The Role of Environmental Information Disclosure Systems and their Impact on Firm Performance

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Abstract

In response to the call for more research on impactful green IS, this paper examines one country-level environmental information disclosure system (EIDs), the U.S. Toxic Release Inventory (TRI), as a strategic tool or infrastructure of green IS and empirically tests the impact of environmental performance on financial performance in the chemical industry using both real financial and forward-looking measures. In particular, the study explores EDIs-inspired environmental managerial efforts and their influence on firms’ financial performance. The study’s finding that firms with better environmental performance also show greater cost competitiveness challenges the view that environmental managerial activities constitute an additional burden irrespective of firms’ business operations. Instead, it suggests, these can be innovative activities that improve a firm’s production efficiency, material resource management, and financial performance and sustainability.

1. Introduction

Information Systems (IS) have dramatically changed our daily lives as well as the structures and boundaries of business. What, however, has been the impact of IS on urgent environmental threats, including climate change? Have IS developed and contributed only to making our lives more prosperous and convenient, regardless of their influence on the environment? Or are IS already playing a critical and strategic role in mitigating environmental risks without our awareness? Despite its importance, few studies have directly addressed the impact of green IS and their power to transform our understanding and practices. Green IS refers to the design, implementation, and impact of information systems that contribute to sustainable business processes (Watson et al. 2008). According to Malhotra et al. (2014), “There is a pressing need for impactful research. By this, we mean studies that go beyond conceptualizing, analyzing, and even designing, to those with demonstrable impact on mitigating the threat of climate change.” Moreover, these environmental threats are more real and near than most of the public realizes. During just the first half of 2013, 36 spills, leaks, or explosions of dangerous chemical materials were reported in Korea alone. Given that these types of risks can have disastrous consequences, firms should regard prevention measures and relevant monitoring efforts and investments as one of their highest priorities. These risks get even bigger as petrochemical industry complexes or production lines become obsolete, which is a global issue regardless of whether it occurs in the south or the north.

This paper examines one country-level environmental information disclosure system (EIDs), the U.S. Toxic Release Inventory (TRI), as a strategic tool or infrastructure of green IS and empirically tests the impact of environmental performance on financial performance using both real financial and forward-looking measures. In this study, environmental information disclosure system refers to a public database designed for policy and program purposes and to support users’ decision making by providing environmental information. The study addresses two main questions: (i) how and why has the TRI system evolved in terms of information required and data analyzing tools and displays? (ii) What substantial managerial activities have firms adopted for improving their environmental performance, and how have these activities influenced not only toxic release reductions, but also business processes and performance? In particular, this study analyzes the substantial environmental management activities that firms report taking to reduce toxic releases. To date, little investigation has been done into the role of the EIDs in inducing firms’ environmental management and whether firms’ transformative efforts have provided measurable financial rewards or simply served as burdensome costs. Unless researchers open the black box in which firms’ responsive activities are recorded, they are unlikely to successfully reveal the linkages between EIDs and environmental and financial performance. Prior research exploring the effect of environmental investments or corporate social re-
sponsibility (CSR) in a broader context has shown mixed results and raised longstanding debates (Margolis and Walsh 2003, Orlitxky et al. 2003, Barnet and Salomon 2012, Ryu 2013).

This study is intended to make several contributions that differentiate it from prior works. First, to the best of our knowledge, it is one of the first studies of green IS that attempts to demonstrate the role of environmental information disclosure by examining a representative TRI case and utilizing confluxes of knowledge in other fields. Second, the study sheds light on a substantial area of management efforts by firms that have been ignored in previous studies examining the relationship between firms’ environmental performance or CSR investments and their financial performance. By identifying environmental management activities as sources of environmental results and theorizing how these activities influence firms’ ordinary production processes, the study reveals important explanations for the linkages between EIDs and firms’ performance. Lastly, analysis of the evolution of TRI and responsive actions of firms has rich political implications for countries developing similar systems, and the financial rewards demonstrated by our analysis also offer an incentive for managers to engage in or increase their environmental management activities.

