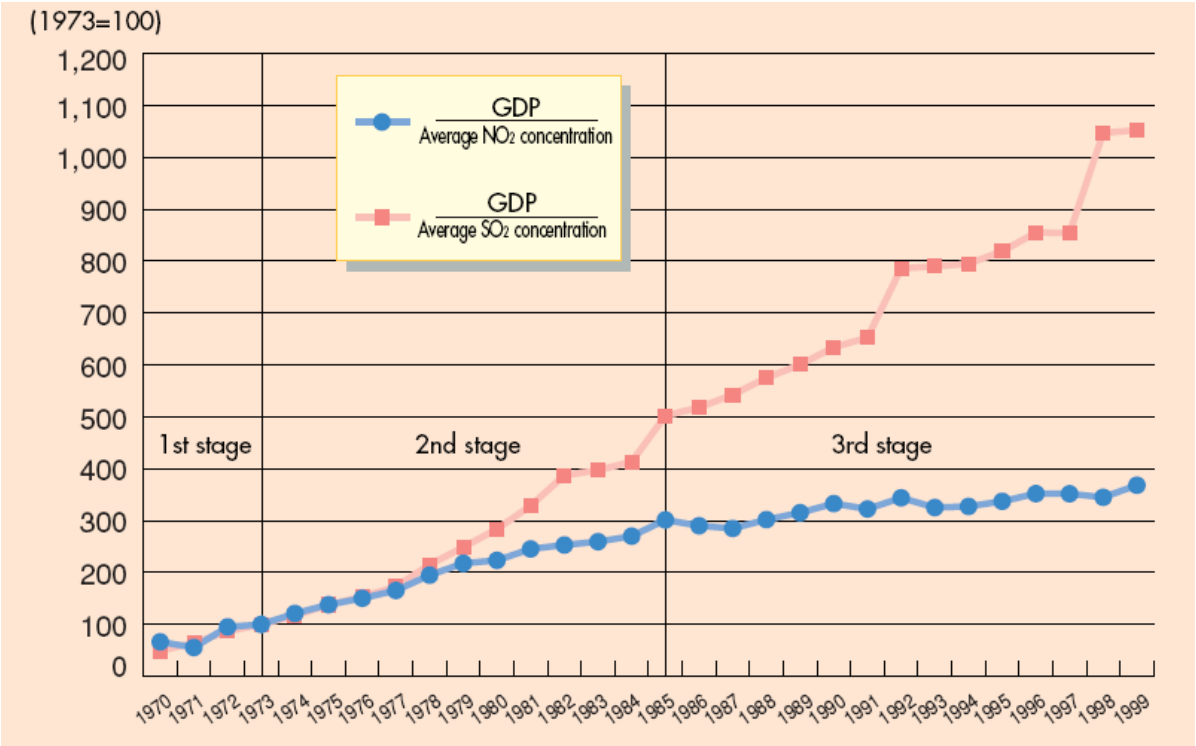
Source: Translated by the author based on MOE (2002b)

Figure 2 Transition of eco-efficiency (final energy consumption, CO_2 emissions, and domestic waste generation)



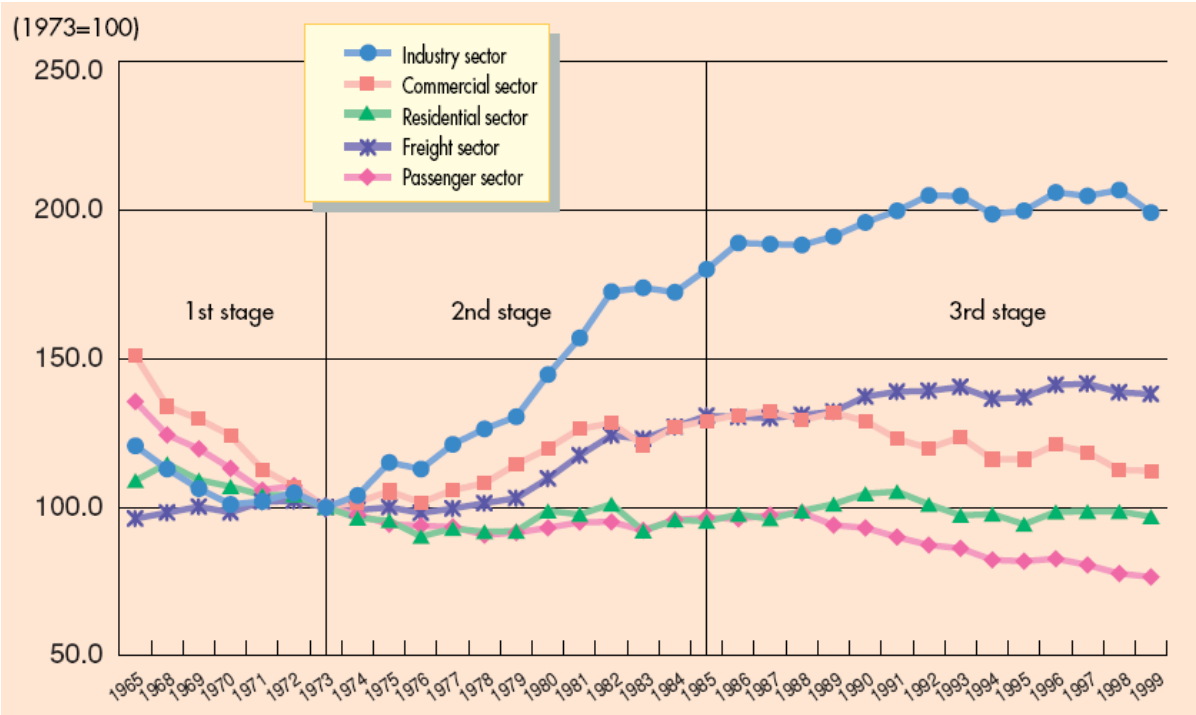
Source: MOE (2002a) Note: Stages were proposed by MOE to explain transition of eco-efficiency in Japan: the first stage is the period of high economic growth before the Oil Shock in 1973; the second is the period of stable economic growth; and the third is the period, since the mid-1980s, in which global environmental problems begun to be recognised (see Table 1).

Figure 3 Transition of eco-efficiency (average NO_2 concentration and average SO_2 concentration)



Source: MOE (2002a)

Figure 4 Transition of energy eco-efficiency in each sector



Source: MOE (2002a)

2. Literature review

As noted above, although there are vast numbers of papers reporting on particular case studies that show that it pays to be green, a smaller body of literature investigates the empirical relationship between environmental and financial performance. Unfortunately, the empirical evidence to date has been somewhat inconsistent (Derwall et al., 2004) — the UK Environment Agency (2004) found that 85 per cent of 60 studies in the U.S. and Europe described positive correlation between financial and environmental variables. Ullman (1985) and Griffin and Mahon (1997) argue that conflicting results in this body of research are mainly due to differences in methodology and in the choice of financial and environmental performance indicators. Empirical studies are categorized in three types: 1) portfolio studies, 2) event studies and 3) (multivariate) regression studies (Derwall et al., 2004, Wagner and Wehrmeryer, 2002)

2.1 Portfolio studies

Studies in this category typically compare mutually exclusive portfolios based on their corporate social leaning (Derwall et al., 2004). For example, Diltz (1995) studied 28 common stock portfolios over the period 1989-1991 to determine the effect of ethical screening and found that environmental screens improved stock performance significantly. Yamashita et al. (1999) showed that their environmentally highest ranked stocks performed significantly better than lowest ranked stocks in the 10 year average of risk-adjusted returns (Jensen's alpha[1]). White (1996) found that his green equity portfolio, comprising firms with an above-average reputation for corporate environmental responsibility, earned risk-adjusted returns (Jensen's alpha) significantly greater than either the overall market, or other portfolios composed of less environmentally responsible

[1] Jensen's alpha is the systematic, market risk-adjusted excess returns, based on the Capital Asset Pricing Model (CAPM).

firms. Blank and Daniel (2002) reported that an equally-weighted eco-efficiency enhanced portfolio delivered somewhat higher performance compared to the benchmark S&P500 during the period 1997-2001. Derwall et al. (2004) used Innovest's corporate eco-efficiency scores and composed two equity portfolios that differed in eco-efficiency characteristics and found that the higher-ranked portfolio provided substantially higher average returns (Jensen's alpha) compared to its low-ranked counterpart over the period 1995-2003.

However, the results from these studies are not positive. Cohen et al. (1997) constructed industry-balanced portfolios with different environmental responsibility characteristics to examine the financial performance difference between low-polluting and high-polluting companies in the U.S. and suggested that there was neither a premium nor a penalty for green investing. Similarly, Guerard (1997) used the social performance database of Kinder, Lydenberg, Domini & Co. (KLD) and found that the portfolios derived from a socially-screened investment universe did not perform differently from those obtained from an unscreened set during the period 1987-1996.

2.2 Event studies

Event studies look at relative changes in stock price following some environmental event. To date, these provide the most pronounced evidence of a linkage between environmental and financial performance (Derwall et al., 2004). Shane and Spicer (1983) demonstrated that companies experienced abnormal declines in stock prices two days prior to pollution figures being reported by the Council on Economic Priorities (CEP). Moreover, on the day of publication, negative returns were significantly larger for companies with a relatively poor pollution control record than for companies with better rankings. Blacconiere and Patten (1994) estimated that Union Carbide

lost $1 billion in market capitalization, or 28%, following the Bhopal chemical disaster in 1984. Hamilton (1995) found a significantly negative abnormal return for publicly traded companies following the first release of TRI pollution figures. Klassen and McLaughlin (1996) reported that positive corporate events, measured by environmental awards given to companies by third parties, were associated with subsequent extraordinary positive returns. Significantly negative returns tend to follow environmental crises. Rao (1996) found that the stock performance of companies after pollution reports by the Wall Street Journal from 1989 to 1993 was significantly lower than their expected market adjusted returns.

Again, however, some empirical studies indicate that there is no relationship. Yamashita et al. (1999) did not find significant stock market responses to environmental conscientiousness scores published in Fortune Magazine July 1993.

A further limitation with event studies is that they often analyse the effect of events that are only partially environmental in nature (King and Lenox 2001). King and Baerwald (1998) discussed that firm size, market power, and unique firm attributes influence how events are reported and interpreted. A firm with good public relations may be able to put a positive drive on negative news. A firm that possesses capable legal staff can deal better with lawsuits.

