Market Valuation of Recognised Environmental Liabilities

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Abstract

We investigate whether the market views recognised environmental liability information differently from disclosed information related to soil contamination. Using Pollutant Release and Transfer Register data, we estimate soil contamination risk for each firm weighted by toxicity, and investigate the effects of this risk, its reduction, and the recognized environmental liabilities on firm's market values. We found, first, disclosed soil contamination risk has a negative impact on firm's market value. Second, the accounting recognition of site clean-up liabilities has a positive impact on market value, although firm-level pollution reduction estimated by disclosed PRTR data doesn't have any impact on market value.

1. Introduction

Soil contamination is a critical environmental issue for businesses in terms of the potential scale of clean-up and the associated costs. Sites that are unused or underutilised because of existing contamination or possible future contamination concerns are referred to as 'brownfields' (USEPA, 2008). The majority of manufacturing plants, in addition to brownfields, face the risk of soil contamination. Despite precautions in the management of chemical substances, the possibility of leakage persists, which will result in soil contamination. Soil contamination is a particularly serious problem in Japan because the country possesses limited land mass, which increases manufacturing business concentration. Soil contamination has attracted substantial public attention in recent decades. Structural changes in the Japanese economy have encouraged many firms either to integrate their manufacturing sites or to move production overseas. The extent of soil contamination is often revealed at the time of land investigation and redevelopment (JMOE, 2007). Other manufacturing-oriented countries face similar current or future soil contamination issues.

Various stakeholders are concerned with soil contamination. The needs of governments, local communities, and environmental activists are reflected in the prevailing legal system. The Soil Contamination Countermeasures Act includes the protective policies of governments,

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and the Pollutant Release and Transfer Register (PRTR) is the database designed by governments, local communities, and environmental activists to monitor firm chemical releases. Creditor interests are reflected in bond ratings by a decrease in the collateral value of the contaminated site (Graham *et al*., 2001). Therefore, this paper addresses soil contamination effects from the perspective of capital market participants.

The previous research analyses the relationship between firm environmental and financial performance (e.g. Margolis and Walsh, 2003; Van Beurden and Gössling, 2008) based on legitimacy theory (Cho *et al*., 2012), stakeholder theory (Orij, 2010), information economics theory (Cho *et al*., 2013), and voluntary disclosure theory (Guidry and Patten, 2012). The accounting for environmental liability has been debated from the perspective of recognition versus disclosure. The Canadian Institute of Chartered Accountants releases a research report on environmental costs and liabilities (CICA, 1993), the American Institute of Certified Public Accountants releases the Statement of Position No. 96-1 on environmental remediation liability (AICPA, 1996), and the European Commission issues a Directive on environmental liability on the prevention and remedying of environmental damage (EC, 2004). However, how market investors value the recognition versus disclosure of environmental liabilities has not yet been a focus of investigation.

With respect to recognition and disclosure, managers, regulators, and academics possess different perspectives (Barth *et al*., 2003). With respect to managers, recognising liabilities would adversely affect their profit, but disclosure would be acceptable. However, regulators and academics often believe that the market values substance over form. In efficient markets with minimal information-processing costs, the accounting treatment (recognition or disclosure) of environmental liabilities is not likely to represent a significant factor. However, if there are costs associated with information processing, systematic biases with respect to the investor processing of information, or differences in the perceived reliability of the data, the accounting treatment of liabilities could be a significant factor in the valuation of firms (Ahmed *et al*., 2006).

Prior research provides evidence that the market considers recognised liabilities to be more reliable than disclosed liabilities (e.g. Davis-Friday *et al*., 2004; Ahmed *et al*., 2006). Campbell *et al*. (2003) identified the effect of accounting recognition that resulted from compulsory clean-up obligations under the United States Superfund Act; however, Moneva and Cuellar (2009) showed an increase in the value relevance of compulsory environmental information but not of voluntary information. Environmental liabilities are accrued from compulsory clean-up obligations, but they are more likely to be accrued from non-compulsory obligations. In Japan especially, the majority of clean-up cases are on a voluntary basis. To our knowledge, no research has explicitly examined whether positive or negative investor valuation of non-compulsory environmental obligations of firms depends

upon recognition or disclosure.

Therefore, this study identifies the effect of accounting recognition from the perspective of the voluntary disclosure theory (Healy and Palepu, 2001). Using a sample of Japanese firms that disclose toxic release data concerning soil contamination risk and recognise contamination costs and liabilities in their financial statements, we investigate whether the market views recognised environmental liability information differently from disclosed information. In this study, recognition represents an amount that has been recorded using double-entry accounting and that is included as separate line items in the financial statements, whereas disclosure refers to information disclosed but not included in the financial reporting (PRTR data).

We first estimate the soil contamination risk of Japanese firms using the PRTR data and toxicity-weighted factors used in King and Lenox (2002). The existing research implies that PRTR data has information value (Moneva and Cuellar, 2009). We then investigate the relationship between the risk and firm market value, and investigate the impact of a reduction in soil contamination risk. Finally, we examine the effect of the accounting information that is recognised on financial statements. We generate two main findings. First, a firm's soil contamination risk has a negative impact on the market value of the firm. Second, although firm level pollution reduction does not impact market value, the recognition of site clean-up costs and liabilities at the firm level has a positive impact on market value.

