Does the Stock Market Value the Firm's Potential Chemical Risk Released and Transferred? : Empirical Study on the Japanese Pollutant Release and Transfer Register System

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Abstract

The Japanese Pollutant Release and Transfer Register (PRTR) system could help investors identify a firm's potential chemical risk related to toxic releases and transfers. If so, investors show a preference for firms with lower risk and the stock market may value the risk. If this is the case, the stock market is likely to play an important role in providing firms with incentives to reduce risk. This paper explores the relationship between company stock market values and quantity of toxic releases and transfers, using Japanese PRTR data. The main finding is that the Japanese stock market negatively values the firm's chemical pollution risk. However, this is only true of releases not transfers, indicating that investors are distinguishing between different types of pollution risk.

Keywords: Pollutant Release and Transfer Register (PRTR), Stock Market, Market Valuation, Pollution, Toxic Chemical Risk

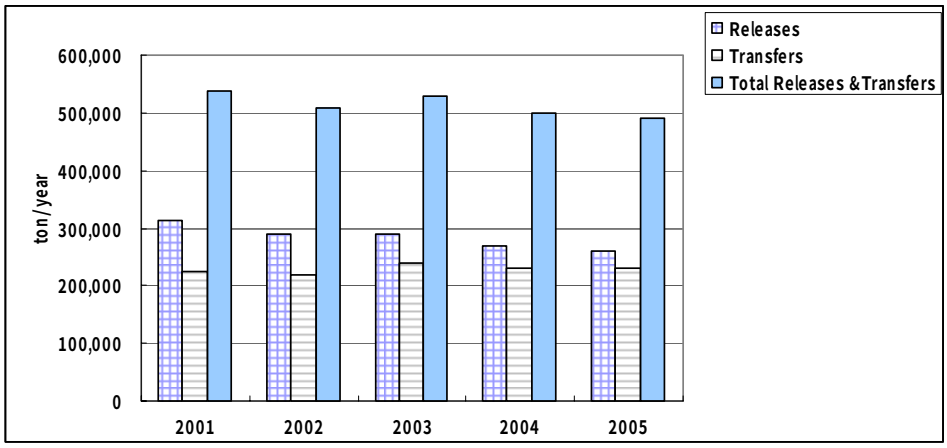
1. Introduction

It is not easy to obtain public acceptance for the introduction of conventional instruments such as the command-and-control regulations or environmental taxes. Thus, policy instruments designed to encourage firm improvement of environmental performance, such as voluntary instruments[1] or information provision policies - which disclose information about the environmental performance of the firm - have been increasingly favored as complements to conventional instruments.

The Pollutant Release and Transfer Register (PRTR) system in Europe and Japan and the TRI (Toxics Release Inventory) system in the U.S. are examples of information provision policies. In Japan, the PRTR system has been in force since 2001. Under this system, the facilities handling chemical substances potentially hazardous to the environment need to estimate annual amounts of each chemical substance released and transferred in waste, and report the data to the government every year. The government has been releasing the summary of the reported data to the public annually since the end of FY2002. The facility-level information on the annual amounts of each chemical substance released and transferred has to must be publicly. When requested. Prior to the PRTR, no record of the volume of toxic emissions existed. Figure 1 illustrates the total amount of the reported releases and transfers from 2001 to 2006. The amounts of air emissions, releases to water bodies, on-site land releases and on-site landfills are included in releases. The amounts of off-site transfers in waste, releases to the publicly owned treatment works are included in transfers. As is shown in Figure 1, these amounts are gradually decreasing.

[1] Use of voluntary instruments represent one approach to environmental policy. OECD categorizes voluntary instruments as follows (OECD 2003): (1) unilateral commitments, which are set by the industry without any involvement of a public authority; (2) agreements negotiated between industry and public authorities; (3) private agreements achieved between polluters and pollutes; and (4) public programs to reduce pollution emissions in which firms can take part voluntarily.

