The disclosure of environmental conservation costs and its relation to eco-efficiency

Evidence from Japan

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Abstract

Purpose – This paper aims to examine whether the amount of costs disclosed as relating to environmental controls is associated with environmental performance in terms of carbon-based eco-efficiency, and whether any relation supports voluntary disclosure theory or legitimacy theory arguments. Further, this paper attempts to determine whether the relations differ across the initial Kyoto Protocol period.

Design/methodology/approach – In this study, the focus was on Japanese firms over the period from 2002 to 2012. Disclosed environmental control costs (capital expenditures and operating costs) were identified and eco-efficiency measures based on carbon emissions were calculated. Relations were tested for using regression models controlling for other potential impact factors.

Findings – This study's results indicate a negative relation between disclosed levels of environmental control costs and eco-efficiency performance measures, and, for two of our three eco-efficiency metrics, this is more pronounced over the Kyoto Protocol period.

Research limitations/implications – These results support a legitimacy theory (as opposed to voluntary disclosure theory) explanation for the relation between the levels of disclosed environmental control costs and carbon-based eco-efficiency.

Originality/value – This study is the first to explore how flexibility in cost classification may be used by companies to foster a disclosure strategy.

Keywords Kyoto Protocol, Environmental disclosure, Eco-efficiency, Carbon productivity, Environmental conservation costs

Paper type Research paper

1. Introduction

In this study, we investigate how environmental accounting information voluntarily disclosed by Japanese firms relates to the companies' underlying ecological-economic performance[1]. More specifically, we examine the association between the magnitude of disclosed environmental conservation costs (ECCs), defined as firm size-adjusted capital expenditures and expenses related to environmental conservation, management and

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operations, and environmental performance, defined as carbon-based eco-efficiency[2]. We focus only on firms actually disclosing ECCs, and we argue that the flexibility in how costs are classified allows firms the ability to manipulate reported ECCs for management purposes. We further test for changes in this relation during the first commitment period of the Kyoto Protocol (2008-2012), as this is an important exogenous event potentially influencing the ECC disclosure strategies of Japanese firms[3].

Prior studies relying on voluntary disclosure theory (Clarkson *et al.*, 2008) and, alternatively, legitimacy theory (Patten, 2002) report contrasting results for the relation between environmental disclosure and environmental performance, and, as such, we attempt to determine which theoretical base appears to capture the specific associations we investigate. Voluntary disclosure theory predicts that firms with better environmental performance (eco-efficiency) use disclosure to inform investors and other stakeholders of their superior strategy, in this case, by signaling a stronger commitment to performance through the disclosure of higher levels of ECC (it predicts a positive association between the magnitude of ECC and eco-efficiency). In contrast, legitimacy theory predicts that firms with worse environmental performance (eco-efficiency) will choose to report higher levels of ECCs in an attempt to project an image of action on the environmental front (Patten, 2005) to alleviate the increased threats to their legitimacy (it predicts a negative association between the magnitude of ECC and eco-efficiency). Based on a sample of 274 Japanese manufacturing firms disclosing ECCs, and with CO_2 emissions and financial data available for 2002-2012, we document that the magnitude of ECCs is negatively associated with three different eco-efficiency measures (environmental intensity [EI], carbon productivity [CP] and return on carbon [ROC]). These results generally hold for different types of ECCs that may more directly impact CO_2 emissions reductions. Our findings thus provide evidence in support of the legitimacy theory arguments.

In the second stage of our analysis, we document that the magnitude of ECC declined during the first commitment period of the Kyoto Protocol (2008-2012), and we attribute this to the severe effects of the global financial crisis of 2008/2009 on the Japanese economy. However, we also find that the relation between performance and levels of disclosed ECC was significantly more pronounced during the Kyoto Protocol period for worse-performing companies relative to their better-performing counterparts. Although limited to results using only two of the three eco-efficiency measures, these results provide some evidence that the worse performing companies may have used the disclosure of ECC over this period in an attempt to appear committed to the country's reduction goals at a time of potentially increased governmental pressures.