This is the first analysis, to our knowledge, to examine the impact of voluntary recognised non-compulsory environmental liabilities on firm market value. Our results contribute to an understanding of the accounting consequences of environmental liability in the following ways. First, the disclosed information concerning soil contamination risk and the recognised clean-up liabilities represent useful data for the investor decision-making process. Our findings relating to pollution risk are consistent with the findings in the existing literature (e.g. Saka and Oshika, 2014), which suggest that the disclosed environmental risks negatively affect a firm's market value. Second, our finding reveals that firm value is positively related to the accounting recognition of environmental liabilities. Capital markets consider the recognition of environmental liabilities as a positive indicator that the firm has already undertaken clean-up action, is taking steps to reduce future risk and uncertainty, and is reducing information asymmetry. Thus, the market could provide an incentive for the firm to engage in clean-up. Third, our analysis provides implications for standards setter that strengthen accounting regulation to require recognition of environmental liabilities would be useful for both investors and firms to reduce information asymmetry and to increase firm value.

The remainder of the paper is organised as follows. Section 2 provides the institutional

background. Section 3 reviews the existing literature and develops our hypotheses. Sections 4 and 5 describe the research design, and the samples and results for our three hypotheses. Section 6 presents a conclusion.

2. Institutional Background

2.1 Soil Contamination Regulation and Firm Actions

The estimates by the JMOE of the total area of soil contamination in Japan is 113 thousand hectares with an asset value of ¥43.1 trillion (US$420 billion) and potential clean-up costs of ¥16.9 trillion (US$165 billion) (JMOE, 2007). Estimates of the total area of potential brownfield are 28 thousand hectares, which represents approximately 50-percent of the Tokyo metropolitan area and clean-up costs of ¥4.2 trillion (US$41 billion). The majority of these contaminated sites have not yet been the focus of clean-up efforts and massive potential environmental liabilities exist.

The Japanese government promulgated the Soil Contamination Countermeasures Act in 2002 to address the issue and introduced subsequent amendments in 2009. However, unlike the comparable Superfund Act in the United States[1], cases that require clean-up under this act are limited because the main aim of the Act is to prevent health hazards to the general population[2]. In fact, approximately 270 investigation orders and 42 clean-up orders resulted from this Act in 2010 (JMOE, 2012b); only a small part considering the scope of potentially contaminated sites requiring clean-up in Japan.

However, many firms implement clean-up activities beyond their legal clean-up obligations because firms experiencing soil contamination face a variety of business risks; operational risk (the suspension of operations and the loss of business), financial risk (the reduction in land prices and the value of the associated collateral), and reputational risk (diminished social credibility). A Geo-Environmental Protection Centre survey conducted in 2012, showed that both contaminated land investigations and clean-up measures have increased significantly in recent years, the majority of which are conducted on a voluntary basis. These voluntarily actions comprise 81-percent of clean-up investigations (4,319 of 5,283 in total) and 81-percent of clean-up measures (1,597 of 1,983 in total), independent of any imposed legal requirements.

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[1] The two relevant laws are the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, and the Superfund Amendments and Reauthorization Act. Together, these laws determine who bears the cost and responsibility for soil and groundwater contamination cleaning with strict liability, no-fault liability, joint liability, and retroactive responsibility as features.

[2] The Soil Contamination Countermeasures Act requires a status assessment when a designated hazardous substance usage facility is abolished, or when there is a possibility of detriment to human health (paragraphs 3 and 5), which requires clean-up of contamination by the site owner to prevent such damage (paragraph 7).
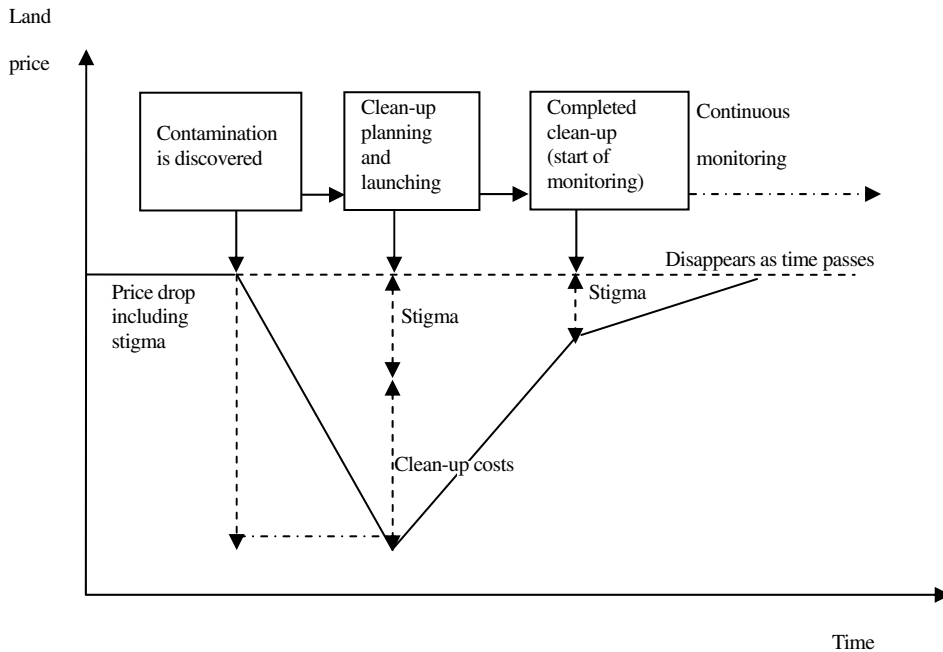
The voluntary environmental actions are significant differentiating features of Japanese firms and result in a distinct experience with respect to environmental liabilities and market valuation of firms, particularly when compared to the United States. For example, the Japan Business Federation representing 1,281 firms, 127 industrial associations, and 47 regional economic organisations has established voluntary action plans to satisfy their environmental commitments. These action plans are a form of self-declaration; however, each industry collects data on firm environmental performance and submits this information for verification to the Japanese Ministry of Economy, Trade, and Industry. This voluntary-based approach has been successful in improving the environmental performance of Japanese firms.