Figure 1.Amounts of Releases and Transfers of Chemical Substances in Japan



If investors prefer that firms that produce lower emissions and thus have lower environmental risk of future liability, the financial market may value the firm's environmental performance. Thus an information provision policy, such as the PRTR system, could help investors identify the firm's environmental performance and enable the financial market value it. As the result, firms would have stronger incentives to improve the environmental performance, as they may be rewarded with easier financing. Therefore, examination of the financial market value of firm environmental performance is a relevant and important topic for understanding firm environmental behavior resulting from information provision policies.

There are several previous empirical studies, which explore how the firm's environmental performance affects their financial performance. Hart and Ahuja (1996) examine whether lower chemical risk contributes positively to financial performance. Konar and Cohen (2001) use Tobin's q as a measure of firm value, and examine whether TRI releases and the number of pending environmental lawsuits diminish firm value. They find that toxic releases were negatively correlated with stock performance. King and Lenox (2002) find that waste prevention leads to financial gain. Cormier and Magna (2007) investigate the impact of environmental reporting on the relationship between a firm's earnings and its stock market value. However, these previous studies focus on the US financial market and it is not well known whether the other financial markets, such as the European or Japanese market, also value the firm's environmental performance.

The purpose of this study is to explore whether the Japanese stock market values firm's chemical risk.

This paper is organized into four sections. It first explains the econometric model in Section 2, and describes the data and measures in Section 3. Section 4 presents the estimation results and a final section provides a summary findings and conclusions.

2. Model

Following Cormier and Magna (2007), the econometric model is constructed as shown in equation (1). Because there is the possibility of the endogeneity problem, it is critical to estimate this model appropriately. Unknown variables may affect both emissions of chemical substances and the market value of the firm. In addition, firms that have a higher market value may reduce emissions more, since they afford the cost for environmental measures, while those with lower emissions may have a higher market value. If either of case is true, , estimation results might be biased. Therefore, a two-stage-least squares (2SLS) specification with lagged variables is used to deal with the endogeneity and the direction of causality problems. The subscripts i and t indicate the firm and year, respectively. Lagged variables help ascertain the causal relationships between market valuation and environmental performance (total amount, released and transferred of the chemical substances). Table_1 provides definition of indicators.

$$\Delta excess-value_{it} = \beta_0 + \beta_1 \Delta\left(\frac{emissions}{sales}\right)_{it-2} + \beta_2 \Delta\left(\frac{advertisement}{sales}\right)_{it-1}$$
$$+ \beta_3 \Delta\left(\frac{currentearnings}{sales}\right)_{it-1} + \beta_4\left(\frac{R\&D}{sales}\right)_{it-1} + \beta_5 \Delta\left(\frac{emissions}{sales}\right)_{it-2} \Delta\left(\frac{currentearnings}{sales}\right)_{it-1}$$
$$+ \beta_6 \Delta\left(\frac{emissions}{sales}\right)_{it-2} \Delta\left(\frac{advertisement}{sales}\right)_{it-1} + \varepsilon_{it}$$

$$\Delta\left(\frac{emissions}{sales}\right)_{it-2} = \alpha_0 + \alpha_1 \Delta\left(\frac{emissions}{sales}\right)_{it-3} + \alpha_2 \Delta\left(\frac{emissions}{sales}\right)_{it-4}$$
$$+ \alpha_3 \Delta\left(foreigninvestors\right)_{it-2} + \alpha_4 \Delta\left(foreigninvestors\right)_{it-3} + \mu_{it} \qquad (1)$$

Further it is hypothesis that emissions reductions in time period t will enhance firm market value in the period t+3.