2.3 Regression analyses

These studies use regression techniques to evaluate the effect of changes in pollution or environmental performance on changes in financial performance. Spicer (1978) reported that companies in the U.S. pulp and paper industry with better environmental performance have higher profitability, lower risk profile and higher price/earnings ratio. However, Chen and Metcalf

(1980) replicated Spicer (1978) and argued that his findings fail to hold once controls were included for the impact of firm size on environmental performance.

More recently, Hart and Ahuja (1996) showed that changes in pollution (U.S. TRI emission per sales dollar) predate changes in financial performance including return on sales (ROS), return on assets (ROA) and return on equity (ROE). Russo and Fouts (1997) found a significant positive correlation between companies' ROA and environmental ratings measured by Franklin Research and Development Corporation (FRDC). Dowell et al. (2000) reported that firms that adopt a single, stringent environmental standard worldwide have higher market valuation (Tobin's q, for the definition see equation (3) in footnote 5, p19) than firms that do not adopt such standards.

Konar and Cohen (2001) reported that poor environmental performance has a significant negative effect on the intangible-asset value (and Tobin's q) of U.S. S&P500 companies. Similarly, King and Lenox (2001) found the evidence of an association between pollution reduction (the U.S. TRI) and financial (Tobin's q) gain.

However, these previous studies have not investigated the causality of environmental performance on firm's profitability fully.

2.4 Japanese studies

There are a limited number of surveys on environmental and financial performance in Japan. Kokubu et al. (2001) examined the determinants of environmental reporting by investigating 1203 Japanese corporations listed in the first section of the Tokyo Stock Exchange and employing the publication or non-publication of environmental reports as a dependent variable in their regression analysis. They concluded that there is no significant correlation between

environmental report publication and financial performance (ROA), though they found that company size and some type of industries, in particular, relatively high polluting industries, have a significant positive influence on the publication of environmental reports. This result is consistent with previous studies by Suda and Kokubu (1994) and Park (1999).

The Daiwa Institute Research Co. (2004) examined the stock performance of Japanese companies which were employed in Social Responsible Investing (SRI) indices and suggested that social responsible company stocks in four industries outperformed the industry average during the period 2001-2003. Additionally, they investigated the stock performance of Japanese companies which published environmental reports and found that these companies outperformed the Tokyo Stock Price Index (TOPIX) during the same period.

3. Theory and hypothesis

As the UK Environment Agency (2004) reported, the hypothesis that it “pays to be green” has become dominant in recent years. Proponents of this hypothesis argue that pollution reduction provides future cost savings by increasing efficiency, reducing compliance costs, and minimizing future liabilities (Porter and van der Linde, 1995, King and Lenox, 2001). Pollution prevention not only saves the cost of installing and operating end of pipe pollution control devices, but it may actually increase productivity and efficiency – less waste implies a better utilisation of inputs resulting in lower raw material and waste disposal costs (Hart and Ahuja, 1996). Furthermore, pollution prevention strategies offer the potential to cut emissions well below the levels required by law, reducing the firm’s compliance and liability costs. In fact, the environmental accounting report of Richo, a Japanese copy machine maker which obtained first prize in the manufacturing

division of the latest Nikkei environmental management rankings, shows that their environmental investments pay handsome returns. Their environmental benefits to costs ratio increased from 1.27 in 2000 to 1.96 in 2003, which means they accrue annual operating benefits (30.3 billion yen[2] in 2003) from such activities as energy savings, improved waste processing efficiency and sales of recycled products nearly two times of their environmental conservation expenditures (15.4 billion yen in 2003) such as for pollution prevention and recycling used products.

Making environmental efforts leads not only to improved accounting-base (operating) profits, but also enhances intangible resources (which are not always reflected in corporate financial statements), such as: (i) firm reputation, (ii) employee expertise and loyalty, and (iii) reduced risk exposure(Russo and Fouts, 1997, UK Environment Agency, 2004). Firstly, a reputation for leadership in environmental affairs will increase sales among green consumers. MOE survey[3] (2002c) shows that green consuming is spreading among industrialised countries, including Japan. Consumers are willing to pay a price-premium for green products[4] (METI, 2003). Thus, attracting such customers can be highly profitable, and a pro-environment reputation, such as that acquired by Toyota through sales of its electric-petroleum-hybrid vehicle, the Prius, is itself a valuable resource. Moreover, other automakers have found it difficult to match this reputation effect, leaving Toyota with a profitable form of product differentiation. Secondly, developing pollution prevention policy necessitates employee involvement, cross-disciplinary coordination and integration, and a forward thinking managerial style (Shirvastava, 1995). For example,

[2] Foreign currency exchange rate: £ 1=198 yen, $1=112 yen, €1=133 yen (as of 3rd July 2005)

[3] According to the study, the proportion of Japanese people who consider environmental impacts of products in their shopping increased from 66% in 1997 to 75% in 2001.

[4] According to the study, 7.5% of respondents will pay for eco-friendly products even though they are more expensive, and 26.2% of them will probably pay for them.

Masamitsu Sakurai, the CEO of Richo, emphasises that environmental conservation activities should not only be conducted by employees in development and manufacturing departments. Instead, all employees, including those in business planning and marketing, are encouraged to develop and provide environmentally-friendly products and services and to organise their workplaces to have less impact on the environment, which greatly contributes to both firm's profitability and environmentally-friendliness (Richo, 2004). Thus, a proactive environmental policy increased the skills of workers at all levels of the firm. Additionally, environmental stewardship attracts top candidates from senior executives to college graduates to the firm, which leads to productivity improvements (Russo and Fouts, 1997). Finally, a proactive environmental policy enables companies to deal with future environmental risk more adequately. It not only reduces future environmental regulation compliance costs, but also leads to the appropriate risk management of all business concerns through enhanced foresight and flexibility of the firm's wide-area management. For example, employing an environmental management system such as ISO14001, which is based on the notion of the four factor circle, 'plan-do-check-act', will provide companies with good opportunity to establish systematic forecasting and controlling of comprehensive business risks. In short, employing a proactive environmental policy enhances intangible asset value[5].

[5] To access intangible asset value, Tobin's q is useful indicator. Following Konar and Cohen (2001), the market value of the firm can be expressed as

$$MV = V_T + V_I \,, \quad (1)$$

where MV is the market value of the firm, and V_T and V_I are the portions of firm value attributable to the tangible and the intangible assets of the firm, respectively. V_T and V_I can be estimated as follows: First, equation (1) is divided by the tangible asset value V_T to obtain

$$(MV / V_T) = 1 + (V_I / V_T) \quad (2)$$

The tangible asset value of the firm, V_T is measured as the replacement cost (RC) of the tangible assets of the firm. RC may be estimated using accounting-based values for the assets of the firm. The left side of equation (2) may then be written as (MV / RC) which is by definition Tobin's q. Thus,

$$\text{Tobin's q} = (MV / RC) = (MV / V_T) = 1 + (V_I / V_T) \quad (3)$$

Thus, for a firm with no intangible asset value, Tobin's q should be equal 1. As the market value of the firm's intangible assets increases, the value of Tobin's q will increase accordingly.

However, Hart and Ahuja (1996) argued that there would appear to be some time lag between the introduction of environmental measures such as emission reduction efforts and the realization of 'bottom line' benefits. Firstly, such efforts require up-front investment in equipment and training. Secondly, the savings from emissions reduction may take some time to be realised as renegotiation of supply and waste disposal contracts, as well as internal reorganization, may be required. For example, cutting emissions by 50% may require that dramatically less raw material is needed. It may lead to not only renegotiation of supply contract and waste disposal contract, but also rearrangement of internal personnel. Thus, it seems to take time to realize accounting-based benefits.

On the other hand, as most event studies show, market valuations of the firm tend to be updated instantly after the environmental event in both cases of damaging (e.g. disclosure of oil spill accident in the sea) and enhancing (e.g. winning environmental performance awards) firm value.

Thus, we propose, at first, three hypotheses to test as follows:

Hypothesis 1: Better environmental performance in time period t enhances operating performance (ROS, ROA, and ROE) in time period t+1. This is theorised to be through lower raw material, compliance, disposal and liability costs and more efficient use of assets and equity.

Hypothesis 2: Better environmental performance in time period t shows no relationship to operating performance in time period t, because time is required for cost savings to be captured.

Hypothesis 3: Better environmental performance in time period t will enhance financial performance (Tobin's q) in time period t through instant market valuation of higher intangible assets such as reputation, management quality, and future risk avoidance.

In addition to these three hypotheses, we might also expect that in the early stages of pollution prevention, quick and inexpensive changes can result in emissions reductions and corresponding cost reductions. In contrast, savings are more difficult to achieve when companies get closer to elimination of pollution, since further reductions will imply rising capital and technology investment (UK Environment Agency, 2004, Hart and Ahuja, 1996).

Moreover, most sector case studies assessed by the UK Environmental Agency (2004) suggested that industries with high environmental impacts are likely to benefit substantially from managing their impacts successfully, though they admitted that there were few comprehensive studies examining the degree of difference in profitability between high and low impact industries (e.g. Butz and Plattner (1999) researched only 39 firms which belong to high polluting industries). Thus, we add two more hypotheses to consider:[6]

Hypothesis 4: Better environmental performance enhances the operating and financial performance more for firms with lower environmental performance than those with higher environmental performance.

Hypothesis 5: Better environmental performance enhances the operating and financial performance more for high polluting industries than low polluting industries.

[6] Hart and Ahuja (1996) tested hypotheses 1, 2 and 4 for only ROS, ROA and ROE (we added hypothesis 3 and 5 for Tobin's q as well). Though they classified ROS and ROA as operating performance and ROE as financial performance, because ROE is also an accounting measure for profitability like ROS and ROA, we classified ROE as operating performance in this paper.

4. Data and Methodology

The sample of firms for this study is drawn from publicly listed companies in Japan. Japan has two stock markets for medium and small sized venture companies, JASDAQ and Tokyo Mothers, in addition to traditional stock exchange in Tokyo, Osaka, Nagoya, Fukuoka and Sapporo. Thus, our sample includes a wider range of firm size, while previous studies tend to deal with only largest firms such as the S&P 500. Though the number of all listed companies in Japan is over 3,600, we deal with only manufacturers which responded to the Nikkei Environmental Management Survey (from hereon the Nikkei survey) and obtained a Nikkei ranking score.