Japanese firms have also assumed a leading role in environmental reporting. Although Saka and Burritt (2003) noted potential problems with the non-comparability of the information initially disclosed in environmental reports, more than 1,000 Japanese firms currently voluntarily issue stand-alone environmental reports. Moreover, the standard of these reports has been steadily improving both quantitatively and qualitatively (JMOE, 2012 a). A KPMG (2011) survey shows that Japanese firms provide high-quality information. Additionally, the progress in environmental reporting has facilitated the introduction of environmental accounting for disclosure and as a tool for environmental management accounting (Kokubu and Nashioka, 2005; Saka *et al*., 2005; Burritt and Saka, 2006a).

The increase in voluntary environmental action entails actual expenditure and investment by firms, which should be recognised in their financial statements. Although there is no specific accounting standard for environmental costs and liabilities in Japan, many companies now voluntarily recognise environmental costs and liabilities as separate line items on their financial statements. Then, whether the market views recognised environmental liability information differently from disclosed environmental information?

2.2 Soil Contamination and Market Value

This section addresses the relationship between soil contamination and market value. Figure 1 depicts the change in the market price of contaminated land from the time that the contamination is discovered to the completion of clean-up and monitoring (Komiyama, 2008). Following the discovery of soil contamination, Figure 1 illustrates that the decrease in the land price is greater than the cost of clean-up; the difference is called 'stigma'. Stigma may arise from increased uncertainty concerning future clean-up and compliance costs, a decline in the firm's reputation, an increased incidence of cancer or environmental disease, or deterioration in work-place conditions from air and/or noise pollution (USEPA, 2000).

Figure 1. Conceivable Change in the Price of Contaminated Land

Land

price

Contamination
is discovered

Clean-up
planning
and
launching

Completed
clean-up
(start of
monitoring)

Continuous

monitoring

Disappears as time passes

Price drop
including
stigma

Stigma

Stigma

Clean-up costs

Time

The accounting for stigma can be interpreted in different ways. If we assume that the market price of the contaminated land in Figure 1 is equivalent to the firm's valuation of the contaminated land, we may interpret such stigma as the 'risk premium' that investors require from a firm with contamination risk. We can then assume that actual clean-up planning, implementation, and completion, shown on the right-hand side of Figure 1, can contribute to the elimination of stigma.

Clean-up activity to address soil contamination does not result in short-term revenue, but only short-term expense. This may discourage firms from clean-up activity. However, if investors evaluate firm soil contamination risk and clean-up activities, and markets penalise the firm for the risk but ultimately value the firm positively, the market may provide an incentive for firms to engage in clean-up and bring indirect firm benefits. Our analysis discerns the contribution of accounting recognition in this market incentive process. Therefore, we investigate the effect of a firm's potential soil contamination risk through PRTR disclosure data and then investigate the effect of accounting recognition on site clean-up costs and liabilities.

The accounting for environmental liabilities has been a topic of debate for many years. Several standard setting and professional accounting bodies have issued guidelines and recommendations concerning the recognition, measurement, and disclosure of environmental

remediation liabilities (CICA, 1993; AICPA SOP96-1; EC 2004). Remediation treatment can take many years to finalise, and management has considerable latitude in deciding when to recognise an environmental liability. Therefore, the measurement or estimation of the amount presents difficulties in the accounting for environmental liabilities (Schaltegger and Burritt, 2000). The accounting treatment of non-compulsory environmental liability is more complex than the legal obligation because the uncertainty of clean-up plans and the costs are greater. No existing research, to our knowledge, investigates the effect of the economic consequences of non-compulsory environmental liability recognition. This paper investigates the value relevance of soil contamination risk and contamination reduction efforts, and then investigates the effect of site clean-up liability recognition on the market value of the firm.

3. Previous Research and Hypothesis Development

3.1 Previous Research

3.1.1 Environmental Pollution, Its Reduction, and Market Value

Environmental pollutants may reduce a firm's future cash flow because of clean-up and pollution prevention expenditure. Previous studies have examined the impact of firm pollution and contamination on the market value of firms. The findings imply that the level of pollution (e.g. Cormier and Magnan, 1997), greenhouse gas emissions (e.g. Saka and Oshika, 2014), and toxic releases (e.g. Konar and Cohen, 2001) all have a significant negative impact on firm market value. Barth and McNichols (1994) employ a proprietary model to estimate site clean-up costs using publicly available Superfund data from the US Environmental Protection Agency and conclude that clean-up cost estimates have a significant negative impact on the market value of potentially responsible party firms. Similarly, Garber and Hammitt (1998) show that additional Superfund exposure appears to increase the cost of capital for chemical firms. Bae and Sami (2005) suggest that the earnings response coefficients for potentially responsible party firms are lower, that is, potential contaminated site liabilities create noise in firm earnings. The past financial accounting research considers environmental issues to be potential costs or liabilities (Gray and Laughlin, 2012).