2. Theoretical Background

In this section, we briefly describe three streams of research relevant to the paper: (i) literature on the effects of environmental information disclosure in line with CSR perspectives; (ii) literature on the optimal content and form of corporate environmental reporting to enhance the effectiveness of relevant programs; and (iii) literature on the relationship between environmental disclosure and targeted environmental performance and between the environmental or CSR investments of firms and their financial performance.

Most of the studies on environmental information disclosure have been conducted in accounting fields within the context of information disclosure effects on firms based on corporate social responsibility (CSR) perspectives. The main approach of this research has been to analyze listed firms’ voluntary disclosure of CSR information in their annual reports. Analyzing publicly listed German companies, Kilian et al. (2014) find that those belonging to “controversial industries” such as chemical manufacturing are more likely to conduct CSR communication activities and describe those firms’ voluntary information disclosure behaviors as “green washing” or “smoke cur- tains”. Legitimacy theory and stakeholder theory provide a partial explanation of why disclosure programs result in improvement of target outputs (i.e., efficient use of energy, reduction of wastes). According to Gray et al. (1996), legitimacy theory is a systems-oriented view of the organization and society within which the entity is assumed to be influenced by, and in turn to have influence upon, the society in which it operates. From this perspective, organizations have no inherent right to resources and exist to the extent that their particular society considers them legitimate. In this context, corporate disclosure policies are one important means by which management can influence external perceptions about their organization (Deegan 2002). Similarly, stakeholder theory explains that information can be employed by an organization to gain the support and approval of its stakeholders or to deflect their opposition and disapproval (Neuet et al. 1998). Information is necessary to change perceptions, and remedial actions that go unreported will not be effective in doing so (Cormier and Gordon 2001). This perspective therefore highlights the strategic importance and power of corporate disclosures.

A second body of relevant research examines how the presentation of environmental information can influence perceptions and how the content and form of data reporting can improve the effectiveness of the relevant systems or programs. To the best of our knowledge, few studies on this topic have been conducted within the main IS field, although a limited number of studies can be found in energy or energy policy journals. Weil et al. (2006) identify several information properties necessary for effective dissemination: it should be simple, understandable, standardized, actionable, and designed to be directly beneficial to at least some of the identified problems. Delmas et al. (2010) analyze the effects of a state-level disclosure program and find that the mandatory program, which requires disclosure of fuel mix portfolios, significantly affects changes in the portfolio mix of 145 utilities with more residential customers.

Lastly, a few studies have examined the effects of environmental disclosure on firms and explored questions similar to our own. Massey (2011) surveyed the managers of approximately 200 firms about the benefits of and concerns about the Massachusetts Toxics Use Reduction Act (TURA) program. Their identification of six toxic use reduction techniques, including improved operations and maintenance and input substitution, may be the first examination of how these techniques and activities affect internal company dynamics. Konar and Cohen (1997), empirically testing the effects of TRI infor-
mation disclosure on the stock price of 130 firms, find that firms exposed to media attention as “pollution companies” based on disclosure of TRI data show negative effects on their stock prices. Scholars have also sought for decades to find whether corporate social performance and financial performance are positively or negatively associated (Barnett et al. 2012). As to the question of whether it really pays to be good, numerous empirical studies have led to mixed results and longstanding debates. Friedman (1970), for instance, views CSR as a management agency problem (i.e., from the perspective of costs only), while according to Jones (1995), Freeman (1984) views it as a long-term investment strategy leading to improved stakeholder relationships that reduce firms’ transaction costs and increase market opportunities. Using contingency theory, Barnet and Salomon (2012) argue that both positions might be correct to some degree and that whether it pays to be good depends upon how well firms are able to capitalize on their social responsibility efforts.

3. The Toxic Release Inventory and Environmental Management Activities

3.1 Toxic Release Inventory (TRI)

The Toxic Release Inventory (TRI) is a publicly accessible database of the United States Environmental Protection Agency (EPA) containing information on the disposal and other releases of over 650 toxic chemicals by more than 20,000 U.S. industrial facilities (EPA, 2012). TRI was established in 1986 by Section 313 of the Emergency Planning and Community Right-to-Know Act created in response to increased concern in the U.S. about chemical accident preparedness. Facilities in a TRI-covered industry sector that produce or use more than a certain amount of a TRI-identified toxic chemical and have at least ten full-time employees must report to TRI every year.