4.1 The Nikkei survey

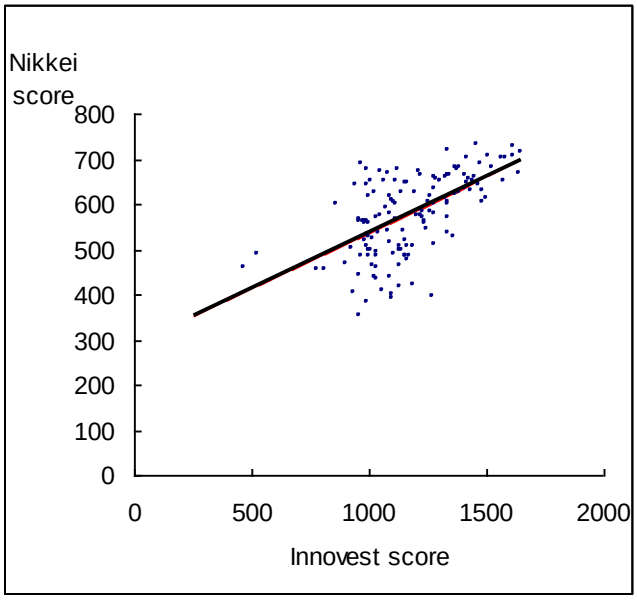
The purpose of the Nikkei survey is to evaluate and rank companies based on their environmental management. It has been conducted every year since 1997 and the latest one marks the eighth (December 2004). Nikkei is a business newspaper company, somewhat like the Financial Times in the UK. Headline results of the survey are reported in the Nikkei Newspaper (with over 3 million circulation) for the top 10 ranking firms and their overall-score in each industrial sector, such as manufacturing, and the Nikkei Industrial Newspaper (180 thousand circulation) publishes full rankings, their overall-score and sub-scores.[7] In 2004, 1,060 companies, 590 from manufacturing and 470 from non-manufacturing sectors, responded to the survey, which shows that the survey is widely recognized by society. Out of 590 manufacturers, non-listed companies are 47, Tokyo Mothers and JASDAQ-listed companies are 47, and others are listed on the traditional stock exchange market.

[7] The full ranking with the overall and sub score started to be reported in 1999 in the Nikkei Industrial Newspaper, so this study deals with the period 1999-2003. We obtained these data through Nikkei Telecom 21, an internet-based business data service provided by Nihon Keizai Shimbun(Nikkei), Inc.

The survey questionnaire is adjusted every year to reflect frequent changes in environmental legal system and company behaviours (see Figure 2 in Section 1) and the questionnaires are different among industrial sectors. The questionnaires for manufactures in 2004 had 126 questions (including sub-questions, see Appendix for the contents of questionnaire). The score set by each question is added up in one of the following 7 categories: 1) management structure and information disclosure, 2) vision, 3) pollution risk, 4) recycling, 5) eco-friendly products, 6) measures against global warming, and 7) measures at non-manufacturing sites (offices). The The overall score is constructed to yield an average score of 500 and a standard deviation of 100 in all manufacturers.

The Nikkei score was employed as the indicator of corporate environmentally-friendliness because it offers the widest coverage of Japanese firms and sectors, longitude data, the greatest data availability, and comprehensive environmental performance criteria. However, to check for possible bias in the Nikkei score (possibly caused by the viewpoint of Japanese mass media), we compared it with the Innovest score, which is compiled by a non-Japanese independent environmental rating company with a different methodology. The Innovest score is one of the most well-established environmental performance scores in the world (see in detail Derwall et al., 2004 and Salo, 2005). The result of simple regression analysis of 139 manufactures' 2003 scores of the two sources shows that they are highly correlated with statistical significance (Multiple R 0.60, F stat 75.2, P-value of coefficient < 0.001, see Figure 5). More importantly, there are no significant differences between the Nikkei and Innovest scores for individual sectors, indicating (at a minimum) that the two surveys are measuring roughly the same variables, and providing a degree of reassurance that the data set is appropriate.

Figure 5 Correlations between Nikkei and Innovest score (Sample: 139)



4.2 Sample selection

Two more screens are applied in selecting firms, in addition to selecting manufacturers because of their more significant environmental impact. Firstly, companies which have experienced a merger or acquisition in the analysis period 1999-2003 are excluded because of the corresponding changes to their corporate financial structure. Most previous studies have ignored this problem; here employing a straightforward procedure on the Toyokeizai database allowed the problem to be corrected. Because the Japanese economy has experienced sluggish long-term performance since the bubble economy burst in 1990, there have been a large number of mergers and acquisitions in the analysis period 1999-2003, and this procedure removed 242 companies from the Nikkei dataset. Secondly, removed were firms with missing data for one or more variables, predominantly the research and development (R&D) intensity and age of firm's assets variables. The final sample size became around 300 for each year of the Nikkei score (328 for 1999, 307 for 2000, 332 for 2001, 283 for 2002, and 285 for 2003), which is still substantially enough for our survey.

4.3 Dependent variables: operating and financial performance

The dependent variables were secured from the Toyokeizai database. Operating performance data – return on sales (ROS), return on assets (ROA) and return on equity (ROE) – and financial performance data – Tobin's q – for each firm were collected for the years 1999-2003. These were often examined in previous studies. These are defined as follows: ROS was measured as net income after tax divided by sales, ROA was net income after tax divided by total assets, and ROE was net income after tax divided by shareholders' equity. Tobin's q was defined as the market value of assets [total assets + market capitalization – shareholders' equity] divided by the replacement costs of assets [net property + investments + current assets]. Although various authors employ a number of different specifications for Tobin's q, this thesis follows Konar and Cohen (2001).

4.4 Control variables: avoiding omission bias

All control variables were obtained from the Toyokeizai database. In choosing control variables, we began with a list of seven causal variables most prevalent in prior studies of performance (Russo and Fouts 1997, Konar and Cohen 2001, King and Lenox, 2001). These were 1) firm growth rate, 2) R&D intensity, 3) capital intensity, 4) age of firm assets, 5) leverage, 6) firm size, and 7) advertising intensity. Additionally, industry dummy variables were used to control industrial factors as was often used in previous studies. Firm size (i.e. sales) was not employed, because the Nikkei environmental performance score and sales are highly correlated (Multiple R 0.5), which can produce multicollinearity and unstable regression estimates. Additionally, advertising intensity (i.e. advertising expenses divided by sales) was eliminated as a control because many

data were missing. This was considered reasonable given that early regressions indicated the variable was consistently insignificant.

The controls variables employed are defined as follows:

1) Firm growth rate is a firm's annual change in sales period 1998-2003. Recent growth in firm-level sales was found to be positively correlated with profitability (Russo and Fouts, 1997, Konar and Cohen, 2001).
2) R&D intensity is research and development expenditure divided by total assets. It has been found to be positively correlated with firm profits (King and Lenox, 2001, Konar and Cohen, 2001). This may be because R&D leads companies to be innovative and hence profitable.
3) Capital intensity is defined as net property divided by sales. This has been found to be negatively correlated with firm profits (Russo and Fouts, 1997, King and Lenox, 2001). This may be because owing more property requires greater debts, which cause greater interest costs and lower profitability.
4) Age of firm assets is proxied by dividing net property (net of accumulated depreciation from gross property) by gross property. This gives us a 0-1 scale for the age of a firm's assets, with a firm closer to 1 having newer assets. Lindenberg and Ross (1981) found that firms with declining capital stocks tend to have lower intangible-asset values. Thus, the age of a firm's assets are regarded to be an important factor in determining its profitability. A firm with older technology may be less efficient and hence not as profitable as a firm with new technology (Konar and Cohen, 2001).
5) Leverage is debt to equity ratio. A firm with much debt tends to lack profitability because of greater interest costs. Thus, leverage has been found to be negatively correlated with firm profits (King and Lenox, 2001).

6) Industrial dummies were used based on the 16 sectors of manufacturing identified by the Securities Identification Code Committee in Japan, but they were reclassified into 9 sectors[8] (using 8 dummies) taking into consideration the similarity in manufacturing processes and products, and avoiding small samples of less than 10 in each sector.

Table 3 contains a list of variable definitions and descriptive statistics (only the Nikkei score 1999 and other variables for 2001 are reported here). This shows enormous variation in the dependent and independent variables among sample firms, which is ideal for econometric analysis. Table 4 presents the correlation between these variables (industry dummy variables were not reported here). This shows that there are no high correlations (less than 0.4) between independent variables, which ensure that there is no fear of multicollinearity problem. Moreover, at the first stage before multi-regression analysis, we can find positive correlations between the Nikkei score and all profitability indicators (see Figure 6, each equation in the graph shows that of the line of best fit). Additionally, it is quite interesting to see there do not exist high correlations between operating and financial performances (highlighted), which is discussed later.

[8] The 9 sectors are 1) Foods, 2) Textiles, 3) Chemicals and Pharmaceuticals, 4) Steel, Metals and Nonferrous metals, 5) Machinery and Precision machinery, 6) Electric machinery, 7) Transport equipment, 8) Oil, Rubber products and Glass and ceramics, 9) Pulp & paper and Other manufacturing.