While many firms bear environmental pollution risk, tangible efforts to reduce pollution can lead to superior financial performance. Certain research shows that waste prevention, or proactive environmental action, can lead to higher profitability and greater firm value (e.g. King and Lenox, 2002; Sangle, 2011) by reducing environmental risk.

3.1.2 Disclosure, Recognition, and Market Value

Mandatory disclosures do not necessarily include all of the information that investors demand; however, firms provide voluntary disclosure of their financial condition to increase

corporate transparency, and to reduce information asymmetry. The potential benefits from extensive voluntary disclosure for firms include the following three types of capital market effects: improved liquidity of stock in the capital market, a reduction in the firm's cost of capital, and an increased following by financial analysts (Healy and Palepu, 2001). Several prior studies find that environmental and social disclosure improve the liquidity of stock (Cho *et al*., 2013), reduce capital costs (Dhaliwal *et al*., 2011), and improve analyst forecast accuracy (Dhaliwal *et al*., 2012). Prior studies also provide evidence of voluntary disclosure theory (Guidry and Patten, 2012; Griffin and Sun, 2013), identify the motivation factors for voluntary environmental disclosure (Boesso and Kumar, 2007; Brammer and Pavelin, 2008; Cox, 2008; De Villers and Van Staden, 2011) and show that environmental GAAP disclosures are value relevant to investors (Cox and Douthett, 2009). These studies address disclosed information; however, Christensen and Demski (2003) state that accounting information contained in financial statements has a comparative advantage over information disclosed extraneously.

The accounting community debates whether markets consider disclosed and recognised financial amounts equivalently. Prior research provides evidence that investors accredit more weight to recognised information than disclosed information, and that the market considers recognised liabilities more reliable than disclosed liabilities (e.g. Davis-Friday *et al*., 2004; Ahmed *et al*., 2006). Aboody (1996) found that investors value recognised oil and gas write -down information more than disclosed write-down information. With respect to environmentally related items, although prior research investigates the value relevance of environmental costs, investments (Moneva and Cuellar, 2009), and emission allowances (Johnston *et al*., 2008; Griffin, 2013), the prior research utilises disclosed data or estimated value, not actual financial statement recognised items. Limited research addresses the value relevance of actual recognised environmental liabilities. An exception is Campbell *et al*. (2003). The authors find the uncertainty-reducing rule of accounting accrual information in the context of contingent Superfund liability valuation.

The majority of previous studies that use soil contamination data, including Campbell *et al*. (2003), focus on compulsory clean-up obligations under the United States Superfund Act. Contrastingly, the majority of site clean-up activity in Japan is on a voluntary basis. However, no research to date examines the relationship between soil contamination and firm value in Japan. One reason for this is that the availability of Japanese firm-level soil contamination data is limited, whereas the United States Environmental Protection Agency ensures that firm-level soil contamination-related data are available to the public. This paper uses PRTR data to estimate soil contamination risk because the PRTR is an internationally standardised system (Burritt and Saka, 2006b) and the data are actually used in practice to assess the soil contamination risk of firms. Using the data, we investigate the effect of the

soil contamination risk, pollution reduction, and accounting recognition of the clean-up costs and liabilities.

3.2 Hypothesis Development

Soil contamination obliges firms to investigate the contamination and clean-up of any affected property. This activity increases potential future cash outflows of direct expenses such as pollution assessment, clean-up cost, indirect expenses relating to pollution control and monitoring costs, and any opportunity costs arising from the suspension of operations during the clean-up. Moreover, firms with soil contamination risk may face opposition and negative campaigns from local communities, leading to a reduction in sales and affecting business relationships. Creditors may also view soil contamination as high risk to decrease in a value of pledged land. These considerations correspond to stigma depicted in Figure 1. We expect, based on previous research findings, that the greater the soil contamination risk, the greater the reduction in the firm's market value. Consequently, our first hypothesis is as follows.

H1. The market values a firm's soil contamination risk negatively.

Under the assumption that we obtain a significant negative relationship between total soil contamination and firm market value, we propose a second testable hypothesis to determine whether the market can value the firm's efforts to reduce soil contamination risk and incorporate this information into stock prices.

The prior research finds a positive relationship between pollution reduction and financial performance (King and Lenox, 2002; Sangle, 2011). Therefore, we hypothesise that investors expect firms that engage in pollution reduction efforts to exhibit a higher firm value because the risk reduction efforts will result in lower future clean-up costs. Therefore, we propose a second hypothesis.

H2. The market reacts positively to firm efforts to reduce soil contamination risk.

When a firm takes action to clean up soil contamination, the firm accrues clean-up expenses and recognises the costs and liabilities on its financial statements. Campbell *et al*. (2003) find that firm-provided accounting information partly alleviates the negative impact of Superfund soil contamination on market value by reducing uncertainty for investors. Their research is derived from accounting recognition resulting from compulsory clean-up obligations under the United States Superfund Act. A significant number of Japanese companies voluntarily take action to clean up beyond any legal obligation and recognise the

clean-up costs and liabilities on their financial statements.