To the best of our knowledge, this is the first study to provide empirical evidence on the association between the magnitude of total disclosed ECC and environmental performance. Further, our study is the first disclosure/performance investigation to use carbon-based eco-efficiency indices as environmental performance measures. This is important because environmental researchers and practitioners recently have directed their attention to eco-efficiency as it can be a strategic objective for the sustainable development of firms in a low-carbon society (Orsato, 2006; Hahn *et al.*, 2010). However, the negative relation we document between eco-efficiency and the magnitude of disclosed ECC, suggests that, at least in the Japanese setting, poorer performing firms appear to be more concerned with enhancing their environmental image than in improving environmental performance.

The remainder of the paper is organized as follows. In the next section, we provide background information, discuss prior literature and develop our hypotheses. This is followed by our sample description, empirical models and results. Our conclusions and the implications of this study are presented in the final section.

2. Background, literature and hypotheses development

2.1 Environmental accounting and reporting in Japan

Originally promulgated in 2000 and then revised in 2005, the Environmental Accounting Guidelines Review Committee of Japan's Ministry of Environment issued the Environmental Accounting Guidelines (Appendix) with the objective of promoting better environmental reporting[4]. Because the guidelines do not require Japanese firms to comply[5], it can be argued that the comparability of environmental accounting information across firms is not as robust as that of financial accounting information. However, most firms publishing environmental accounting information use a consistent approach to measure and report it and have been doing so for more than 10 years. The guidelines encourage consistency and comparability by recommending that current period ECCs and other environmental accounting information be published along with historical information[6]. The guidelines also provide specific examples in an attempt to standardize the measurement and collection of ECCs[7]. Further, and important to our investigation, ECC information is broken down in detail across various business activities, enabling us to identify information items directly related to environmental and financial results for our analyses. However, because of the voluntary nature of the reporting, firms have considerable discretion in determining what costs to include within the environmental classifications.

ECCs are important in environmental accounting research for several reasons. First, ECCs have been used in prior research as a proxy for the degree of firms' voluntary environmental protection efforts (Wang *et al.*, 2014) or to indicate governmental environmental regulation (Sueyoshi and Goto, 2009). Further, both Clarkson *et al.* (2004) and Johnston (2005) provide evidence suggesting at least some aspects of ECCs are perceived positively in the stock market. Second, as top management recognizes the importance of adopting a sustainability strategy, the magnitude of firms' ECC has been increasing worldwide (Chan-Fishel, 2002). Third, effective ECC management is critical for firms producing eco-friendly products to compete in product pricing and to expand their market share. For example, many Japanese firms include ECCs as part of target costs in the implementation process of a target cost management system and in the design for environment which manages the target costs strategically from the planning stage. Park and Kokubu (2010) show that both the environmental and economic performance of firms that manage environmental costs as part of target costs are consistently higher than that of control firms[8]. Collectively, therefore, it appears that ECCs play a critical role in environmental accounting research and practice.

2.2 Related literature

Recent research relies on two competing theories to explain the relationship between environmental disclosure and environmental performance: voluntary disclosure theory and legitimacy theory. These theories present opposite predictions. Voluntary disclosure theory predicts a positive association between environmental disclosure and environmental performance. Under this theory, firms with better environmental performance because of their proactive environmental strategies have incentives to disclose more credible environmental information that poor performers find difficult to imitate to inform stakeholders of their unobservable strategies (Bewley and Li, 2000; Al-Tuwaijri *et al.*, 2004; Clarkson *et al.*, 2008). In other words, when firms determine that the benefits from voluntary environmental disclosure are greater than their proprietary costs (e.g. regulatory pressure and potential ammunition for environmental protection groups), they are more likely to voluntarily disclose environmental information (Li *et al.*, 1997). Legitimacy theory, on the other hand, predicts a negative association between environmental disclosure and

environmental performance. Firms seeking to gain or maintain social legitimacy have an incentive to use communication strategies, including financial report disclosures, to potentially influence social perceptions of their firms (Cho and Patten, 2007; Cho *et al.*, 2012c). Thus, corporations with poorer environmental performance may use environmental disclosures as a tool for gaining or maintaining societal legitimacy. In other words, if firms with poor environmental performance face threatened legitimacy and increased political and social pressures, these firms will use disclosure in an attempt to change stakeholder perceptions about their environmental performance (Patten, 2005).