Table 3 Descriptive statistics

Variable (Units)	Description	Mean	Standard deviation	Minimum	Maximum
ROS 2001 (%)	Net income after tax divided by sales in 2001	−1.47	9.08	−82.57	21.41
ROA 2001 (%)	Net income after tax divided by total assets in 2001	−0.52	4.58	−21.95	12.02
ROE 2001 (%)	Net income after tax divided by shareholders' equity in 2001	−2.26	12.80	−60.07	84.98
Tobin's q 2001 (ratio)	Market value of assets [total assets + market capitalization − shareholders' equity] divided by replacement costs of assets [net property + investments + current assets] in 2001	1.03	0.46	0.39	4.85
Intangible Firm Value 2001 (million yen)	Market value of assets minus replacement costs of assets in 2001	48,012	264,743	−137,948	3,553,144
Nikkei score 1999 (points)	Firm's overall score in Nikkei Environmental Management Survey 1999	487.9	89.9	362.0	806.0
Sales growth 1998–2003 (%)	Firm's annual change in sales period 1998–2003	0.28	5.73	−17.65	30.20
R&D intensity 2001 (ratio)	Research and development expenditure divided by total assets in 2001	0.03	0.03	0.00	0.15
Capital Intensity 2001 (ratio)	Net property divided by sales in 2001	0.40	0.25	0.06	1.87
Age of firm's assets 2001 (ratio)	Net property (net of accumulated depreciation from gross property) divided by gross property in 2001	0.40	0.12	0.17	0.79
Debt to Equity ratio 2001 (%)	Debt divided by shareholder's equity in 2001	147.26	164.89	9.49	1465.69

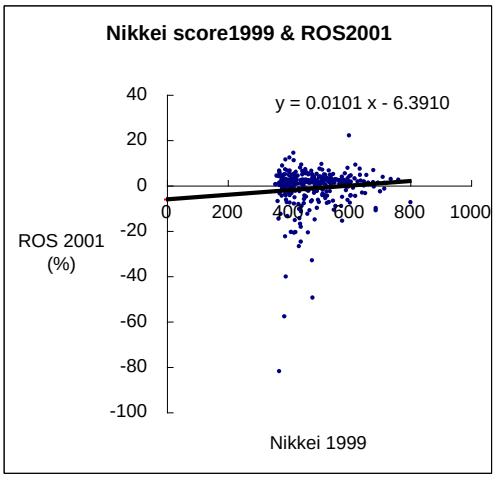
Note: sample 328

Table 4 Correlations

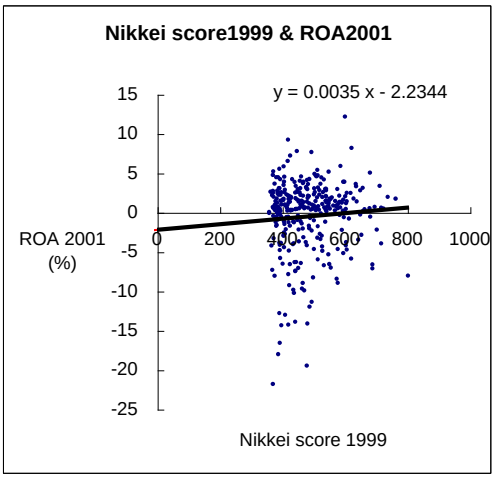
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1 ROS 2001	1.00										
2 ROA 2001	0.90	1.00									
3 ROE 2001	0.75	0.87	1.00								
4 Tobin's q 2001	0.10	0.18	0.11	1.00							
5 Intangible Firm Value 2001	0.17	0.20	0.11	0.48	1.00						
6 Nikkei score 1999	0.10	0.07	0.03	0.27	0.31	1.00					
7 Sales growth (98–03)	0.17	0.25	0.23	0.27	0.05	−0.04	1.00				
8 R&D intensity 2001	0.09	0.07	0.03	0.30	0.26	0.40	0.10	1.00			
9 Capital Intensity 2001	−0.20	−0.14	−0.05	−0.06	−0.11	−0.13	−0.12	−0.23	1.00		
10 Age of firm's assets 2001	−0.06	0.01	0.01	0.09	−0.11	−0.32	0.09	−0.28	0.28	1.00	
11 Debt to Equity ratio 2001	−0.12	−0.19	−0.13	−0.02	−0.06	−0.04	−0.18	−0.14	0.15	0.05	1.00

Note: sample 328, Correlations between dependent variables are highlighted

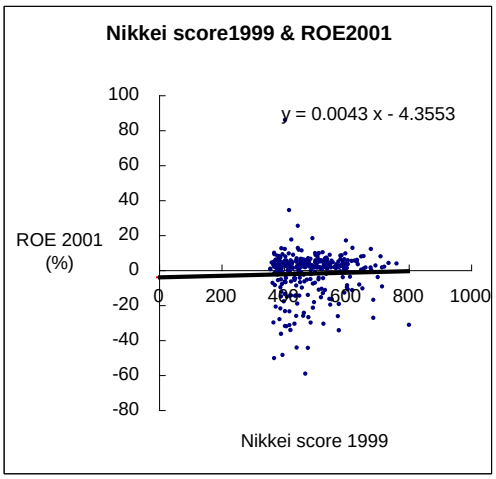
Figure 6　Correlations between Nikkei score and dependent variables (Sample: 328)



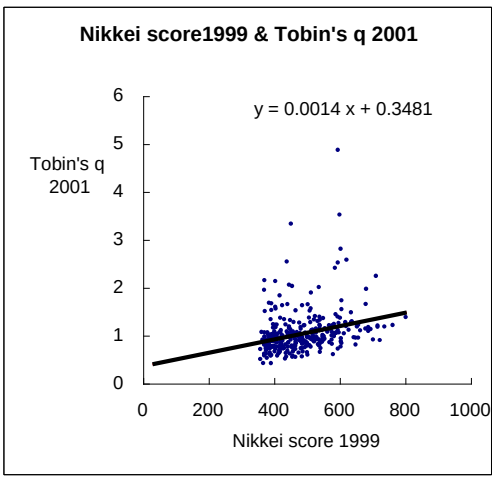
Multiple R: 0.10, P-value of coefficient: 0.071



Multiple R: 0.07, P-value of coefficient: 0.212



Multiple R: 0.03, P-value of coefficient: 0.586



Multiple R: 0.27, P-value of coefficient: 0.000

4.5 Regression procedure and hypothesis testing

Multiple regression analysis was used to test the hypotheses. In response to each year's Nikkei score, four separate models were run for ROS, ROA, ROE, and Tobin's q as dependent variables. The estimation equations are shown as below (4) - (7).

$$\text{ROS} = b_0^{s} + b_1^{s}(\text{Nikkei 1999}) + b_2^{s}(\text{Sales growth}) + b_3^{s}(\text{R\&D intensity}) + b_4^{s}(\text{Capital intensity}) + b_5^{s}(\text{Age of firm's assets}) + b_6^{s}(\text{Debt to equity ratio}) + b_7^{s}(\text{type of industry}) - - - b_{14}^{s}(\text{type of industry}) + e^{s}, \quad (4)$$

where b_i^s for i {1...14} are the regression coefficients and e^s is an error term when ROS is the dependent variable.

$$\text{ROA} = b_0^a + b_1^a(\text{Nikkei 1999}) + b_2^a(\text{Sales growth}) + b_3^a(\text{R\&D intensity}) + b_4^a(\text{Capital intensity}) + b_5^a(\text{Age of firm's assets}) + b_6^a(\text{Debt to equity ratio}) + b_7^a(\text{type of industry}) - - - b_{14}^a(\text{type of industry}) + e^a, \quad (5)$$

where b_i^a for i {1...14} are the regression coefficients and e^a is an error term when ROA is the dependent variable.

$$\text{ROE} = b_0^e + b_1^e(\text{Nikkei 1999}) + b_2^e(\text{Sales growth}) + b_3^e(\text{R\&D intensity}) + b_4^e(\text{Capital intensity}) + b_5^e(\text{Age of firm's assets}) + b_6^e(\text{Debt to equity ratio}) + b_7^e(\text{type of industry}) - - - b_{14}^e(\text{type of industry}) + e^e, \quad (6)$$

where b_i^e for i {1...14} are the regression coefficients and e^e is an error term when ROE is the dependent variable.

$$\text{Tobin's q} = b_0^q + b_1^q(\text{Nikkei 1999}) + b_2^q(\text{Sales growth}) + b_3^q(\text{R\&D intensity}) + b_4^q(\text{Capital intensity}) + b_5^q(\text{Age of firm's assets}) + b_6^q(\text{Debt to equity ratio}) + b_7^q(\text{type of industry}) - - - b_{14}^q(\text{type of industry}) + e^q, \quad (7)$$

where b_i^q for i {1...14} are the regression coefficients and e^q is an error term when Tobin's q is the dependent variable.

To test hypotheses 1-3, for example, an initial run was made with the Nikkei 1999 score and 1999 dependent variables (time t). Additional runs were then made lagging the dependent variables on additional year each time, i.e. 2000 (time t+1), 2001 (time t+2), 2002 (time t+3) and 2003 (time t+4). Note that only 2001 data for all control variables (except sales growth 1998-2003 per annum) was used consistently for every regression, while the Nikkei score 1999-2003 was used respectively.

To test hypothesis 4, the sample was split on the industry means of Nikkei environmental score, yielding high and low environmental performance firms within each industry. These firms were then aggregated into either a high or low environmental performance sub-sample. This procedure ensured that the most and least environmentally-friendly firms were captured. Separate regressions were then run on these two sub-samples.

To test hypothesis 5, the sample was split on the basis of Konar and Cohen (2001)'s sector-analysis results on intangible-asset loss due to environmental performance in the U.S. firms and Kikuchi's survey (2005) on the environmental conservation expenditure of Japanese firms. We defined chemicals & pharmaceuticals, pulp & paper, other manufacturing, and steel, metals & nonferrous metals as high polluting industries, and the rest manufacturing sectors as low polluting industries. Separate regressions were then run on these two sub-samples. For testing hypotheses 4 and 5, we used the Nikkei 1999 as the environmental independent variable, considering that it provided the results of longest subsequent performance.

5. Results

The full regression results for hypotheses 1-3 are presented in Table 5 (only for Nikkei score coefficients and statistical significance by showing P-value). This shows, as a whole, that better environmental performance has a positive effect on both the operating and financial performance net of the control variables performance. In regard to operating performance (ROS, ROA, and ROE), though most coefficients lack statistical significance, at least for Nikkei score 1999,

hypothesis 1, that better environmental performance in time period t enhances operating performance in time period t+1, is confirmed with statistical significance (ROS and ROA: $P<0.01$, ROE: $P<0.10$). For Nikkei 2000 and 2001, coefficients became stronger and more significant in the subsequent year (t+1). For Nikkei 2002, we could not confirm hypothesis 1. However, hypothesis 2, that better environmental performance in time period t shows no relationship to operating performance in that period, is confirmed in every year.

Concerning Tobin's q, we found highly significant positive correlations between environmental performance and financial performance in every year except Nikkei 2000 – Tobin's q 2000. Thus, hypothesis 3, that better environmental performance in time period t enhances financial performance (Tobin's q) in time period t, is almost confirmed. The reason for this difference of statistical significance in coefficients between operating and financial performance against environmental performance may be that, firstly, environmental efforts tend to be costly in accounting basis, and take some time to realize its fruits or it may become difficult to be paid, in particular, at the time of rapidly changing of environmental law and policy in current Japan. Secondly, on the other hand, Japanese financial market may realize firm's environmental efforts and evaluate them as intangible-asset value appropriately without a time-lag.