Guidry and Patten (2010) demonstrate the relationship between the quality of sustainability reporting and the market reaction, Barth *et al*. (1997) and Cox (2008) identify the factors that influence environmental disclosure in annual reports, and Cox and Douthett (2009) conclude that environmental GAAP disclosures are value relevant to investors. However, no extant research investigates the effect of recognised environmental accounts arising from non-compulsory obligations. The recognised clean-up liabilities on a firm's financial statements may reduce uncertainty for investors with respect to the timing and amount of future clean-up costs that are associated with soil contamination. Additionally, investors are aware that if the firm recognises clean-up costs and liabilities on their financial statements, the firm is already undertaking clean-up action that will reduce future contamination-related risk. This contributes to stigma reduction following the planning and implementation of clean-up activity as Figure 1 shows. Therefore, we investigate the effects of the recognised accounts on firm market value, and whether the recognised clean-up costs and liabilities offset the downward valuation from soil contamination risk. Our third hypothesis is as follows.

> *H3*. The market values a firm's recognition of site clean-up costs and liabilities on the financial statements positively.

4. Research Design
4.1 The Estimation of a Firm's Soil Contamination Risk

The previous research results show both short-term announcement effect and value relevance of PRTR data (Hamilton, 1995; Konar and Cohen, 2001; Ferraro and Uchida, 2007; Connors *et al*., 2013). Therefore, we estimate each firm's soil contamination risk from the PRTR data[3]. According to the 'Act on Confirmation of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof' from fiscal year 2001, firms handling chemical substances that are registered by the Act are required to measure the volume released and transferred and report the data to the Japanese government. The data for 21 substances out of 26 specific hazardous substances included in the Soil Contamination Countermeasures Act are available

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[3] Two other potential data sources are available in Japan to estimate each firm's soil contamination risk. The first is the registry under the Soil Contamination Countermeasures Act. However, the actual number of instances requiring clean-up are limited, and the registry does not disclose the site owner. Therefore, the registry is not suitable for capturing the total risk of soil contamination at the firm level. The second is the soil contamination disclosure from firm environmental reports. However, it was difficult to obtain a large, reliable, and consistent data set from these reports.

from the PRTR data. Therefore, our analysis employs the 21 substances as representative data for the estimation of each firm's soil contamination risk[4].

We recorded the volume of the 21 chemical substances that were released into the environment, treated on-site, and transferred off-site at the facility level and summed them at the firm level. We followed the method of King and Lenox (2002) to measure the total soil contamination risk for each firm[5]. We calculated the sum of the release of all 21 chemical substances, weighting each by its toxicity using the reportable quantities risk factor. The factor is used to define the reporting requirement thresholds for hazardous substance release under the United States Superfund Act. We apply the King and Lenox (2002) method and aggregate the facility-level contamination to measure each firm's soil contamination risk (CNTM):

$$\text{CNTM}_{it} = \sum_{k=1}^{K_i} \sum_{j=1}^{21} \alpha_{itj} \times \text{chemical}_{itjk}, \tag{1}$$

where CNTM_{it} is the soil contamination risk for firm i in year t, chemicali_{tjk} is the amount of chemical substance j released and transferred by the firm's kth facility, and α_{itj} is the toxicity weight of chemical substance j[6].

4.2 The Empirical Models

This study employs a valuation approach based on the valuation models in Barth and McNichols (1994) and Campbell *et al*. (2003). By defining firm market value in terms of both financial and pollution factors, a valuation approach allows for the direct assessment of the usefulness of the information. Thus, we estimate the following relation:

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4 These 21 substances include tetra chloromethane, 1,2-dichloroethane, 1,1-dichloroethylene (vinylydene dichloride), cis-1,2-dichloroethylene, 1,3-dichloropropene (D-D), dichloromethane (methylene dichloride), tetra-chloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, benzene, cadmium and its compounds, chromium (VI) compounds, mercury and its compounds, selenium and its compounds, lead and lead compounds, boron and boron compounds, 2-chloro-4,6-bis (ethylamino)-1,3,5-triazine (shimazine; CAT), S-4-chlorobenzyl N,N-diethylthiocarbamate (thiobencarb), thioperoxydicarbonic diamide [(H2 N)C(S)] 2S2, tetramethyl (Thiram), polychlorinated biphenyls (PCBs). The five hazardous substances not included are cyanogen compounds, alkyl mercury, arsenic and arsenic compounds, fluorine and fluorine compounds, and organic phosphorus.

5 King and Lenox (2002) proxy firm-level total emissions by summing firm's each chemical release and weighting each substance by its toxicity using the reportable quantities.

6 If a site does not exceed one ton of annual release and transfer volume of PRTR chemical substances, it is not required to register. The information on such a site is, therefore, not included in our estimation of soil contamination risk.

$$\text{MVE}_{it} = \beta_0 + \beta_1 \text{BVE}_{it} + \beta_2 \text{NI}_{it} + \beta_3 \text{CNTM}_{it} + \beta_4 \text{RCG}_{it}$$
$$+ \beta_5 \text{RCG}_{it} \times \text{CNTM}_{it} + \upsilon_{it}, \tag{2}$$

where *i* and *t* denote the firm and the year, respectively. The variables defined in Equation (2) are as follows: MVE represents the market value of equity in year *t* (as at the end of June); BVE represents the book value of equity; NI represents net income; CNTM represents the total soil contamination risk calculated by total pollutant release and transfer (in grams) in period *t*, which is the proxy for the firm's future cash outflows to clean-up; and RCG represents an indicator variable equal to one if the firm recognises its environmental costs and liabilities on its financial statements and zero otherwise. We deflate MVE, BVE, and NI by sales.