$$\Delta excess-value_{it} = \beta_0 + \beta_1 \Delta\left(\frac{emissions}{sales}\right)_{it-3} + \beta_2 \Delta\left(\frac{advertisement}{sales}\right)_{it-1}$$
$$+ \beta_3 \Delta\left(\frac{currentearnings}{sales}\right)_{it-1} + \beta_4\left(\frac{R\&D}{sales}\right)_{it-1} + \beta_5 \Delta\left(\frac{emissions}{sales}\right)_{it-3} \Delta\left(\frac{currentearnings}{sales}\right)_{it-1}$$
$$+ \beta_6 \Delta\left(\frac{emissions}{sales}\right)_{it-3} \Delta\left(\frac{advertisement}{sales}\right)_{it-1} + \varepsilon_{it}$$

$$\Delta\left(\frac{emissions}{sales}\right)_{it-3} = \alpha_0 + \alpha_1 \Delta\left(\frac{emissions}{sales}\right)_{it-4} + \alpha_2 \Delta\left(\frac{emissions}{sales}\right)_{it-5}$$
$$+ \alpha_3 \Delta(foreigninvestors)_{it-3} + \alpha_4 \Delta(foreigninvestors)_{it-4} + \mu_{it} \qquad (2)$$

Table_1 Summary of variable definitions for all variables used in empirical analysis

Dependent variable	**Definition**
Excess-Value (value of the firm by investors)	[market value-book value]/sales
Explanatory variable	
Emissions	
Total emissions	The sum of releases and transfers
Releases	Releases to air, water, land and those injected underground.
Transfers	Releases to off-site for treatment, energy recovery or disposal
Sales	Total sales
Advertisement	Advertising expenditure
Current Earnings	Current earnings
R&D	Research and development expenditures
Foreign Investors	The ratio of foreign investors

3. Data and Measures

Firm-level financial data for firms listed in the Nikkei 300 stock index were obtained from Nikkei Needs database. The Nikkei 300 is the stock index created by Nikkei Inc. and composed of 300 companies listed on Japanese stock exchanges. Industries represented in the sample are the following: food and beverage; pulp and paper; chemical; pharmacy; oil; tuber; steel; nonmetal; machinery; metalworking; electric equipment; automobile; electric machinery; precision instrument; textiles; transportation; construction; and gas. Annual releases and transfers of the firms, were obtained from Ministry of the Environment's PRTR database. Quantities of toxic releases and transfers were aggregated and matched merged at firm level. After eliminating the missing data, the full sample included 140 firms. There are 840 firm-year observations for the year 2001-2006.

Financial performance

Financial performance of the firm is measured as "Excess values ". "Excess values " have been used in a previous study by Khanna, Quimio, and Bojilova (1998) where they showed that participation in the 33/50 program lowered toxic emissions from chemical firms. Similar to that study, "excess-values" in this study is measured as [market value-book value]/sales. Market value is equal to the stock price multiplied by the number of shares outstanding. The stock price is defined as the maximum stock price in the corresponding year.

Pollution performance

Environmental performance (emissions/sales) is measured as the ratio of total emissions to sales. Total emissions (total) are defined as the sum of on-site toxic releases (releases) and off-site transfers (transfers). On-site releases include discharges to air, water, land and those injected underground. Off-site transfers are releases sent off-site for treatment, energy recovery or disposal.

These measures not only capture the efficiency of production processes and prevention but also they are standardized by firm size. It is preferable to use product amount instead of sales for their variables, but those data are not available. The analysis disaggregates the emissions to sales ratio into two parts - the ratio of on-site releases to sales and the ratio of off-site transfers to sales - to see if the effect of emissions reduction on market value is different for certain types of pollutants or

disposal method. In particular, on-site releases to land account higher toxicity than off-site transfers. Khanna, Quimio, and Bojilova (1998) report that the relationship between off-site transfers and on-site releases is considered be substitutes. However, the PRTR data do not confirm this.

It is predicted that the coefficient of the lagged total emissions variable will be negative, as will the coefficients for on-site releases and off-site transfers. Reducing all kind of emissions is likely to increase market value. Market fears the future litigation risk for high pollutant firms. Additionally, green consumers and investors may have negative perceptions toward high pollutant firms. If the coefficient for on-site releases is different from that of off-site transfers, the impacts of the emissions reductions on market value may depend on pollutant type. Such a finding would be in line with King and Lenox (2002) who find evidence that reducing total emissions is not profitable, but reducing pollution by preventing waste is profitable.