3.2. The evolution of the TRI system

TRI is a comprehensive database based on an exchange network, which includes information not only on toxic releases but on related topics such as CO₂ emissions. TRI is also an example of a policy program that effectively operates as country-level EIDs. Since its launch in 1986, the TRI system has evolved continuously in terms of providing value-added information and analytic tools for enhancing data usefulness. The most important decision in designing the EIDs was what data should be required, given that “behavior responds congruently to what the information measures” (Bae et al. 2010). In its early stages, the TRI disclosed only toxic release data (in pounds). Disclosing the amount of toxic releases made by individual companies obviously was of great importance in holding those companies responsible for their actions. It also means that the EPA is equipped with an infrastructure of credible data collection and a monitoring process for the qualifying information. Toxic release disclosure by states also turned out to be effective in influencing federal decision making on budget spending on relevant activities (Patten 1998). Some, however, have complained that the raw TRI data do not reflect the toxicity of individual chemical materials and therefore limit the useful information related to public health. Accordingly, the EPA has developed a toxicity-weighted measure called the Risk-Screening Environmental Indicator to appropriately inform the public. Bae et al.’s 2010 study comparing states that disseminate raw TRI data and states that analyze and disseminate the data in terms of health risks find that the latter did lead to significant reductions in health risks, whereas the former lowered the total number of pounds of chemicals released but had little effect on health risks. The EPA also started to require companies to report qualitative information on their various managerial Pollution Prevention Activities taken to reduce toxic releases, for the purpose of encouraging firms’ relevant efforts and knowledge sharing through specific examples and solutions.

At the same time, the originally intended quasi-regulation effect of disclosure cannot be fulfilled unless the gathered information is accessible by vast numbers of stakeholders and utilized actively to reduce toxic releases. For that purpose, the TRI has developed a number of analytic application tools for users, most of which are communities. For instance, TRI-NET is a convenient query tool that can be downloaded to personal computers. My RTK is a mobile application tool that enables users to learn exactly what facilities are located in their neighborhood and what toxic chemicals they produce. These are intended to increase the disclosure’s effectiveness by providing processing tools that are conveniently accessible and easy to use. There are also tools for firms, such as TRI-Meweb, a web-based application that enables facilities to file a paperless TRI report, significantly reducing data errors and allowing instant receipt confirmation of submissions (EPA, TRI Data and Tools).

Among the data provided by TRI, the qualitative information about Pollution Prevention Activities (PPAs) is particularly relevant to the questions ad-
dressed in this study, as it sheds light on specific behaviors taken by firms to improve their environmental performance (e.g., reducing toxic releases). This information on firms’ behaviors that has been directly or indirectly induced by the mandatory disclosure program can be thought of as a black box, a source of valuable information that can be used to help remedy the lack of understanding about the dynamics of managerial activities which has been responsible in part for the limitations of previous studies.

3.3 Source of reduction: environmental managerial activities

The term source reduction refers to any practice that reduces the total quantity of chemical waste generated at the source (EPA 2012). In 2012, a total of 3,152 facilities (15% of all TRI facilities) reported initiating 10,250 source reduction activities. EPA has categorized eight types of such activities, the most reported of which were good operating practices, process modifications, and spill and leak prevention. The following examples of each type of these activities demonstrate the range of these behaviors.

Good operating practices, which in 2012 amounted to more than 30% of source reduction activities, refers to activities such as increasing the frequency of planned maintenance, continuously adjusting the batch schedule to minimize product changes, and reducing overall operator-controlled scrap through hands-on technical training. For example, LINDE LLC reported that increasing the frequency of their planned maintenance with a focus on packing and gasket materials resulted in a decrease in both emissions and use of raw materials. The second most common type of activities is process modifications, such as modifying the production process to reduce the use of toxic materials such as solvents. Other examples include using solvents for an additional cycle before disposal, installing a printing press that more efficiently recovers solvents, optimizing reaction conditions and replacing toxic materials with non-toxic ones. Spill and leak prevention is another of the main management activities companies employ.