We expect the estimated coefficient for CNTM to be negative. Additionally, we specify the recognition of environmental costs and liabilities on each firm's financial statements (RCG) as a proxy variable for the firm's accounting treatment associated with soil contamination. Recognition of environmental costs and liabilities clarifies the amount of firm obligation for clean-up. This potentially reduces investor uncertainty with respect to future cash outflows. Accounting recognition eases the downward pressure on valuation by investors that is associated with the soil contamination. We expect the estimated coefficient for RCG to be positive.

To further investigate the effect of contamination reduction on firm market value, we estimate an alternative valuation model that includes two components of CNTM; the expected soil contamination (ECNTM) and the contamination reduction (RDCT).

$$\text{MVE}_{it} = \beta_0 + \beta_1 \text{BVE}_{it} + \beta_2 \text{NI}_{it} + \beta_3 \text{ECNTM}_{it} + \beta_4 \text{RDCT}_{it}$$
$$+ \beta_5 \text{RCG}_{it} + \beta_6 \text{RCG}_{it} \times \text{ECNTM}_{it} + \upsilon_{it} \tag{3}$$

To create ECNTM, we estimate the quadratic relation between firm sales and total soil contamination risk for each industry in each year using standard OLS regression:

$$\text{CNTM}_{it} = e^{\beta_{0mt}} \text{SALE}_{it}^{\beta_{1mt}} \text{SALE}_{it}^{ln(\text{SALE}_{it})\beta_{2mt}} e^{\epsilon_{imt}}, \tag{4}$$

where SALE_{it} represents firm sales, β_{0mt}, β_{1mt}, and β_{2mt} are the estimated coefficients for sector *m* in year *t*, and ε_{imt} is the residual. We use the estimated function to predict the soil contamination risk each firm should generate given its size, industry, and year, using the

residual to measure the relative performance of each firm in preventing soil contamination risk:

$$\text{CNTM}_{it}/\text{ECNTM}_{it} = e^{\epsilon_{imt}}, \tag{5}$$

where

$$\text{ECNTM}_{it} = e^{\beta_{0mt}}\text{SALE}_{it}^{\beta_{1mt}}\text{SALE}_{it}^{ln(\text{SALE}_{it})\beta_{2mt}} \tag{6}$$

is predicted soil contamination risk for firm i in year t. By standardising the residuals ε_{imt} to reflect our confidence in the different estimations, we construct the variable RDCT_{it} to measure the firm's efforts at contamination reduction.

$$\text{RDCT}_{it} \equiv -e^{\epsilon_{it}/\sigma_{\epsilon_{mt}}} \tag{7}$$

Based on the firm's financial performance (sales), investors predict the potential level of soil contamination and demand a corresponding price discount. However, the firm's contamination reduction efforts also signal lower potential environmental liabilities. Therefore, we expect the respective estimated coefficient for ECNTM (RDCT) to be negative (positive).

5. Sample Selection and Empirical Results

5.1 Data Description and Sampling

Our sample is composed of PRTR registered firms listed on the Tokyo, Nagoya, and Osaka stock exchanges and those firms that report the release and transfer of specific hazardous substances included in the Soil Contamination Countermeasures Act during the period 2004 to 2007. We excluded firms that were PRTR registered, but for which the release of specific hazardous substances was zero. The PRTR data are publicly disclosed with a two-year delay; therefore, firms with PRTR data from 2006 to 2009 constitute the sample of firms with soil contamination risk. We also limit our sample to firms that operate in seven industries with sizable environmental burdens (chemical, electrical and electronic equipment, transportation equipment, steel, nonferrous metals, precision machinery, and the fibre industry) based on the results of previous studies (e.g. Barth *et al*., 1997; Garber and Hammitt, 1998). A greater number of firms in these industries recognise clean-up costs and

liabilities on their financial statements.

We obtain the financial and stock price data from the Nikkei NEEDS Financial QUEST. We eliminated the firms that were missing required variables for the analysis. The resulting sample was composed of 768 firm/year observations from the period 2006 to 2009. Table 1 provides descriptive statistics for these variables, whereas Table 2 includes the correlation matrix.

Table 1. Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Max	Min
1 MVE	Market value of Equity	0.633	0.604	7.261	0.050
2 BVE	Book value of Equity	0.553	0.354	2.301	0.023
3 NI	Net income	0.022	0.049	0.271	-0.245
4 CNTM	Log of total soil contamination risk of firm	-0.317	4.816	8.995	-13.015
5 ECNTM	Log of expected soil contamination risk of firm	-0.411	2.998	7.523	-11.427
6 RDCT	Log of firm's reduction of soil contamination risk	11.823	1.931	17.061	7.837
7 RCG	Recognition of environmental liabilities on financial statements	0.040	0.197	1.000	0.000