In Japan, two years must elapse before PRTR information is released. Therefore, the first estimated model includes two-year lag variables. An alternative model, using 3 year lag variables, is also estimated. It is predicted that emissions reductions in the time period t-2 and t-3 will enhance the market value in the time period t.

Controls

I include a number of control measures commonly used in the analysis of financial performance ad controls.

The ratio of advertising expenditure to sales (advertisement /sales) is a proxy for pressure from consumers. If the coefficient is positive, this suggests that firms with high advertising expenditures have a good image to market value, due to consumer loyalty. If the coefficient is negative, this suggests that firms with high advertising expenditures have bad image to market value, due to cost.

The ratio of current earnings to sales is a proxy for firm profitability. It is predicted that this coefficient is positive because the market is likely to value firms with stable profitability. A one-year lag variable for current earnings per sales is added because it takes time to disclose this information to the market.

The degree of innovativeness of firms is represented by the inclusion of research and development (R&D) expenditures per unit sales. Research and development (R&D) expenditures per sales is calculated by dividing research and development expenditures by sales. Because, R&D may be found to positively

correlated with firm profit, it is included as a control. Additionally, highly innovative firms are likely to realize savings and efficiencies in the production process. Khannna, Quimmio, and Bojilova (1998) find weak support that greater R&D intensity leads to a reduction in TRI chemical on-site releases and off-site transfers. As a result, it is predicted that the effect on the market value will also be positive in Japan. A one-year lag variable for R&D expenditures per sales is included because it takes time for this information to be disclosed.

The interactive term coefficient for emissions and current earnings per sales (emissions/sales*currentearnings /sales) is expected to be positive. The denominator of this variable, "current earnings per sales" is a proxy for profitability. This interactive term captures the potential case that the effect of emissions reductions on firms with high profitability is different from that on firms with low profitability. This interactive term is useful to see indirect effects of emission reductions through profitability on market value. It is predicted that the coefficient will be positive because firms with high profitability can afford to implement more environmental measures. If the direction for coefficient of on-site to releases is different from that of on-site transfers, the impacts of the emissions reduction on market value depend on pollutant type and disposal method. The cost of preventing on-site releases has been found to be different from that of off-site transfers (King and Lenox 2002). If the coefficient of on-site releases is negative, this means that firms with high profitability are more likely to increase market value when they decrease on-site releases. If the coefficient of transfers is negative, this means that firms with high profitability are more likely to increase market value when they decrease off-site transfers.

An interaction term for the count of total emissions and lagged advertising expenditure (emissions/sales*advertisement/sales) was included to see if the effect of total emissions reduction on firms with high consumer pressure is different from that on firms with low consumer pressure. This interactive-term is useful to see indirect effect of emission reductions through advertising expenditure on market value. It is predicted that this coefficient will be negative because firms with high pressure from consumers will try to avoid high environmental risk that will lose consumer loyalty. If the interactive-term for on-site releases with lagged advertising expenditure is negative, this will suggest that firms with high consumer pressure are likely to increase more market value when firms decrease on-site releases. If the interactive-term for off-site transfers with lagged advertising expenditure is also negative, this will suggest that firms with high consumer pressure are likely to

increase more market value when firms decrease off-site transfers.

Foreign investors are said to be stricter about environmental management. The ratio of foreign investors is a measure of pressure from investors. It is expected that the coefficient for foreign investors per sales (foreigninvestors) will be negative. Table 2 shows the basic statistics of the sample.