Table 5　Results of regression analysis for hypothesis 1-3

Coefficients of environmental performance

ROS	1999	2000	2001	2002	2003	samples
Nikkei 1999	0.00539	0.01538 ***	0.00531	0.00470	0.00612	328
	(0.26137)	(0.00475)	(0.37478)	(0.55512)	(0.18065)	
Nikkei 2000		0.00373	0.00618	−0.00200	0.00160	307
		(0.39046)	(0.16600)	(0.64095)	(0.67654)	
Nikkei 2001			0.00325	0.00602	0.00554	332
			(0.46098)	(0.18390)	(0.15817)	
Nikkei 2002				0.00662	−0.00075	283
				(0.19025)	(0.83715)	
Nikkei 2003					0.00303	285
					(0.41094)	

ROA	1999	2000	2001	2002	2003	
Nikkei 1999	0.00210	0.00856 ***	0.00208	0.00323	0.00590 *	328
	(0.45057)	(0.00305)	(0.47495)	(0.42279)	(0.05496)	
Nikkei 2000		0.00270	0.00315	−0.00063	0.00173	307
		(0.30355)	(0.24154)	(0.80937)	(0.53816)	
Nikkei 2001			0.00210	0.00405	0.00437 *	332
			(0.39685)	(0.15207)	(0.08978)	
Nikkei 2002				0.00468	0.00065	283
				(0.11472)	(0.79721)	
Nikkei 2003					0.00194	285
					(0.45509)	

ROE	1999	2000	2001	2002	2003	
Nikkei 1999	0.00353	0.03578 *	0.00143	0.00467	0.01387 *	328
	(0.63959)	(0.07185)	(0.86537)	(0.72214)	(0.09865)	
Nikkei 2000		0.01700	0.00430	−0.00892	0.00881	307
		(0.41766)	(0.60011)	(0.35344)	(0.31943)	
Nikkei 2001			0.00214	0.00458	0.01145	332
			(0.76821)	(0.60533)	(0.10126)	
Nikkei 2002				0.00975	0.00684	283
				(0.31693)	(0.37906)	
Nikkei 2003					0.01010	285
					(0.25577)	

Tobin's q	1999	2000	2001	2002	2003	
Nikkei 1999	0.00199 ***	0.00097 *	0.00135 ***	0.00099 ***	0.00100 ***	328
	(0.00008)	(0.06052)	(0.00000)	(0.00001)	(0.00043)	
Nikkei 2000		0.00078	0.00110 ***	0.00091 ***	0.00089 ***	307
		(0.16490)	(0.00031)	(0.00002)	(0.00140)	
Nikkei 2001			0.00111 ***	0.00112 ***	0.00125 ***	332
			(0.00377)	(0.00000)	(0.00002)	
Nikkei 2002				0.00088 ***	0.00114 ***	283
				(0.00036)	(0.00020)	
Nikkei 2003					0.00092 ***	285
					(0.00635)	

Note: P-value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01

Table 6 presents the results of multiple regression analysis for Nikkei score 1999 with four (ROS, ROA, ROE and Tobin's q) models. Although total explained variance is small (adjusted $R^2 < 0.32$), this level is comparable with other similar studies (e.g. Russo and Fouts, 1997: $R^2 < 0.35$, Huselid, 1995: $R^2 < 0.17$). It is quite interesting to see the strongest explanatory power of the operating performance models is in time period t+1 (year 2000), which is also when environmental performance works well. This suggests that environmental factors play a quite significant role among independent variables in explaining profitability. The coefficients of the independent control variables are generally the same direction as would be expected from

previous studies. Sales growth is positive and highly significant against all profitability indicators except ROE 2000. Though R&D intensity does not show consistent results against operating performances, it is consistently positive and highly significant with Tobin's q. Capital intensity proves to be negative in most cases, as found in previous research. The age of firm's assets is positive except in the case of ROE 2002, especially, with statistical significance for most Tobin's q. Debt to equity ratio is shown as negative in most cases as expected.

To understand fully how much the market evaluates intangible-assets, we turn our attention to the effect of firm environmental performance on intangible firm value (IFV), following Konar and Cohen (2001). IFV can be obtained by subtracting the replacement costs of assets from the market value of assets (see equation (1) in Footnote 5, p19).

We regressed for a case of Nikkei 1999 – IFV 2001 using the same control variables as before. The estimation equations are shown as below (8).

$$\begin{aligned} IFV = {} & b_0^I + b_1^I(\text{Nikkei 1999}) + b_2^I(\text{Sales growth}) + b_3^I(\text{R\&D intensity}) \\ & + b_4^I(\text{Capital intensity}) + b_5^I(\text{Age of firm's assets}) + b_6^I(\text{Debt to equity ratio}) \\ & + b_7^I(\text{type of industry}) - - - b_{14}^I(\text{type of industry}) + e^I , \end{aligned} \quad (8)$$

where b_i^I for i {1...14} are the regression coefficients and e^I is an error term when IFV is the dependent variable.

Table 7 reports that the results are qualitatively similar to those reported in Table 6, and the environmental variables still remain positive and statistically significant. To estimate the economic impacts of the environmental performance of firms on their intangible-asset value, we calculated IFV based on the equation of Table 7 below.

Table 6 Results of regression analysis with controls coefficients (environmental performance variable: Nikkei 1999)

Dependent variable: ROS	1999		2000		2001		2002		2003	
Intercept	−3.00562		−13.78217	***	−3.52354		4.37605		−2.32451	
	(0.38501)		(0.00048)		(0.41424)		(0.44649)		(0.48089)	
Nikkei 1999	0.00539		0.01538	***	0.00531		0.00470		0.00612	
	(0.26137)		(0.00475)		(0.37478)		(0.55512)		(0.18065)	
Sales growth (98-03)	0.17586	**	0.13432	*	0.21610	**	0.16590		0.14375	**
	(0.01389)		(0.09536)		(0.01536)		(0.16111)		(0.03467)	
R&D intensity 2001	−12.52627		−20.22393		8.02292		11.69210		3.18580	
	(0.47211)		(0.30432)		(0.71190)		(0.68619)		(0.84782)	
Capital Intensity 2001	−3.33846	*	−3.58979	*	−7.37955	***	−7.78127	***	0.38935	
	(0.05181)		(0.06409)		(0.00062)		(0.00653)		(0.81141)	
Age of firm's assets 2001	7.90080	**	10.05489	**	3.10970		1.36218		6.70694	*
	(0.03023)		(0.01474)		(0.49268)		(0.82145)		(0.05347)	
Debt to Equity ratio 2001	−0.00587	**	−0.01822	***	−0.00293		−0.00252		−0.00331	
	(0.01443)		(0.00000)		(0.32609)		(0.52496)		(0.14656)	
Number of observations	328		328		328		328		328	
F stat	3.241	***	7.350	***	4.132	***	1.973	**	1.888	**
Adjusted R^2	0.088		0.214		0.118		0.040		0.037	

Dependent variable: ROA	1999		2000		2001		2002		2003	
Intercept	−1.00028		−7.19357	***	−1.20382		2.27895		−1.44114	
	(0.61908)		(0.00058)		(0.56700)		(0.43312)		(0.51484)	
Nikkei 1999	0.00210		0.00856	***	0.00208		0.00323		0.00590	*
	(0.45057)		(0.00305)		(0.47495)		(0.42279)		(0.05496)	
Sales growth (98-03)	0.14125	***	0.13811	***	0.15150	***	0.18691	***	0.22091	***
	(0.00072)		(0.00131)		(0.00052)		(0.00192)		(0.00000)	
R&D intensity 2001	−10.26478		−9.14381		5.43757		2.53582		−1.34481	
	(0.31133)		(0.38096)		(0.60760)		(0.86243)		(0.90391)	
Capital Intensity 2001	0.01965		−1.74243	*	−2.72955	***	−4.24197	***	−1.00858	
	(0.98425)		(0.08993)		(0.00908)		(0.00340)		(0.35726)	
Age of firm's assets 2001	3.84601	*	6.65817	***	3.96695	*	0.74768		3.00342	
	(0.06948)		(0.00238)		(0.07318)		(0.80651)		(0.19674)	
Debt to Equity ratio 2001	−0.00562	***	−0.01091	***	−0.00379	***	−0.00181		−0.00123	
	(0.00006)		(0.00000)		(0.00936)		(0.36617)		(0.42158)	
Number of observations	328		328		328		328		328	
F stat	3.991	***	9.603	***	5.974	***	3.219	***	3.584	***
Adjusted R^2	0.114		0.269		0.176		0.087		0.100	

Dependent variable: ROE	1999		2000		2001		2002		2003	
Intercept	−2.23886		−12.34919		−5.46618		10.48548		−5.09517	
	(0.68094)		(0.38843)		(0.36919)		(0.26910)		(0.39973)	
Nikkei 1999	0.00353		0.03578	*	0.00143		0.00467		0.01387	*
	(0.63959)		(0.07185)		(0.86537)		(0.72214)		(0.09865)	
Sales growth (98-03)	0.36028	***	−0.20293		0.42673	***	0.51519	***	0.46842	***
	(0.00142)		(0.49078)		(0.00073)		(0.00860)		(0.00020)	
R&D intensity 2001	−40.64630		−107.30129		17.24824		−0.88134		−16.73356	
	(0.13889)		(0.13719)		(0.57351)		(0.98527)		(0.58276)	
Capital Intensity 2001	1.88302		−15.05961	**	−1.75815		−6.99212		−1.38959	
	(0.48487)		(0.03413)		(0.55940)		(0.13684)		(0.64252)	
Age of firm's assets 2001	4.12234		19.95029		4.88124		−13.57454		4.57771	
	(0.47121)		(0.18507)		(0.44516)		(0.17342)		(0.47131)	
Debt to Equity ratio 2001	−0.00946	**	−0.11163	***	−0.00687		−0.01683	**	0.00616	
	(0.01231)		(0.00000)		(0.10277)		(0.01055)		(0.14109)	
Number of observations	328		328		328		328		328	
F stat	2.643	***	11.651	***	4.116	***	2.689	***	2.105	**
Adjusted R^2	0.066		0.313		0.118		0.067		0.045	

Note: P-value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01
Industry dummy variable have been included (not reported here).