BASF Corporation, a global chemical group, implemented a new policy to reduce spills due to hose failure: based on employee recommendations, they required all hoses used to transfer chemicals to be identified electronically and tested annually. Among the other important types of activities are raw material modifications, such as those reported by the RENCO Group that included largely eliminating the use of a high xylene-content material through the use of flame and plasma surface treatments and better formulations of water-based painting technology. An example of another type of activity, inventory control, is Honeywell’s reported 22% reduction in their use of lead by adopting a just-in-time inventory system to minimize raw material storage and potential waste streams from expired or out-of-specification products. A final type of PPAs, product modifications, is directly related to the customer side, unlike those above that mostly occurred in the raw material sourcing and manufacturing processes. Superior Brass & Aluminum Casting has been working with customers to replace their current alloy, which has a maximum of 6% lead, with a new alloy that has a maximum of 0.09% lead in response to customers’ looking for low-lead or lead-free alternative alloys. Product modifications also include the restructuring of existing businesses or products. For instance, a disinfectant products manufacturer has phased out a cleaning product that uses 2-phenylphenol as a reactant and developed new products that do not use this material.

Our review of source reduction components above, proportions, and description details reveals several important implications. First, managerial activities for improving environmental performance may also result in changes in a firm’s ordinary production processes and business activities. Second, the changes reported within organizations are related mainly to the production side rather than the demand side. Third, the effect of these activities on firms’ operational efficiency and costs are mixed. For instance, recycling a toxic material can reduce the amount of raw materials used and improve the marginal cost of goods, although changes in facilities or equipment may require capital expenditures and learning costs. We will discuss these countervailing effects in more detail in the next section.

4. Hypotheses

Manufacturing industries are characterized by the high proportion of the cost of goods sold (COGS) in their total costs. COGS includes the cost of materials, labor, and utilities. Among these, the proportion of material costs is obviously higher in some industries than in others, as in the chemical industry, where purchased materials are processed and converted into chemical products through automated production.

\[ \text{Depreciation costs may also be included in COGS, depending on a specific country’s accounting principles. The COMPUSTAT, the source of financial information in this study, excludes depreciation costs, and thus COGS in this study is understood as cash basis production-related costs except amortization costs.} \]
lines. Material costs also are often vulnerable to changes in external conditions determining prices (e.g., LNG price for electric utilities). Hence, minimizing the waste of materials and increasing resource efficiency through volume are critical in helping companies control their cost competitiveness.

As noted above, good operating practices constitute the largest class of PPAs intended to reduce chemical wastes and toxins. From the perspective of cost competitiveness, it is likely that companies can increase their resource management efficiency by decreasing their use of raw materials and waste without incurring much if any additional cost. In comparison, the effects of process modifications appear more ambiguous, as they are associated with modifying manufacturing lines or processes. If a company has already optimized its manufacturing processes and lines, changing the existing system or equipment may require additional capital expenditures or opportunity costs, including employee training. Managerial activities categorized as raw material modifications may also require supplementary costs if managers decide to replace hazardous materials with more expensive environmentally friendly ones. But this is not always the case, as some companies report reducing their use of highly toxic chemical materials by inventing new treatment technologies or finding better formulations. Lastly, product modifications associated with demand-side activities are strategically critical since they influence a company’s present and future business and may result in future-oriented restructuring in the long run. But such changes are generally incremental and may not be linked to such measures of financial performance as sales growth. On the contrary, a decrease in sales could happen in the process of changing a business’s portfolio, although it is also possible that consumers or the stock market may reward these changes if they perceive them as desirable.