Table 2 Descriptive statistics.

variables	Mean	Std. Dev.	Min	Max
(market value-total assets)/sales	273.81	5803.57	-27.54	147477.30
Advertisement expenditure (millions)	8820.35	15583.01	11.00	113522.00
R&D expenditure(millions)	26030.89	55019.54	19.00	480013.00
total assets(millions)	1206068.00	1796334.00	498.82	14300000.00
current earnings(millions)	47787.93	96769.00	-231816.00	1104781.00
sales(millions)	822072.90	1174720.00	4938.00	10200000.00
the ratio of foreign investors	0.20	0.13	0.01	0.76
Advertisement expenditure/sales	0.01	0.02	0.00	0.18
R&D expenditure/sales	0.04	0.05	0.00	0.53
current earnings/sales	0.08	0.14	-0.80	1.00
Total emissions (kg)	588287.2	900698.8	1.5	7238953.0
Releases (kg)	299838.7	552681.3	0	4930572
Transfers (kg)	288448.5	573327.0	0	6379417.0

4. Estimation Results

I estimate the model by a two-stage-least squares (2SLS) specification. Table 3 presents the estimation results of Excess values function (Eq.1) using 2 year lag variables. Table 3 shows the estimation results using 3 year lag variables.

Table_3 Market value function (2 year lag case)

Dependent variable: Excess values

Variables \ emissions	total	release	transfer
$\Delta\left(\frac{emissions}{sales}\right)_{it-2}$	−0.021 (−0.17)	−0.95** (−2.06)	0.0094 (0.06)
$\Delta\left(\frac{advertisement}{sales}\right)_{it-1}$	−1.50	−32.74**	3.07

	(−0.16)	(−2.29)	(0.31)
$\Delta\left(\frac{currentearnings}{sales}\right)_{it-1}$	7.89*** (5.05)	6.54*** (4.17)	6.52*** (4.15)
$\Delta\left(\frac{R\&D}{sales}\right)_{it-1}$	−0.35 (−0.89)	−0.08* (−1.83)	−12.90** (−2.78)
$\Delta\left(\frac{emissions}{sales}\right)_{it-2}\left(\frac{currentearnings}{sales}\right)_{it-1}$	−0.34 (−0.89)	−9.08* (−1.83)	−0.23 (−0.45)
$\Delta\left(\frac{emissions}{sales}\right)_{it-2}\left(\frac{advertisement}{sales}\right)_{it-1}$	−10.33** (−3.04)	183.9** (2.28)	−1.71** (−2.92)
cons	0.21** (1.99)	−0.10** (−2.79)	0.18* (1.76)
Adj R-squared F stat	0.29 22.6***	0.30 23.32***	0.06 6.65**

First stage dependent variable : $\Delta\left(\frac{emissions}{sales}\right)_{it-2}$			
	total	release	transfer
$\Delta\left(\frac{emissions}{sales}\right)_{it-3}$	0.32*** (8.51)	0.004 (0.13)	0.36*** (10.09)
$\Delta\left(\frac{emissions}{sales}\right)_{it-4}$	−0.08** (−2.41)	−0.071** (−3.31)	−0.21** (−6.31)
$\Delta(foreigninvestors)_{it-2}$	−1.02 (−0.97)	−1.98*** (−5.24)	−0.14 (−0.23)
$\Delta(foreigninvestors)_{it-3}$	1.00 (0.92)	0.83** (2.11)	0.27 (0.41)

***, ** and * indicate statistical significance at the 1% level, the 5% level and the 10% level respectively; t-value in parentheses.

The coefficient for total emissions/sales is negative. This is consistent with the hypothesis that reducing total emissions will enhance market value. But it is not statistically significant. The coefficient for releases/sales is negative statistically significant. This is consistent with the hypothesis that reducing on-site releases will enhance market value. The coefficient for transfer/sales is positive. This suggests

that increasing off-site transfers will enhance market value. But it is not statistically significant. There is off-site transfer to recyclers, which includes recycling for the recovery of solvents and the recovery of metals and other recovery. The share of these chemicals that re-enter the industrial stream versus the share that is disposed is not known. It may be that this complexity makes the reduction effect of the transfers unclear to the investors.

The coefficient for advertisement/sales and is negative and statistically significant for releases. This finding indicates that firms with high consumer pressure are more likely to decrease market value. But this coefficient is not significant in the case transfers and total emissions.