$N = 768$

Table 2. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10
1 MVE	1.000									
2 BVE	.633*	1.000								
3 NI	.554*	.255*	1.000							
4 CNTM	-.014	.124*	.042	1.000						
5 ECNTM	-.046	.171*	.023	.620*	1.000					
6 RDCT	.052	-.231	-.045	-.711*	-.517*	1.000				
7 RCG	-.068	-.088	-.044	.006	-.111*	-.157*	1.000			
8 RCG×CNTM	-.011	-.027	-.044	.182*	.198*	-.151*	-.037*	1.000		
9 RCG×ECNTM	-.009	.012	-.046	.119*	.281*	-.155*	-.459*	.685*	1.000	
10 RCG×RDCT	-.067	-.086	.004	-.013	-.128*	.180*	.991*	-.143*	-.516*	1.000

$N = 768$; * $p < .01$

5.2 The Results of the Analysis

We first estimate three models with respect to CNTM over the entire panel after controlling for year fixed effects, as shown in Table 3. Because observations were collected

over a four-year period, it is important to control for any potential time effects. We hypothesise that firm contamination risk and its reduction directly affect firm market value. However, it is possible that year-specific contamination reduction factors, for example, technical innovation aimed at reducing hazardous pollutants, jointly affect firm value. We employed a fixed-effects regression to account for unobserved differences between the sample years because it is difficult to observe and include any possibly confounding year-specific attributes in the analysis. The fixed-effects specification allows each year to have a separate intercept, and thus controls for stable year attributes.

Model 1 contains an intercept indicator variable. We find that the greater the level of pollutants produced by a firm, the lower the stock market valuation. The pollution coefficient for CNTM is significant ($p < 0.1$, one-tailed test) and negative. The t-tests employ White's cross-section standard errors. This finding is consistent with the empirical literature on potential environmental liabilities (e.g. Barth and McNichols, 1994), and supports Hypothesis 1. The estimated coefficient for the recognition intercept variable (RCG) is significant and positive, corresponding to our predictions ($p < 0.05$). This infers that the valuation implications of pollution for firms with environmental costs and liabilities recognition differ from those of non-recognition firms. Interestingly, the sum of the estimated coefficients for RCG and CNTM is positive ($0.085 = 0.089 - 0.004$), and the Wald test indicates that it is significant ($p = 0.003$, $F(1, 760) = 8.89$). This result indicates that recognising environmental costs and liabilities on the firm's financial statements has a positive effect that exceeds the negative effect of potential pollution risk on stock prices. This counter effect of recognition is consistent with Hypothesis 3. This suggests that the recognition of clean-up costs and liabilities on financial statements reduces uncertainty in the firm's future cash outflows, and even has a positive impact on market value by signalling to investors that the firm has taken action with respect to site clean-up to reduce future risk.

Model 2 shows that the estimated pollution coefficient for CNTM in the fixed-effects model is statistically significant ($p < 0.1$) and negative. The coefficient for the interaction term (RCG × CNTM) is statistically significant ($p < 0.001$) and positive. This offsets the magnitude and sign of the estimated coefficient for the pollution variable CNTM. The sum of these coefficients displays a small positive value ($0.003 = 0.007 - 0.004$), and the Wald test indicates that it is not significant at the 10-percent level ($F = 1.34$). This appears to suggest that on-balance-sheet recognition substantially offsets the impact of environmental risk.

Table 3 also provides the result that estimates Model 3. The model contains both the intercept indicator variable and the slope indicator variable on RCG. The result shows that CNTM is negatively related to the firm's stock price at the 5-percent level and that the

coefficient for RCG × CNTM is positively significant ($p < 0.001$), as is the case with the results of Model 2. The Wald test indicates that the sum of these coefficients is not significant at the 10-percent level ($0.009 = 0.013 − 0.004$, $F = 1.466$). The coefficient for the RCG intercept indicator, however, is not significant as opposed to the result of Model 1.

Table 3. Regression of Soil Contamination Risk and Recognised Clean-up Liabilities on Firm Value

Variable	Predicted sign	Model 1	Model 2	Model 3
C		0.062	0.064	0.065
		(0.074)	(0.074)	(0.073) †
BVE	+	0.894	0.895	0.895
		(0.050) ***	(0.050) ***	(0.050) ***
NI	+	5.324	5.326	5.326
		(1.652) ***	(1.650) ***	(1.651) ***
CNTM	−	-0.004	-0.004	-0.004
		(0.002) †	(0.003) †	(0.004) *
RCG	+	0.089		-0.091
		(0.030) **		(0.095)
RCG×CNTM	+		0.007	0.013
			(0.002) ***	(0.005) ***
N		768	768	768
R^2(adjusted)		.584	.584	.584
F statistic		155.0 ***	155.1 ***	135.5 ***

White cross-section standard errors are in parentheses;
† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$ (one-tailed except intercept)

We explore the effects of the pollution components (expected soil contamination and contamination reduction) on market valuation based on Equation 3 (Models 4, 5 and 6). Table 4 presents the results from the fixed-effects regression. The results in Model 4 show a negative relationship with the expected soil contamination variable ECNTM ($p < 0.01$). Similarly, we find evidence in both Models 5 and 6 that ECNTM is negatively related to a firm's stock price ($p < 0.01$, respectively). Contrastingly, the coefficients for the contamination reduction variable RDCT are not significant in all three of the Models. This does not support Hypothesis 2, which states that the market does not value the firm's pollution reduction estimated by PRTR disclosure data. It represents an inconsistent finding with King and Lenox (2002) who find that expected contamination reduction positively

relates to financial performance.