Studies of the environmental performance/environmental disclosure relation date back more than three decades, although many of the early investigations did not attempt to differentiate across theoretical explanations. Patten (2002) notes that the early studies (Ingram and Frazier, 1980; Wiseman, 1982; Freedman and Wasley, 1990; Fekrat *et al.*, 1996) largely reported insignificant associations between environmental performance and environmental disclosure. However, Patten further identifies that these early studies failed to control for omitted factors associated with the level of environmental disclosure (firm size and industry membership), had small samples and used inadequate measures of environmental performance. In an attempt to address these issues, Patten (2002) investigates the link between environmental disclosure, measured using a modified Wiseman index, and environmental performance, measured by Toxics Release Inventory (TRI) data scaled by sales. Patten finds a negative correlation between environmental performance and environmental disclosure, supporting legitimacy theory arguments. Similarly, Bewley and Li (2000) examine determinants related to environmental disclosures in Canada and find that firms with higher pollution propensity and greater media coverage of their environmental performance are more likely to disclose general environmental information, a result consistent with legitimacy theory. Similarly, Hughes *et al.* (2001) also find that firms with poor environmental performance, measured by CEP ratings, generally make more extensive environmental disclosures, a finding mirrored by Cho and Patten's (2007) investigation using KLD concern scores as the measure of environmental performance.

More recently, Clarkson *et al.* (2011) specifically examine the association between environmental performance and both the level and the nature of voluntary environmental disclosures in the Australian context. Their results consistently indicate that firms with a higher pollution propensity not only disclose more environmental information but also rely on disclosures that are inherently more objective and verifiable, a finding supporting legitimacy arguments. Cho *et al.* (2012a) focus more specifically on the disclosure of environmental capital expenditures and find that poorer environmental performers based on TRI releases were more likely to disclose the spending and that disclosure did not correlate with improved future performance. Both Cho *et al.* (2012b) and Cho *et al.* (2015), although primarily focusing on other issues[9], report significantly negative relations between environmental performance and environmental disclosure for their respective samples of US firms.

However, not all studies report such relations. For example, Al-Tuwaijri *et al.* (2004) estimate simultaneous equations to investigate associations among environmental disclosure, environmental performance and financial performance using the percentage of total waste recycled as a proxy for environmental performance. They document a positive association between environmental performance and environmental disclosure, although their focus is on information which is largely non-discretionary in nature. In addition, Clarkson *et al.* (2008) re-examine the relation between environmental performance and environmental disclosure by testing competing predictions from voluntary disclosure and legitimacy theories. Their extensive disclosure index is constructed using Global Reporting

Initiative (GRI) sustainability reporting guidelines, and they measure environmental performance using two within-industry rankings – toxic releases scaled by sales and the percentage of waste recycled. Consistent with Al-Tuwaijri *et al.* (2004), they find a positive association between environmental performance and voluntary environmental disclosures, supporting voluntary disclosure theory. Focusing more specifically on the content of disclosure in Carbon Disclosure Project reports, Luo and Tang (2014) find a significant positive relation between disclosure and performance with respect to carbon intensity and carbon mitigation for a sample of US and Australian companies. In summary, findings of research testing the two theories are mixed and inconclusive.

2.3 Hypotheses development

While a number of the prior studies of the environmental performance/environmental disclosure relation include environmental spending items within their disclosure scales (Cho and Patten, 2007; Clarkson *et al.*, 2008; Cho *et al.*, 2012a), they do not consider differences in the amount of spending that gets disclosed. Given the flexibility firms have with respect to identifying costs as being environmental in nature, we conjecture that decisions on the magnitude of ECCs to disclose (what gets classified as environmental spending) are tied to disclosure choice. More specifically, firms may be more inclined to classify costs as being environmental related when they also choose to disclose their ECCs. Accordingly, we extend prior research by focusing exclusively on companies including ECC disclosure and attempt to determine whether the amount of spending disclosed appears to be used as a signal of superior sustainability strategy or as a legitimation device.