In summary, the main activities reported as PPAs are associated with production processes such as purchasing and preparing raw materials, modifying production process or lines, and changing procedures and developing new technologies. PPAs appear to affect firms’ cost competitiveness positively by decreasing their marginal material costs and increasing their resource management capabilities. On the other hand, PPAs can also increase costs by replacing previously used materials with higher-cost ones or by changing facilities, which could increase overall COGS and lower the firms’ profitability. In short, it is not clear in which direction PPAs will affect firms’ cost competitiveness, especially given the possibility that these factors may offset one another. Thus, the question is worthy of empirical testing.

The link between strong environmental management and improved perceived future financial performance has been theorized by Klassen and McLaughlin (1996), who argue that environmental performance produced by environmental management initiatives affects the financial performance and market valuation of a firm. Their theory is also in line with the assumptions of other studies (Konar and Cohen, Porter, Hart, S, Dowell et al).

For these reasons and the sake of empirical testing, we posit the following hypotheses:

H1: Better environmental performance fostered by firms’ environmental managerial activities will positively affect their production efficiency and material resource management, leading to greater cost competitiveness.

H2: Better environmental performance fostered by firms’ environmental managerial activities will generate intangible net benefits and be positively associated with their market value.

5. Research Method

5.1. Data collection and Sampling

To test these hypotheses, we utilized a data panel that included 600 observations. The analysis was conducted at firm level, and the sample consisted of 100 randomly selected chemical firms for which both TRI data and financial performance data were available from 2007 to 2012. We did not include the missing values rather than substitute them with other values, and thus the final number of observations was 470. The data we employed came from two sources: TRI for the selected facilities’ environmental performance and COMPUSTAT for the financial performance of their parent companies. From the TRI data set, we collected samples from chemical industries to control for industry heterogeneity as much as possible. Since corporate financial performance and market value are largely determined by which industries they belong to, limiting our sample to a single industry seemed appropriate for the purpose of identifying whether environmental managerial activities or environmental performance affect firm financial performance. Further, the chemical industry is highly representative of the TRI data pool because it is the second-largest industrial sector that emits toxic releases (around 15% of total emissions in 2012), following only metal mining (40%); together with electronic utilities (14%), these three sectors account for
two thirds of toxic releases. Within the selected industry, the first stage of data collection and screening was to randomly select the companies for the sample and aggregate their facilities-level data regarding annual toxic releases at the firm level. The second and more time-consuming stage was matching the randomly selected companies with the COMPUSTAT data, taking care to avoid errors in matching entities (as in cases where a holding company is not the same entity as its affiliates even if they have very similar names).

5.2. Dependent variables

Our measure of firm performance and valuation was based on manufacturing cost (cost of goods sold) and Tobin’s q in order to capture effects in both the short-term or real financial performance and the long-term or forward-looking benefits. Since we conjectured that a firm’s environmental performance presumably promoted by PPAs or similar management practices directly related to changes in production systems and cost efficiencies often derived from the use of recycled raw materials, the cost of goods sold (COGS) ratio was employed as a measure of cost competitiveness. Even changes of one or two percentage points in the COGS ratio enormously affect a firm’s profitability, making cost competitiveness a primary concern for both management and investors. If we had access to detailed manufacturing costs such as material, labor, and utility costs, we would be able to analyze the dynamics of different effects (directions and magnitudes) of environmental management on each component of COGS. Given the absence of such data, we will instead examine the net effects of environmental performance as a manifestation of environmental management in terms of overall COGS. This is a more direct measure of relevant factors than conventional ones such as net income. Further, the COGS measure is relatively free from accrual influences such as depreciation policy and appraisal accounts, unlike previously used accounting measures.

Tobin’s q ratio is widely used to as a measure of firm’s intangible value based on the Efficient Market Hypotheses assumption. Following prior studies (Bharadwaj et al. 1999, Konar 2001), we use Chung and Pruitt’s method (1994) to calculate the approximates from the COMPUSTAT data source. According to Bharadwaj et al. (1999), “The advantage of this method is that it uses a simple formula that requires financial and accounting information available…and is highly correlated with q calculated by using the more traditional Lindenberg and Ross method.” As a forward-looking measure, this dependent variable is expected to represent the stock market’s perception of a firm’s environmental efforts and performance or capture the intangible benefits related to them. Since Tobin’s q is defined as market value relative to replacement value, for a firm with no intangible asset value (or market premium), the market value of the firm should equal the replacement value of its tangible assets, and Tobin’s q should equal 1 (Konar and Cohen 2001).