The coefficient for current earnings/sales is positive and statistically significant in all cases. This seems to be reasonable because highly profitable firms are good to investors.

The coefficient for R&D/sales is negative and statistically significant in releases and transfers cases. This finding is that the firms with high R&D expenditure in the time period t-1 are more likely to decrease the market value in the time period t. This seems not to be reasonable, but it may take more time to for R&D to affect market value. The coefficient of total emissions case is not significant.

The coefficient for emissions/sales*current earnings/sales is negative and statistically significant in releases. But this is not statistically significant in transfer and total emissions. This finding suggests that firms with higher profitability are more likely to get market value compared firms with low profitability when they decrease on-site releases. This implies that reduction of on-site releases may be additional effect on market value for firms with high profitability. They may be able to afford to expend their environmental management to prevent on-site releases due to their high profitability. Harrison and Antweiler (2003) show that reducing on-site releases carries a lower cost than reducing off-site transfers.

The coefficient for emissions/sales*advertisement/sales is negatively significant for total emissions and transfers. This result indicates that firms with high advertising expenditure per sales are more likely to increase market value compared to firms with low advertising expenditure per sales when they reduce

their total emissions and off-site transfers. But the coefficient for emissions/sales is positively significant in releases. This result suggests that firms with high advertising expenditure to sales ratios are more likely to increase market value compared to firms with low advertising expenditure to sales ratios when they increase on-site releases. The advertising expenditure to sales ratio indicates consumer pressure. High consumer pressure may cause firms with polluting high total emissions or off-site transfers to reduce pollution. But the same effect is not felt by firms with high on-site releases.

Table_4 presents market function for three-year lagged emissions. The coefficient for emissions/sales for total emissions is positive but not statistically significant. It is also positive but not statistically significant in releases. It is negative but not statistically significant in transfers. This suggests that reducing total emissions, on-site releases, and off-site transfers in time period t-3 will no longer enhance market value in time period t.

The coefficient for advertisement/sales and is negative but not statistically significant in total, releases and transfers. This finding means that higher consumer pressure does not affect firm market value.

The coefficient for current earnings/sales is positive and statistically significant in all cases. This seems to be reasonable because highly profitable firms are good to investors. This result is same as two-year lagged case for emissions.

The coefficient for R&D/sales is negative and statistically significant for total emissions, releases and transfer models. This finding can be interpreted to mean that the firms with high R&D expenditure in the time period t-1 are more likely to decrease the market value in the time period t. R&D expenditure in the period t-1 may be costly to firms and that it may take more time for R&D investment to affect market value.

The coefficient for emissions/sales*current earnings/sales is positive but not significant for total, releases and transfers models. This result is different for the case in time period t-2 for emissions as compared to t-3. This suggests that emission reduction in the period t-3 has no impact on market value in the period t

for firms with high profitability in the period t-1. This implies that the effect of emission reduction in the period t-3 on market value has no relationship with firm profitability.

The coefficient for emissions/sales*advertisement/sales is not significant in the total, releases, and transfer models. This indicates that emission reduction in the period t-3 has no effect on market value through consumer pressure.

Table_4 Market value function (3year lag case)

Dependent variable: Excess values

emissions / Variables	total	release	transfer
$\Delta\left(\frac{emissions}{sales}\right)_{it-3}$	0.06 (0.54)	0.14 (0.64)	−0.05 (−0.23)
$\Delta\left(\frac{advertisement}{sales}\right)_{it-1}$	−0.14 (−0.01)	−0.42 (−0.04)	−1.24 (−0.12)
$\Delta\left(\frac{currentearnings}{sales}\right)_{it-1}$	2.82** (2.19)	2.91** (2.33)	2.28** (2.15)
$\Delta\left(\frac{R\&D}{sales}\right)_{it-1}$	−12.03** (−2.60)	−11.60** (−2.49)	−11.85** (−2.58)
$\Delta\left(\frac{emissions}{sales}\right)_{it-3}\left(\frac{currentearnings}{sales}\right)_{it-1}$	0.47 (0.94)	1.01 (0.82)	0.74 (1.02)
$\Delta\left(\frac{emissions}{sales}\right)_{it-3}\left(\frac{advertisement}{sales}\right)_{it-1}$	−0.89 (−0.22)	−1.52 (−0.16)	0.92 (0.13)
Cons	0.12 (1.09)	0.13 (1.17)	0.11 (0.99)
Adj R-squared F stat	0.29 22.6***	0.03 3.93***	0.04 3.93***