Based on voluntary disclosure theory, firms would classify more costs as ECCs to signal their superior efforts and strategies to protect the environment. Hence, voluntary disclosure theory predicts a positive association between environmental performance and ECCs[10]. On the other hand, according to legitimacy theory, firms with poorer environmental performance would report higher levels of ECCs to project an image of taking meaningful action (Patten, 2005). Therefore, we investigate whether disclosed ECCs align more closely with voluntary disclosure or legitimacy theory.

As we discuss in more detail below, we use eco-efficiency indices as our measure of environmental performance[11]. Eco-efficiency captures the relation between the economic value and the environmental impact of a product or service (WBCSD, 2000). If an improvement in environmental performance (e.g. CO_2 emissions reduction) is attributed to a decrease in production, the relative value of environmental performance to productivity efficiency has not been improved. The concept of efficiency plays a vital role in contemporary ecological economic theory (Jollands, 2006). Because the world economy's energy and material resource bases are limited, ecological economics identifies the efficiency of resource use as an important strategy to achieve sustainable development. Eco-efficiency is an efficiency concept that is well-suited to maximize the economic value of the product or service of a firm and minimize the environmental impact. Eco-efficiency also focuses on business opportunities and allows companies to become more resource-efficient (environmentally responsible) and more profitable. Therefore, it is a key contribution to sustainable development (Burnett and Hansen, 2008)[12].

We argue that, under voluntary disclosure theory, companies with better eco-efficiency because of superior, but unobservable, environmental strategies choosing to disclose their ECCs would be more likely to classify costs as being environmental in nature to signal this superior position. In contrast, if firms use the disclosure of ECCs to project an image of environmental concern to offset the potential social and political impacts of poor performance, we would expect spending amounts to be negatively associated with

eco-efficiency measures. Accordingly, we state our first set of hypotheses (reflecting the alternative arguments) as:

H1a. The magnitude of environmental conservation costs is positively associated with eco-efficiency as predicted by voluntary disclosure theory.

H1b. The magnitude of environmental conservation costs is negatively associated with eco-efficiency as predicted by legitimacy theory.

In the second stage of our analysis, we examine firms' disclosure strategies on ECCs in relation to their eco-efficiency before and during the first quantified emission limitation and reduction commitment period of the Kyoto Protocol (2008-2012). Because the Japanese Government took the initiative to lead other developed nations in regard to the Kyoto Protocol, it may have borne a higher level of moral responsibility to achieve its binding target of carbon emissions reductions. Sueyoshi and Goto (2010) note that the Japanese Government was increasing pressure on Japanese manufacturing firms to reduce CO_2 emissions during the first commitment period of the Kyoto Protocol to comply with the their environmental policy. If ECC disclosure is used in an attempt at legitimation, we would expect the increased governmental pressures to heighten the relation between performance and disclosed ECCs, as worse-performing companies would have more incentive to appear to be working toward the government's goals. No such change in relation would appear to be predicted under voluntary disclosure theory. Accordingly, we test for differences in the relation between performance and disclosure over the Kyoto Protocol period (relative to prior years)[13] and we state our second hypothesis (in null form) as:

H2. The association between environmental conservation costs and eco-efficiency will not be different before and during the first commitment period of the Kyoto Protocol.

3. Research design

3.1 Model for environmental conservation costs and environmental performance (eco-efficiency)

3.1.1 Environmental conservation costs measure. For the purposes of our study, environmental conservation costs consist of environmental investments and environmental expenses. Environmental investments are capital expenditures allocated during a target period for the purpose of environmental conservation. Environmental expenses are the recorded expenses or losses arising from the consumption of goods or services for environmental management and operation (Environmental Accounting Guidelines, Ministry of Environment in Japan 2005).

In this study, we use two different measures of ECCs and examine the relation of each to eco-efficiency measures. Our primary test uses total ECCs (TECCs), as CO_2 (the primary performance factor we focus on as discussed below) is emitted over the entire value chain of a firm, and managing all the activities related to environmental protection is essential for effective CO_2 emissions reductions (Kolk and Pinkse, 2005; Jeswani *et al.*, 2008)[14]. In subsequent tests, we use what we label as current ECCs (CECCs) by excluding environmental R&D costs from TECCs because environmental R&D costs may not affect CO_2 emissions reductions in the short-term[15].