Moreover, the results of Models 5 and 6 are consistent with the results in Table 3. The coefficient for the interaction term of the recognition indicator and the predicted soil contamination is positively significant in both Models. In Model 6, the Wald test indicates that the sum of the coefficients for RCG and RCG × ECTMN is not significant at the 10-percent level ($0.004 = 0.014 - 0.010$, $F = 0.381$), which suggests that on-balance-sheet liabilities that are a result of soil contamination compensate for the negative impact of soil contamination on the firm's stock price.

Table 4. Regression of Expected Soil Contamination Risk,
Contamination Reduction and Recognised Clean-up Liabilities on Firm Value

Variable	Predicted sign	Model 4	Model 5	Model 6
C		0.123	0.128	0.132
		(0.065) †	(0.067) †	(0.067) **
BVE	+	0.894	0.895	0.895
		(0.051) ***	(0.051) ***	(0.051) ***
NI	+	5.324	5.328	5.329
		(1.652) ***	(1.649) ***	(1.650) ***
ECNTM	−	-0.009	-0.010	-0.010
		(0.004) **	(0.004) ***	(0.004) **
RDCT	+	0.002	0.002	0.002
		(0.012)	(0.012)	(0.013)
RCG	+	0.084		-0.077
		(0.029) **		(0.079)
RCG×ECNTM	+		0.008	0.014
			(0.003) **	(0.008) *
N		768	768	768
R^2(adjusted)		.584	.584	.584
F statistic		135.7 ***	135.8 ***	120.6 ***

White cross−section standard errors are in parentheses;
† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$ (one-tailed except for intercept)

6. Summary and Conclusion

The accounting treatment of environmental liabilities is a widely debated issue (e.g. CICA, 1993; EC, 2004). Additionally, many debates centre on the effect and the differences

between accounting recognition and disclosure. Certain research provides evidence that the market considers recognised liabilities to be more reliable than disclosed liabilities; however, no prior research examines the same issue in the light of environmental liabilities. The purpose of our study is to investigate how market value recognised environmental liabilities on financial statements versus disclosed environmental information on soil contamination. Soil contamination is a primary environmental issue confronting Japanese firms and involves massive clean-up costs. Although most Japanese firms are not required to undertake compulsory clean-up, unlike firms in the United States a substantial number of Japanese firms implement site clean-up activities voluntarily.

This paper first estimates a firm's soil contamination risk using disclosed toxic release data. We then empirically examine the relationship between soil contamination risk and firm market value, and investigate the impact of the firm's reductions in contamination using the disclosed data. Finally, we examine the effect of recognition of site clean-up costs and liabilities on financial statements with respect to investor valuation.

The analysis of Japanese listed firms from seven environmentally risk-intensive industries yielded three main findings. First, firm-level soil contamination risk has a negative impact on the market value of the firm. Second, firm-level pollution reductions estimated by disclosed data do not impact the market value of the firm. Finally, the recognition of site clean-up costs and liabilities at the firm level has a positive impact on the market value of a firm.

To our knowledge, this is the first study to investigate how market value recognised environmental liabilities on financial statements versus disclosed environmental information. Our results contribute to the knowledge concerning the accounting consequences of environmental issues beyond the existing research, which shows that a firm's soil contamination risk negatively affects firm market value, and accounting recognition positively affects firm market value.

We assert that the recognition of site clean-up costs and liabilities has two effects. The first is to offset any downward valuation from soil contamination risk by reducing information asymmetry and uncertainty of the firm's future cash outflow. Accounting recognition reduces the stigma associated with soil contamination. The second effect of recognition of site clean-up and liabilities is that it signals that the firm has already undertaken clean-up and is reducing future risk causing a positive impact on firm market value. These results also provide firms with an incentive to rehabilitate any of their sites with soil contamination. Our analysis has implications concerning the market assessment of the accounting consequences of firms facing soil contamination risk. Improved transparency through accounting recognition of environmental liabilities could be an effective way to encourage firms to engage in clean-up, aside from mandatory regulation. These implications

could be equally applicable to other manufacturing countries with similar legal and market environments.

With respect to future research, we provide evidence that markets use recognised financial statement information differently from disclosure information. However, previously documented differences in capital market use of recognised and disclosed items have included a combination of (1) information effects, for example, differential processing costs or differences in reliability, or (2) systematic cognitive biases among investors (Bratten *et al*., 2013). To investigate whether our results are linked to one or both of these findings requires additional investigation. Additionally, in terms of research method and sample, the hazardous weighting factor used to estimate firms' soil contamination risk could be improved, because the concept of reportable quantities is based on the current state of knowledge and neglects the risk of nanomaterials. Finally, the extension of the analysis to a wider sample of industries is necessary given that we focus on only seven industries in this analysis.

The recognised environmental liabilities represent just a fraction of the potential clean-up costs of ¥16.9 trillion. Because remediation treatment can take many years to finalise, the measurement or estimation of the financial amount is the central problem with respect to the accounting treatment of environmental liabilities (Schaltegger and Burritt, 2000). Our findings suggest that accounting regulations could offer instruction to firms that highlights that recognising potential environmental liabilities increases the transparency of environmental liabilities and can reduce a firm's stigma from soil contamination increasing the positive valuation from the market. We consider our research to be an initial step in the investigation of environmental liabilities and the significant consequences of environmental liability accounting practices.

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