Dependent variable: Tobin's q	1999	2000	2001	2002	2003
Intercept	−0.49674	0.40486	0.04183	0.29675 *	0.57964 ***
	(0.16857)	(0.27488)	(0.83749)	(0.06170)	(0.00467)
Nikkei 1999	0.00199 ***	0.00097 *	0.00135 ***	0.00099 ***	0.00100 ***
	(0.00008)	(0.06052)	(0.00000)	(0.00001)	(0.00043)
Sales growth (98-03)	0.02087 ***	0.03328 ***	0.02080 ***	0.01601 ***	0.01796 ***
	(0.00514)	(0.00002)	(0.00000)	(0.00000)	(0.00002)
R&D intensity 2001	6.61083 ***	5.28517 ***	3.82395 ***	2.59687 ***	3.51121 ***
	(0.00031)	(0.00488)	(0.00023)	(0.00124)	(0.00069)
Capital Intensity 2001	0.21547	0.06608	−0.01513	−0.10678	−0.08721
	(0.22743)	(0.71858)	(0.88088)	(0.17379)	(0.38712)
Age of firm's assets 2001	1.08460 ***	1.17086 ***	0.66458 ***	0.37712 **	0.12201
	(0.00441)	(0.00281)	(0.00208)	(0.02398)	(0.56846)
Debt to Equity ratio 2001	−0.00012	−0.00005	0.00018	0.00034 ***	0.00024 *
	(0.62652)	(0.84147)	(0.21232)	(0.00198)	(0.08912)
Number of observations	328	328	328	328	328
F stat	5.119 ***	4.858 ***	7.804 ***	7.437 ***	6.246 ***
Adjusted R^2	0.150	0.142	0.226	0.216	0.183

Note: P-value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01
Industry dummy variable have been included (not reported here).

Table 7 Results of regression analysis for Intangible Firm Value

Dependent variable: Intangible Firm Value	2001
Intercept	−342,753.2 ***
	(0.00726)
Nikkei 1999	717.5 ***
	(0.00006)
Sales growth (98-03)	1,301.6
	(0.61824)
R&D intensity 2001	1,551,470.3 **
	(0.01570)
Capital Intensity 2001	−57,724.9
	(0.35855)
Age of firm's assets 2001	48,514.7
	(0.71600)
Debt to Equity ratio 2001	−20.6
	(0.81445)
Number of observations	328
F stat	3.648 ***
Adjusted R^2	0.102

Note: P-value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01
Industry dummy variable have been included (not reported here).

If a company increases its Nikkei environmental score by 50 points (10 % of average score), IFV would be increased by 36 billion yen (179 million pounds), which is 21% of the average total assets of 328 sample firms. Though we have not much knowledge of costs for each firm to raise 50 points in Nikkei score (it may be far less than 36 billion yen), this suggests that environmental efforts pay substantially with higher intangible-assets value.

Hypotheses 4 and 5 were tested by the two split-sample analyses are shown in Tables 8 and 9 (Figures 7 and 8 respectively for visual understanding). Table 8 shows that the impact of environmental effort on operating performance tended to be higher for firms with the worse-than-sector-average environmental performance than better-than-sector average environmental performance, although the results are not statistically significant (highlighted coefficients mean bigger value than its counterpart and the worse sub-sample has more highlighted figures). The results for operating performance are consistent with, but are hardly proof for, hypothesis 4 (that there are diminishing returns to environmental effort, so that better environmental performance improves operating and financial performance more for dirtier than for already green firms). For Tobin's q, in contrast, firms with better environmental performance have significant positive correlations in all years, while firms with worse environmental performance have no significant correlations except in year 2002. At first glance, this result for Tobin's q appears to contradict hypothesis 4. In other words, although the results on operating performance are consistent with hypothesis 4, it appears that the market evaluates the environmental efforts of already green companies *more* favourably than the efforts of relatively dirty companies. This may be because better companies disclose more information, such as publishing environmental reports, which enables investors to evaluate firm's efforts more properly. Thus, hypothesis 4 is partially confirmed for operating performance, but the opposite result emerges, with statistical significance, for financial performance.

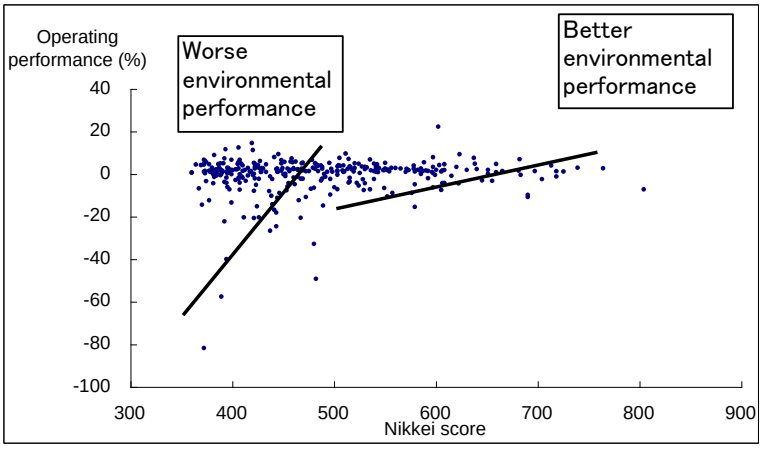
Table 8 Results of regression analysis for hypothesis 4

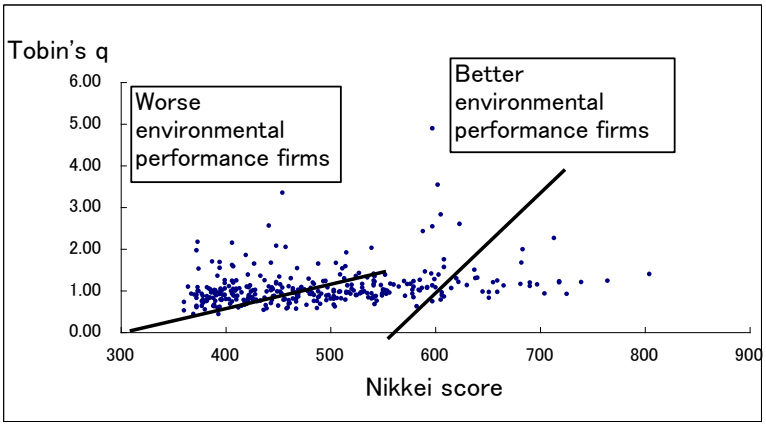
Coefficients of environmental performance

Better environmental performance firms	1999	2000	2001	2002	2003	observations
ROS	0.00328	0.00658	0.00663	0.01155	0.00394	139
	(0.55006)	(0.19232)	(0.42534)	(0.30485)	(0.49772)	
ROA	0.00542	0.00587	0.00154	0.00347	0.00493	139
	(0.27328)	(0.13720)	(0.74132)	(0.46904)	(0.19618)	
ROE	0.01189	0.01570 *	0.00134	0.01156	0.01422	139
	(0.37603)	(0.07754)	(0.90374)	(0.34888)	(0.20135)	
Tobins q	0.00258 **	0.00189 **	0.00202 ***	0.00124 ***	0.00174 ***	139
	(0.04113)	(0.02012)	(0.00118)	(0.00814)	(0.00143)	
Worse environmental performance firms	**1999**	**2000**	**2001**	**2002**	**2003**	
ROS	0.00770	0.03160	0.00680	−0.01156	0.00695	189
	(0.66653)	(0.12402)	(0.75385)	(0.69159)	(0.67644)	
ROA	0.00150	0.01832 *	0.00395	−0.00922	0.00640	189
	(0.86700)	(0.07357)	(0.69467)	(0.54796)	(0.57190)	
ROE	0.00128	0.07148	0.00733	−0.05873	0.02311	189
	(0.95782)	(0.36016)	(0.81204)	(0.25988)	(0.45212)	
Tobins q	0.00133	0.00060	0.00108	0.00124 **	0.00139	189
	(0.15279)	(0.73557)	(0.14736)	(0.04099)	(0.10391)	

Note: P−value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01
Highlighted coefficient shows higher value than coresponding one.

Figure 7 Correlations of worse and better environmental performance firms (Image graph)





Next, a multi-regression analysis was undertaken to examine the difference between high and low polluting industries on correlations between environmental efforts and profitability (industrial dummy was not used here). Table 9 describes that, in regard to operating performance, low polluting industries seem to have higher correlation coefficients between environmental and operational performance than high polluting industries, though statistically insignificant (again, highlighted figures show a higher coefficient and there are more highlighted figures in the low polluting industry sub-sample). This suggests that it is less costly in accounting basis for low polluting industries to achieve environmental improvements. On the contrary, as for Tobin's q, the high polluting industry sub-sample has larger coefficients with statistical significance than the low polluting industry. This suggests that the market evaluates firms' environmental efforts in high polluting industries more than others. This may be because the market pays more attention to high polluting industries from the viewpoint of corporate environmentally-friendliness and this is intuitively understandable. Thus, hypothesis 5, that better environmental performance enhances the operating and financial performance more for high polluting industries than for low polluting industries, is partially confirmed only for financial performance with statistically significance, and is rejected for operating performance.