3.1.2 Environmental performance (eco-efficiency) measures. In contrast to prior studies of the environmental performance-environmental disclosure relation, we focus more specifically on CO_2 emissions to construct our eco-efficiency indices. These represent the ratio between the economic value and the environmental impact of a product or service simultaneously (WBCSD, 2000)[16]. Following prior studies (WBCSD, 2000; Bebbington, 2001; Jollands, 2006; Hahn *et al.*, 2010), we measure eco-efficiency using EI, CP and ROC. EI is CO_2 emissions divided by sales. CP is measured by the ratio of CO_2 emissions to labor

productivity (value added)[17]. When the value added created by a firm increases or the level of CO_2 emissions decreases (either without changes or with improvements in the other factor), CP improves. ROC is measured by the ratio of CO_2 emissions to operating income. When operating income increases and the level of CO_2 emissions decreases (either without changes or with improvements in the other factor), ROC improves.

3.1.3 Empirical model. To test the association between the magnitude of disclosed ECCs and eco-efficiency as described in *H1a* and *H1b*, we estimate the following empirical model using ordinary least squares regression:

$$\boldsymbol{ECC}_{i.t} = \beta_0 + \beta_1 \boldsymbol{EE}_{i.t} + \beta_2 \boldsymbol{SIZE}_{i.t} + \beta_3 \boldsymbol{LEV}_{i.t} + \beta_4 \boldsymbol{IND}_{i.t} + \beta_5 \boldsymbol{YEAR}_{i.t} + \varepsilon \quad (1)$$

Our primary test variable is eco-efficiency ($EE_{i,t}$), which, in independent estimations, is the EI, CP and ROC metric[18]. As noted above, ECCs ($ECC_{i,t}$) are measured separately as TECC and CECC.

We include other control variables that potentially affect the magnitude of ECCs. Prior studies (Patten, 2002; Clarkson *et al.*, 2008, 2011); Cho *et al.*, 2012a) document that larger firms make more extensive environmental disclosures than smaller firms. In addition, larger firms have more slack resources for environmental investments, and, accordingly, it is possible that the magnitude of ECCs could be related to firm size. If so, we would anticipate a positive association between ECCs and SIZE. We measure firm size ($SIZE_{i.t}$) as the natural log of the firm's total assets for each firm in each year of the study. We include leverage ($LEV_{i.t}$) to control for each firm's debt level, and we measure this as the ratio of total liabilities to total assets (Cho *et al.*, 2012a). The monitoring demand for information increases with leverage (Clarkson *et al.*, 2011), and high-levered firms have fewer financial resources for environmental investment than low-leveraged firms. Hence, leverage is likely to be negatively associated with the magnitude of ECC. We include industry dummies ($IND_{i.t}$) and year dummies ($YEAR_{i.t}$) to control for industry and year effects. To address independence issues among multiple observations in the same firm, standard errors are clustered by the firm level.

Al-Tuwaijri *et al.*'s (2004) analysis indicates that environmental disclosure and environmental and economic performance can be endogenously determined. To address potential endogeneity issues, we first consider the time lag effect between eco-efficiency and the decision relating to ECC, replacing current year eco-efficiency measures with lagged variables (t-1 and t-2 time-series variables) (Johnston, 2005; Coles *et al.*, 2006). Second, we estimate two-stage least square (2SLS) regressions. All of our endogenous (EI, CP and ROC) and exogenous (size and leverage) variables are included in the right-hand side in the first-stage regressions following Coles *et al.* (2006), and we include the predicted values of eco-efficiency in the second stage model as test variables. Third, we estimate a firm fixed-effect model to address potential omitted variables problems. Current eco-efficiency measures (t variable) are used to estimate the firm fixed-effect model.