5.3. Independent variables

Following previous researchers (Konar et al. 2001, Klassen et al. 1996), we employed the yearly toxic release level of each firm divided by corresponding sales as a proxy for environmental performance. Given that the key latent construct of interest is a firm’s environmental managerial activities as drivers of environmental performance, it might be ideal to use information on pollution prevention activities (PPAs) as a measurement to examine the relationship between the two. Although PPAs are useful in providing an understanding of a firm’s managerial actions and their influence on operation processes, they are not appropriate for empirical purposes. Only around 15 to 20% of facilities report PPAs, according to the EPA. Furthermore, PPAs are inherently qualitative information in the form of written descriptions of relevant corporate actions. Although the EPA has categorized and counted the number of PPA activities, the counts do not guarantee the intensity or degree of each firm’s environmental management (e.g., a firm reporting ten PPAs does not guarantee that it made more effort to reduce toxic releases than another firm reporting two PPAs). Unlike PPAs reporting, which is not mandatory, all plants in TRI must report the amount of toxic release and go through the process of third-party certification.

Based on previous research (e.g., Barnett and Salomon 2012, Brynjolfsson et al. 1994, Klassen and McLaughlin 1996, Khanna and Damon 1999) and for the purpose of a parsimonious model, we employed several key control variables that affect the financial performance of each firm, including firm size, capital intensity, R&D intensity, and sales growth. Although some studies have also included advertising intensity, advertising expenses were missing for most of our sample of chemical firms; considering the characteristics of heavy industries, we replaced it instead with capital. A summary and descriptive statistics of these variables are presented in Tables 1 and 2.

Table 1. Summary of Variables
5.4. Estimation

Considering the skewed distributions of key variables along with a potential linear function of the model specified, we employed a lin-log model. We started with the pooled regression estimation, and the initial models are as follows.

\( \text{COGS}_{it} = \beta_0 + \beta_1 \ln \text{EP}_{it} + \beta_2 \ln \text{Size}_{it} + \beta_3 \ln \text{CapitalInt}_{it} + \beta_4 \ln \text{RDInt}_{it} + \epsilon_{it} \)

(1)

\( \text{Tobin's } q_{it} = \alpha_0 + \alpha_1 \ln \text{EP}_{it} + \alpha_2 \ln \text{Size}_{it} + \alpha_3 \ln \text{CapitalInt}_{it} + \epsilon_{it} \)

(2)

\( \text{COGS}_{it} \): Cost of Goods Sold of firm i at year t divided by Sales

\( \text{Tobin's } q_{it} \): Tobin's q of firm i at year t

\( \text{EP}_{it} \): Environmental performance of firm i at year t (Toxic release divided by sales)

\( \text{Size}_{it} \): Total assets of firm i at year t

\( \text{Sales growth}_{it} \): 1-(current Sales divided by previous year sales)

\( \text{CapitalInt}_{it} \): Capital Intensity measured by Capital expenditure of firm i at year t divided by Sales

\( \text{RDInt}_{it} \): R&D Intensity measured by R&D expenses of firm i at year t divided by Sales

Based on Durbin-Watson tests, we found an autocorrelation problem in the data. Because our data set is a panel covering six years and measures of the financial performance of firms such as COGS are apt to have such characteristics of autocorrelation, we controlled a within-firm AR (1) process by creating new (purged) residuals the sample autocorrelation reflected. The White’s specification test for detecting heteroscedasticity indicated that we had no reason to reject the null hypotheses (no heteroscedasticity), and the VIF test also indicated little multicollinearity problem. Although we conducted a robustness check and corrected the problem that violates the OLS assumptions, there are potential risks in estimating the biased parameters through the pooled regression due to the panel data structure, which is a combination of time series and cross-section data. Therefore, we controlled the systematic time effects by creating year dummies in the initial models (1-2, 2-2). Regarding industry heterogeneity, note that we had already limited the sample to the chemical industry in our research design because firms’ performance is predominantly determined by their industry.