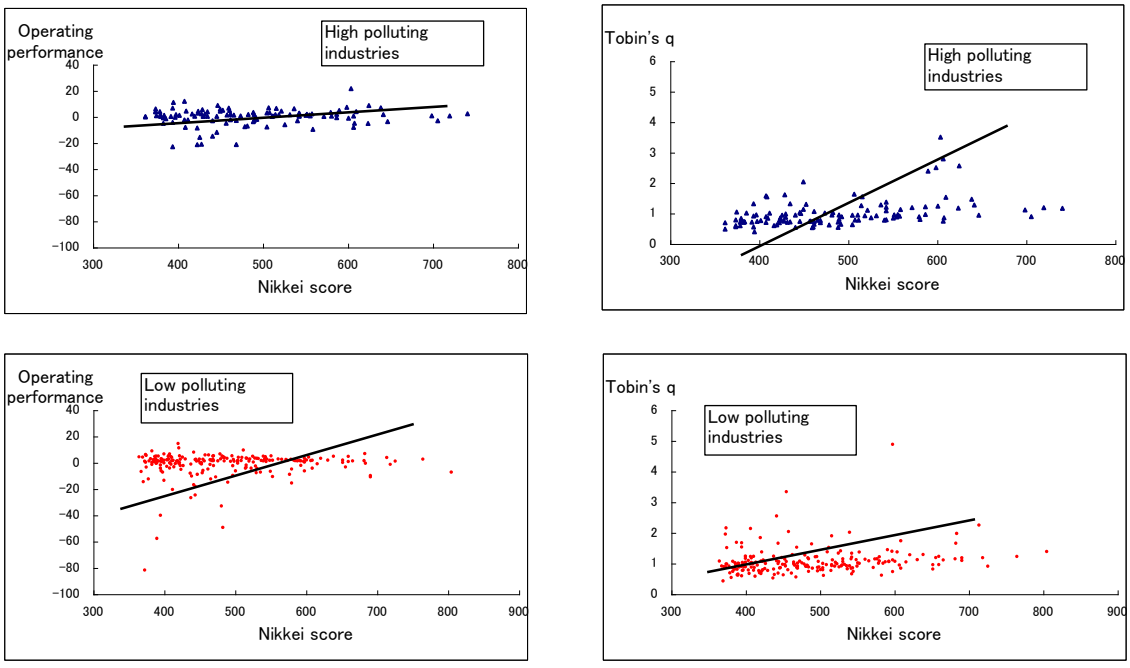
Table 9　Results of regression analysis for hypothesis 5

Coefficients of environmental performance

High polluting industries	1999	2000	2001	2002	2003	observations
ROS	0.00390	0.01179 *	0.00434	0.00838	−0.00804	117
	(0.54431)	(0.05714)	(0.53900)	(0.64655)	(0.27290)	
ROA	0.00358	0.00824 *	0.00386	0.00411	−0.00169	117
	(0.39016)	(0.06874)	(0.37469)	(0.65558)	(0.67977)	
ROE	0.00915	0.02457 *	0.00942	0.00271	−0.00801	117
	(0.46157)	(0.08586)	(0.40336)	(0.92276)	(0.51862)	
Tobins q	0.00213 ***	0.00218 ***	0.00187 ***	0.00158 ***	0.00194 ***	117
	(0.00045)	(0.00048)	(0.00005)	(0.00019)	(0.00007)	
Low polluting industries	**1999**	**2000**	**2001**	**2002**	**2003**	
ROS	0.00659	0.01705 **	0.01053	0.00645	0.01339 **	211
	(0.30364)	(0.02670)	(0.20931)	(0.39569)	(0.01906)	
ROA	0.00124	0.00891 **	0.00430	0.00495	0.01001 **	211
	(0.72908)	(0.01790)	(0.27990)	(0.20039)	(0.01529)	
ROE	0.00010	0.04165	0.00445	0.00990	0.02429 **	211
	(0.99136)	(0.14867)	(0.70504)	(0.46685)	(0.02588)	
Tobins q	0.00182 ***	0.00010	0.00099 ***	0.00070 ***	0.00041	211
	(0.00764)	(0.88212)	(0.00477)	(0.00467)	(0.22214)	

Note: P−value are in parentheses. * P<0.10, ** P<0.05, *** P<0.01
Highlighted coefficient shows higher value than coresponding one.

Figure 8　Correlations of high and low polluting industries (Image graph)



6. Discussion

The results of this study suggest that it does pay to be green. At least, environmental efforts are positively correlated with both operating and financial performance, especially for financial performance with statistical significance. Next, our concern should be paid to the 'reverse causality' hypothesis: do better environmental efforts lead to enhanced profitability or do more profitable companies tend to invest in environmental conservation activities? This has never been answered clearly in previous studies, but an important question.

As the first step, we tested mean difference analysis for examining causality that better environmental performance lead to enhanced profitability as follows: 210 companies having a Nikkei score both in 1999 and in 2003 were divided into a "better half" group (105 companies with improving Nikkei scores from 1999 to 2003) and a "worse half" group (105 companies with decreasing Nikkei scores)[9]. We tested for the mean difference in the rise of ROS, ROA, ROE and Tobin's q during the period 1999-2003 between these two groups (one-tail test). The null hypothesis is that there is no difference between the two groups' improvements in operating and financial performance.

Table 10 shows that the mean differences for all operating performance (ROS, ROA and ROE) are statistically significant. However, we can not identify mean difference as significant for Tobin's q, although the P-value shows as not so insignificant (0.18). Thus, the results of the mean difference analysis suggest that companies which raised their Nikkei scores from 1999 to 2003 had improved their operating performance significantly, and also, without statistical significance, less degraded financial performance (note that overall Japanese stock market performance

[9] Though the Nikkei environmental management survey adjusts its questionnaire and evaluation methods slightly every year, reflecting recent changes in environmental policy and corporate behaviour, we assumed that this did not affect the difference between the 1999 and 2003 Nikkei scores.

worsened due to the sluggish national economy during the period 1999-2003).

Table 10 Results of mean difference analysis

Rise in ROS 1999-2003

	Better	Worse
Mean	2.60565	0.57552
Variance	52.98155	50.41411
Observations	105	105
df	104	
t Stat	1.99143	
P(T<=t) one-tail	0.02453	

Rise in ROA 1999-2003

	Better	Worse
Mean	2.27648	0.43381
Variance	31.16825	22.73836
Observations	105	105
df	104	
t Stat	2.56568	
P(T<=t) one-tail	0.00586	

Rise in ROE 1999-2003

	Better	Worse
Mean	5.06305	0.91343
Variance	314.66234	212.50979
Observations	105	105
df	104	
t Stat	1.83877	
P(T<=t) one-tail	0.03440	

Rise in Tobin's q 1999-2003

	Better	Worse
Mean	-0.03609	-0.13896
Variance	0.44295	0.74597
Observations	105	105
df	104	
t Stat	0.91614	
P(T<=t) one-tail	0.18086	

The U.S. Environmental Protection Agency (2000) argued that firms that have better environmental performance may generally be well-managed, and hence, the high-quality management indicated by good environmental performance leads to improved financial performance. Hart and Ahuja (1996) commented that a 'virtuous circle' exists with regard to the relationship between the environmental performance and profitability – that is, firms can realise cost savings and reinvest these savings in further environmental efforts for a number of years before the investment/savings balance turns negative. King and Lenox (2001) suggested that environmental management capabilities and other capabilities may prove to be complementarities. Thus, this causality issue appears to defy simple explanations such as, the pursuit of better environmental performance leads to improved profitability, or profitable firms are more willing to spend money on environmental protection.

To clarify the causality between the environmental performance and profitability, further serious examination is required, and this is left for future research.

7. Conclusion

7.1 Findings of this study

This paper has focused on examining the relationship between the environmental performance and profitability of Japanese listed manufactures, using two reliable data sources, the Nikkei survey and the Toyokeizai database. We tested five hypotheses, based on previously-proposed explanations, by multiple regression analysis. Our findings are:

1) Corporate environmental efforts have a positive effect on the operating performance with some time-lag (1 year) in most cases, rather than having near-instant effect (hypothesis 1 and 2 are broadly confirmed).
2) Environmental efforts immediately have a significantly positive effect on financial performance through the market evaluation of intangible-assets value (hypothesis 3 is almost confirmed).
3) Control variables used in the multi-regression analysis have generally the same direction to profitability as previous studies showed.
4) Intangible-asset valuation by the market is significantly correlated with firm's environmental performance and this suggests that environmental efforts offer substantial rewards.
5) Better environmental performance tends to enhance the *operating* performance more for firms with lower environmental performance than those with higher environmental performance, while the contrasting result is obtained concerning *financial* performance (hypothesis 4 is partially confirmed only for *operating* performance).
6) Better environmental performance enhances the *financial* performance more for high polluting industries than low polluting industries, while the contrasting result is obtained

regarding *operating* performance (hypothesis 5 is partially confirmed only for *financial* performance).

7) Mean difference analysis suggests that firms which raised their environmental performance score achieved operating performance improvements statistically significantly more than firms whose scores decreased, and experienced less degradation in financial performance.

7.2 Contribution to the literature

In addition to these findings, this study contributes to the academics and business managers as follows:

1) This study provides long-term (five year) effects of comprehensive environmental performance indicators with a substantial sample size, while most previous studies tested only performance over a single or a few years and used a narrow-range of environmental performance indicators such as toxic chemical emission (the U.S. TRI), which can be regarded as somewhat arbitrary.
2) This study deals with both operating and financial performance and compares their difference, while most previous studies referred to only one or other.
3) This study deals with a wider range of firms including middle and small sized firms and excludes those firms which have undergone mergers or acquisitions, processes which change firms' financial structure during the analysis period. In contrast, most previous studies deal with only the largest firms such as the S&P 500, and without special consideration of M&As.
4) This study deals with the Japanese listed manufacturing sector, one of the lowest-polluting and most-efficient manufacturing sectors in the world. Hence, the conclusion drawn may

prove helpful not only to Japanese firm managers and policy-makers, but also to executives in other countries who follow Japanese firms.

7.3 Areas for future research

Regarding future work, firstly, analysis using sub-score (not only overall-score) of the Nikkei Survey may yield fruitful results. As mentioned in Section 4.1, the Nikkei Survey (2004) has 7 categories: 1) management structure and information disclosure, 2) vision, 3) pollution risk, 4) recycling, 5) eco-friendly products, 6) measures against global warming, and 7) measures at non-manufacturing sites. Thus, to investigate which sub-score is the most (and least) influential to firm's profitability would be of interest. Our hunch suggests that pollution risk and recycling factors may be related to the operating performance, because these can reduce operating costs directly. Also, such factors as management structure and information disclosure, vision, and eco-friendly products, may have a positive effect on financial performance through the market valuation of intangible-assets value.

Secondly, as stated earlier, causality between environmental efforts and profitability should be examined fully. In spite of different field, Acemoglu et al. (2005) investigated the relationship between higher income per capita and democracy using cross-country data set, and suggested that causality can be clarified by introducing advanced econometric technique such as fixed effect regression and instrumental-variables setting. Thus, if time and computer software[10] permit, the causality issue could be explained by controlling firm's fixed effects with each firm dummy variable and setting valid instruments for environmental performance that could not affect profitability through other channels.

[10] Microsoft Excel used in this study, can deal with only up to 16 independent variables in regression analysis, which is not suitable for fixed effect regression using many dummy variables.