First stage dependent variable : $\Delta\left(\frac{emissions}{sales}\right)_{it-3}$

	total	release	transfer
$\Delta\left(\frac{emissions}{sales}\right)_{it-4}$	0.23** (5.70)	0.003 (0.13)	0.23** (5.86)
$\Delta\left(\frac{emissions}{sales}\right)_{it-5}$	0.16** (5.03)	−0.71** (−3.31)	−0.13** (−3.4)
$\Delta(foreigninvestors)_{it-3}$	−1.93 (−1.53)	−1.98** (−5.24)	−0.60 (−0.77)
$\Delta(foreigninvestors)_{it-4}$	−0.006 (−0.0)	0.83** (2.11)	−0.31 (0.41)

***, ** and * indicate statistical significance at the 1% level, the 5% level and the 10% level respectively.

t-value in parentheses

5. Conclusions

Findings show that the more a firm prevents on-site releases in the time period t-2, the higher its market value in the time period t. There is no evidence that higher transfers or higher total emissions affect market value. Firms that have a larger volume of toxic on-site releases are likely to face greater social pressure from communities and stakeholders to undertake measures to improve their environmental performance. Transfers are likely to have no impact. Findings show that profitability and consumer pressure have an indirect impact on market value through pollution reduction.

There is no evidence of significant relationship between the emissions reductions in the time period t-3 and the market value in the time period t. This suggests that the information of chemical risk in the period t-3 has no impact to market value. Furthermore, the timing of disclosure of information may be important role to firm.

Findings show that investors prefer firms with lower on-site releases and thus lower environmental risk which reduces possibility of the future liability, the financial market may value firm's environmental performance. Thus the PRTR information provision policy seems to help investors identify the firm's environmental performance and enables the financial market value it, perhaps because improved environmental performance that is recognized by the market will

enable easier financing.

Previous studies have all focused on the US financial market to examine if the financial market values firm's environmental performance. Until, it was unknown whether the same factors matter for firms in other financial markets, including that of Japan.

This paper examined whether the Japanese financial market values the chemical risk using the PRTR data. It finds that the market negatively values the risk of pollution. This finding reinforces prior studies of the effects of toxic emissions on US firm performance. Hence, the disclosure of the information on firm's environmental performance such as PRTR system possibly gives firms incentives to improve their performance. Therefore, the information provision policy should be considered to be effective policy instrument complementing the conventional policy instruments.

References

[1] Andrew, King and Michael, Lenox, Exploring the Locus of Profitable Pollution Reduction, Management Science. 48(2) (2002)289-299.

[2] Cormier Denis and Magnan Michel, The revisited contribution of environmental reporting to investors' valuation of a firm's earnings: An international perspective, Ecological economics 62(2007)613-626

[3] Hart, Stuart and Gautam Ahuja, "Does it Pays to be Green?" An Empirical Examination of the Relationship Between Emission Reduction and Firm Performance, Business Strategy and the Environment (1996)30-37.

[4] Kathryn Harrison and Werner Antweiler. Incentives for Pollution Abatement: Regulation, Regulatory Threats, and Non-Governmental Pressures: Journal of Policy management 22(2003).361-382

[5] Konar, Shameek and Mark A. Cohen, Does the market Value Environmental Performance? The Review of Economic and Statistics. 83(2) (2001)281-289.

[6] Wilma Rose Q.Anton and George Deltas and Madhu Khanna. Incentives for environmental self-regulation and implications for environmental performance: Journal of Environmental Economics and Management 48(2004).632-654