\( \text{COGS}_{it} = \beta_0 + \beta_1 \ln \text{EP}_{it} + \beta_2 \ln \text{Size}_{it} + \beta_3 \ln \text{CapitalInt}_{it} + \beta_4 \ln \text{RDInt}_{it} + \beta_{10} \text{Year} + u_{it} \)

(1-2)

\( \text{Tobin's } q_{it} = \alpha_0 + \alpha_1 \ln \text{EP}_{it} + \alpha_2 \ln \text{Size}_{it} + \alpha_3 \ln \text{CapitalInt}_{it} + \alpha_4 \ln \text{RDInt}_{it} + \alpha_{11} \text{Year} + u_{it} \)

(2-2)

Lastly, to examine the robustness of our pooled regression with a year-fixed model, we employed the random effects model or error components model, which allowed us to control unobservable or latent heterogeneity arising from different subjects. The advantage of the random effects model is that we were able to capture the cross-section or individual-specific error component by incorporating the stochastic intercept of each subject i without sacrificing the degree of freedom. The model is based on the assumption that samples are randomly selected. The most appropriate method here is the method of generalized least square (Gujarati and Porter, 2012).

\( \text{COGS}_{it} = \beta_0 + \beta_1 \ln \text{EP}_{it} + \beta_2 \ln \text{Size}_{it} + \beta_3 \ln \text{CapitalInt}_{it} + \beta_4 \ln \text{RDInt}_{it} + \beta_{10} \text{Year} + e_{it} + u_{it} \)

(3)

\( \text{Tobin's } q_{it} = \alpha_0 + \alpha_1 \ln \text{EP}_{it} + \alpha_2 \ln \text{Size}_{it} + \alpha_3 \ln \text{CapitalInt}_{it} + \alpha_4 \ln \text{RDInt}_{it} + \alpha_{11} \text{Year} + e_{it} + u_{it} \)

(4)
6. Empirical Results

Table 3 lists the results from the estimation of both OLS with the time-fixed model and GLS of the random effects model. For the dependent variable COGS, the coefficient of environmental performance shows a positive relationship with the COGS ratio. That is, higher toxic releases (normalized by a firm’s production, here represented by sales) are related to higher manufacturing costs and lower profitability if other conditions are equal. If a firm’s toxic releases (in pounds per US million dollars) decrease by 1%, it may also have the effect of decreasing the COGS ratio by 0.00027% points on average. The results of random effects are consistent in cost competitiveness, although the magnitude of coefficient is smaller.

Table 3. Analysis Results

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<td>-0.1849**</td>
<td>-0.190***</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(1.39)</td>
<td>(-2.92)</td>
<td>(-3.45)</td>
</tr>
<tr>
<td>Sales growth</td>
<td></td>
<td></td>
<td>0.3554**</td>
<td>0.473**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.86)</td>
<td>(2.17)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.8147***</td>
<td>1.033***</td>
<td>2.166***</td>
<td>1.878***</td>
</tr>
<tr>
<td></td>
<td>(8.37)</td>
<td>(7.37)</td>
<td>(7.17)</td>
<td>(4.01)</td>
</tr>
<tr>
<td>Year effects</td>
<td>YES</td>
<td></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Firm effects</td>
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<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Number of observations</td>
<td>470</td>
<td>470</td>
<td>433</td>
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* = p<0.10 ** = p<0.05 *** = p<0.01, t statistics in parentheses
This result supports Hypothesis 1 that better environmental performance promoted by firms’ environmental managerial activities will affect their cost competitiveness positively. Because firms’ managerial activities focus on reducing the use of toxic materials in production processes through good operating practices without incurring much capital investment, they improve the marginal production costs such as the material costs that constitute the highest portion of COGS in chemical firms and generate benefits in terms of cost competitiveness. This is in line with theories that view CSR investments as long-term investments leading to improved stakeholder relationships and market opportunities and with theories predicting positive effects of corporate environmental performance on financial performance. But our results differ from those of previous works in finding an association between environmental performance and short-term financial performance as well. The study also offers new insight into the potential reasons behind the relationship between environmental performance and financial performance by illuminating specific firm behaviors such as Pollution Prevention Activities described earlier, may improve environmental performance.