One interesting aspect of this study is the different results between operating performance and financial performance. Operating performance (ROS, ROA, and ROE) is based on traditional accounting rules, so is more conservative and stable, while financial performance (Tobin's q) includes market valuation which is more flexible and unstable, but is regarded as the best available unbiased estimate (Fama, 1970). As the study showed, Japanese financial market does evaluate firm's environmental efforts as intangible-asset value, which is not easily reflected in accounting-based value.

However, *Keizai-doyukai* (The Japanese Association of Corporate Executives, 2003) shows that over 60% of senior Japanese corporate managers regard environmentally and socially responsible activities as costs, with less than 20% believing such efforts are beneficial investments. This may be attributable, firstly, to the shortage of empirical studies on environmental efforts and profitability in Japan. Secondly, in those studies which do exist, conclusions have been usually founded on traditional accounting-based profitability indicators, which, even though they do not show environmental efforts as damaging for modern Japanese firms, do not reveal the benefits of environmental efforts as clearly as indicators based on market valuation.

Recently, on a global basis including Japan, corporate accounting reform has progressed toward more market-based valuation of assets and liabilities, such as securities, land, and pension-related liabilities. Thus, in the near future, as greater emphasis is placed on market-based valuation, our finding that better environmental performance has highly significant positive effects on financial performance may be acknowledged as strongly encouraging further corporate environmental efforts.

Appendix: Contents of Nikkei Environmental Management Survey Questionnaire 2004 (translated by the author)

(1) Management structure and information disclosure

F3	The number of group firms within the boundary of under the parent firm's environmental management
Q1SQ1	Disclosure status of the input amounts of electricity, fuel oil and gas at the manufacturing sites
Q2SQ1	Disclosure status of the amounts of wastes and final disposal at the manufacturing sites
Q11SQ2	Disclosure status of the amounts of greenhouse gases at the manufacturing sites
Q21	Status of the supporting system for business partners to make environmental efforts
Q26(a/b)	Status of the environmental management system such as ISO14001 at the manufacturing sites
Q27(a/b)	Status of the education system for encouraging the employees at manufacturing sites to raise awareness on the environment
Q28	Status of the system for encouraging the employees to promote environmental activities
Q29	Publishing status of environmental or CSR reports including the information on environmental impacts and the environmental activities
SQ	Disclosure status of the contents of environmental or CSR reports Transition of numerical data on waste amounts Transition of numerical data on greenhouse gas emission Transition of numerical data on toxic chemical substance emission Transition of numerical data on recourse input amounts Numerical data on environmental impact of every factory and business site Status of community citizen's complaints against the environment at factories and business sites, environmental accidents, and after-the-fact handling
Q30	Disclosure status of numerical data on the environmental impacts of firm's products
SQ	Status of disclosed contents
Q31	Status of disclosure of environmental accounting, its definition, and its methodology
SQ1	Methodology of environmental accounting
SSQ	Scope of environmental accounting
SQ2	Status of activities for encouraging practical use of environmental accounting
Q32	Status of stakeholder communication on the environment
Q33	Status of environmental accidents, legal and regulatory violations with significant impacts on customers and others during these three years.
SQ1	Concrete details of environmental accidents, legal and regulatory violations
SQ2	Details of after-the-event handling of environmental accidents, legal and regulatory violations
Q34	Contents of environmental social activities

(2) Vision

Q1SQ3	Status of reduction target for energy input amounts at manufacturing sites
SSQ1	Scope of the target
SSQ2	Details of the target
Q2SQ4	Status of reduction target for waste quantities at manufacturing sites
SSQ1	Scope of the target
SSQ2	Target year or completion year for zero-waste-to-landfill (zero-emission) at manufacturing sites of the parent and subsidiary firms
SSQ3	Details of the target
Q11SQ3	Status of target set for greenhouse gases in 2010 at manufacturing sites
Q11SQ4	Status of target set for greenhouse gas reduction at manufacturing sites
SSQ1	Scope of the target
SSQ3	Details of the target
Q14SQ1SSQ	Status of mid- and long-term target setting for CO2 emission by domestic logistics
Q15SQ	Status of the target set for the introduction of low-polluting vehicles
Q23SQ1	Status of the mid- and long-term target setting for emission of chemical substances designated by the Pollutant Release and Transfer Register (PRTR) Law

(3) Pollution risk

Q22	Status of gripping of atmospheric impacts
SQ	Amounts of NOx and SOx emitted, and change from previous year
Q23	Policy of gripping of chemical substances including PRTR Law designated substances
SQ1	Amounts of used, emitted and transferred gripping chemical substances
SQ2	Status of activities for reduction of chemical substance emission and transfer
Q24	Status of policy setting for avoiding chemical substance leakage accidents
SQ	Details of the policy
Q25	Policy on soil pollution at business sites
SQ2	Policy on polluted soil, if any
SQ3	Status of estimation of potential costs by soil pollution

(4) Recycling

Q2(a/b)	Status of gripping of waste amounts at manufacturing sites
SQ2	Scope of gripping of waste amounts
SQ3	Extent of recycling, discharging and final disposal of waste (in 1990, 2002, 2003 and 2004)
Q3	Status of definition of zero-emission
SQ1	Details of definition of zero-emission
SQ2	Plan for revision of the definition of zero-emission
SQ3(a/b)	Status of zero-emission at manufacturing sites
Q4	Status of waste management
Q5	Status of selection criteria for waste disposal business partners
SQ	Status of policy and management for avoiding illegal waste disposal by business partners

(5) Eco-friendly products

Q16	Practical environmental measures regarding firm's products
SQ1	Status of CO2 emission estimation from the use of products
SSQ	Amount of CO2 emitted from the products and amounts of CO2 emission reduction by eco-design (in 2002, 2003, and 2004)
SQ2	Status of estimation of reduction of virgin resource inputs for firm's products
SSQ	Amounts of virgin resource consumption for manufacturing and amounts of reduction by eco-design (in 2002, 2003, and 2004)
SQ3	Status of gripping and estimation of amounts of used products
SSQ	Quantities of used products collected and quantities re-used (in 2002, 2003 and 2004)
SQ4	Status of recycling system
SSQ	Quantities of used products and waste reused (in 2002, 2003 and 2004)
SQ5	Status of estimation of reduction of final disposal by eco-design of products
SSQ	Quantities of final disposal reduced by eco-design (in 2002, 2003 and 2004)
SQ6	Status of estimation of reduction amounts of packaging material
SSQ	Quantities of packaging material (in 2002, 2003 and 2004)
SQ7	Status of gripping of heavy metal substances
Q17	Status of original equipment manufacturing (OEM)
SQ	Scope of traceability of OEM products
Q18	Status of life cycle assessment (LCA)
SQ1	Status of disclosure of LCA data
SQ2	Status of use of LCA data
Q19	Status of green procurement
SQ1	Measure of enhancement of green procurement
SQ2	Action against suppliers of green procurement
Q20	Action against business customers of green procurement

(6) Measures against global warming

Q1(a/b)	Status of energy inputs at manufacturing sites
SQ2	Amounts of electricity, fuel oil and gas inputs at manufacturing sites (in 1990, 2002, 2003 and 2004)
Q11(a/b)	Status of gripping of greenhouse gas (GHG) emission at manufacturing sites
SQ1	Scope of gripping GHGs
SQ3	Total amounts of GHG emission and GHG emission by units (in 1990, 2002, 2003, 2004 and 2010 target)
Q12	Status of target setting for total GHG emission reductions in 2008-2012
SQ1	Scope of the target
SQ2	Amounts of GHG emitted (in 1990 and 2003)
	Status of estimation on GHG emission in case of business-as-usual
	Status of estimation on GHG emission with reduction policy
SQ3	Action plan for achieving targets
Q14SQ1	Status of gripping of CO2 emission by domestic product logistics
SSQ	Amounts of CO2 emission by domestic product logistics and emission by units (in 1990, 2002, 2003, 2004 and 2010 target)
SQ2	Action plan for reduction of CO2 emission by domestic product logistics
SSQ	Status of disclosure of the action
SSSQ	Detailed contents of disclosed information
Q15	Status of introduction of low-polluting vehicles
SQ	Status of use of low-polluting vehicles and ratio to total vehicles

(7) Measures at non-manufacturing sites (offices)

Q1(c/d)	Status of gripping of energy input amounts at non-manufacturing sites (offices)
SQ4	Quantities of electricity, fuel oil and gas inputs at offices (in 1990, 2002, 2003 and 2004)
SQ5	Status of target setting for energy input amounts at non-manufacturing sites (offices)
SSQ1	Scope of the target
SSQ2	Details of the target
Q2(c/d)	Status of gripping of waste amounts at non-manufacturing sites
SQ5	Amounts of recycling, discharging and final disposal of waste (in 1990, 2002, 2003 and 2004)
SQ6	Status of reduction target for waste amounts at non-manufacturing sites
SSQ1	Scope of the target
SSQ2	Target year or achieving year for zero-waste-to-landfill (zero-emission) at non-manufacturing sites of the parent and subsidiary firms
SSQ3	Details of the target
Q3SQ3(c/d)	Status of zero-emission at non-manufacturing sites
Q6	Status of action for fractional recovery of used material at non-manufacturing sites
Q7	Status of gripping of paper use amounts at non-manufacturing sites
SQ	Quantities of paper used (in 2002, 2003 and 2004)
SSQ	Status of target setting of paper use reduction at non-manufacturing sites
Q8	Status of gripping of paper waste amounts at non-manufacturing sites
SQ	Quantities of paper waste (in 2002, 2003 and 2004)
SSQ	Status of target setting for paper waste reduction at non-manufacturing sites
Q10	Status of green purchasing at non-manufacturing sites
SQ2	Goods for green purchasing
SQ3	Status of target setting for green purchasing
SQ4	Green purchasing rate to total purchasing (in 2002, 2003 and 2004)
Q11(c/d)	Status of gripping of CO2 emission at non-manufacturing sites
SQ5	Amounts of CO2 emission at non-manufacturing sites (in 1990, 2002, 2003, 2004 and 2010 target)
SQ6	Action plan for reduction of CO2 emission at non-manufacturing sites and reduction estimates from 2003-2010
SQ7	Status of target setting for GHG total emission amounts at non-manufacturing sites
SSQ1	Scope of the target
SSQ3	Details of the target
Q12SQ1	Scope of GHG reduction target in 2008-2012
Q26(c/d)	Status of the environmental management system such as ISO14001 at the non-manufacturing sites
Q27(c/d)	Status of the education system for encouraging the employees at non-manufacturing sites to raise environmental awareness

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