Our argument regarding causality here is based on a number of assumptions. First, financial performance, the COGS ratio, is a final outcome of business operations while environmental performance, measured by toxic releases, is the process output occurring in production lines. This is plausible as there is a preceding relation, although that this argument admittedly is not free from possible endogeneity in the decision-making process (i.e., managers may decide the level of toxic releases considering firm performance). Second, we assume that the difference in environmental performance can be ascribed to the difference in environmental management of firms if other factors affecting toxic releases, such as industry and firm heterogeneity, are controlled. This assumption is based primarily on the theoretical reasoning discussed earlier, although our random effects model tries to capture other explanatory effects as possible.

As for the dependent variable Tobin’s q, we find that the coefficient of environmental performance is statistically significant and the direction is negative as conjectured in Hypothesis 2. That is, higher toxic releases (reflecting lower environmental management and performance) relates to the lower market value measured by Tobin’s q. This is consistent with the findings of prior studies (Konar and Cohen 2001) and the theoretical reasoning that investors perceive and respond to a firm’s environmental performance as potential costs or liabilities that will be reflected in the market value. Time-variant effects are significant in Tobin’s q model, which may be ascribed to stock market fluctuations. However, the coefficient of environmental performance in the random effects model is not statistically significant, although the direction is consistent with the former result.

7. Conclusions

The TRI disclosure system has continuously evolved, providing users with more value-added information by developing various useful data analytic and display tools such as mobile maps and data query applications. These more convenient and accessible analysis tools are intended to improve the effectiveness of information disclosure as quasi-regulation by increasing the transparency of companies’ effect upon the environment and neighboring communities and by encouraging the social monitoring of stakeholders. This in turn is expected to pressure or motivate the reporting companies to make their environmental efforts a significant priority and eventually reduce toxic releases.

Our study finds that firms with better environmental performance have greater cost competitiveness, which suggests that their environmental managerial activities focusing on the use of toxic materials in production processes may positively contribute to their production efficiency, in particular by reducing marginal material costs. These findings have a number of important implications for managers, most important of which is that environmental managerial activities may not constitute an additional burden irrespective of firms’ business operations but rather serve as innovative activities that can increase the production efficiency and material resource management of the firm. This implies that environmental management activities can allow managers to achieve both social and firm purposes. The study thereby challenges the concept that CSR should be viewed simply as a cost or matter of ethics. Further, it shows their short-term financial effects using more direct indicators tied to relevant activities than previous works examining environmental management creates long-term market opportunities.

This work is not without its limitations. First, these results should be understood as limited to the relationship between the environmental performance affected by PPAs or similar activities of chemical manufacturers and their cost efficiency rather than their final profitability or overall investment effects. Second, since the financial records of the individual facilities examined were not accessible, this analysis, like previous studies, was conducted at the firm level. Therefore, it is not free from the financial compounding effects from other businesses in which the studied firms might be involved other than the chemical business reported in TRI. Third, despite the theoretical support and reasoning behind our assumption of causality, there still remains the endogeneity issue in
our empirical model, as discussed earlier. This study makes an original contribution to current knowledge regarding the relationship between CSR and firm value by examining the intermediaries or responsive management activities undertaken by firms within the studied context to improve environmental performance. By employing a more direct financial measure such as COGS that is tied to a firm’s managerial actions, it tries to resolve the problem of measurement pointed out as one of reasons for previous mixed results. The paper’s discussion of the evolution of TRI in terms of value-added information and analytic tools may also provide guidance for other countries preparing effective EIDs. Lastly, the financial rewards demonstrated by our analysis also offer an incentive for managers to engage in or increase their environmental management.

References