Next, we add a one/zero indicator variable (KYOTO) to designate observations from the first commitment period of the Kyoto Protocol and construct the interaction variable (EEKYOTO) to test for differences in association between ECCs and eco-efficiency during the commitment period. The KYOTO dummy is coded as 1 if observations come from fiscal years 2008 through 2012 and, 0 otherwise. We state this model as:

$$\begin{aligned} ECC_{i.t} = {} & \beta_0 + \beta_1 EE_{i.t} + \beta_2 KYOTO_{i.t} + \beta_3 EEKYOTO_{i.t} \\ & + \beta_4 SIZE_{i.t} + \beta_5 LEV_{i.t} + \beta_6 IND_{i.t} + \beta_7 YEAR_{i.t} + \varepsilon \end{aligned} \quad (2)$$

The main variables in the model are defined in Table I.

Variable	Description
ECC	
Total ECC (TECC)	Environmental investments + Environmental expenses
Current ECC (CECC)	Total ECC − Environmental R&D costs (¥m)
Global ECC (GECC)	ECC for reducing greenhouse gas emissions
CO_2 emissions	Emissions that arise from directly from sources that are owned and controlled by the company (Scope 1)
Eco-efficiency	
Environmental Intensity (EI)	(CO_2 emissions (ton)/sales (¥m) multiplied −1
Carbon productivity (CP)	Value added (¥m)/CO_2 emissions (ton)
Return on carbon (ROC)	Operating income (¥m)/CO_2 emissions (ton)
Kyoto protocol dummy (KYOTO)	1 if fiscal year covers 2008 through 2012, 0 otherwise
SIZE	Natural logarithm of total assets
LEV	Total liability (¥m)/total assets (¥m)

Table I.
Definitions of variables

4. Results

4.1 Sample selection and sample profile

The sample period of our study covers 2002 through 2012. Because the Environmental Accounting Guideline in Japan was made public in May 2001, 2002 is the first year for which the data are available. The year 2012 is chosen as the last year for our analysis because the first quantified emissions limitation and reduction commitment for the Kyoto Protocol ended that year.

Data on carbon emissions are obtained from the Environmental Report Plaza, which is released by the Ministry of Economy, Trade and Industry in Japan, and sample firms' environmental reports[19]. The companies' financial data are obtained from the Nikkei Economic Electronic Databank System (NEEDS). We obtain ECC data from firms' sustainability reports. Of the 851 firms included in the Environmental Report Plaza as of March 2014, we identified 280 as manufacturing firms (3,360 firm-year observations) with available data for 2002-2012. Next, we drop 1,270 firm-year observations with unavailable environmental costs, CO_2 emissions and/or financial variables. Finally, to alleviate problems related to influential observations, we Winsorize the top and bottom 1 per cent of all variables used in the regressions. Our final sample consists of 274 manufacturing firms (2,322 firm-year observations).

Table II presents descriptive statistics on all variables used in the regressions. The mean and median total assets for the sample firms are ¥589,981m and ¥209,296m, respectively. The means (medians) of actual CO_2 emissions (RCO_2) and ECCs (RECC) are 2,040,468 tons (146,500 tons) and ¥11,279m (¥2,453m), respectively, indicating that these two variables are positively skewed. Thus, we scale these two variables by the firms' sales. The mean of the firms' leverage is 0.486. The mean (median) of value added and operating income are ¥91,251m (¥37,414m) and ¥33,184m (¥10,533m), respectively. The mean of CP is 0.544, and the mean of ROC is 0.196. Industry composition (not tabulated) shows that chemicals/pharmaceuticals have the highest number of observations (19.68 per cent), followed by electrical goods (9.99 per cent) and transportation equipment (8.87 per cent). Other firms are evenly distributed across industries.

Table III presents Spearman correlation coefficients for our primary variables. As expected, our three eco-efficiency metrics (EI, CP and ROC) are highly correlated with each other. At the bivariate level, TECC is significantly negatively related to each of the eco-efficiency measures, which is consistent with *H1*. None of the correlation coefficients for

Table II.
Descriptive statistics

Variable	*N*	Mean	Minimum	Q1	Median	Q3	Maximum	SD
RCO_2	2,322	2,040,468	1,320	33,000	146,500	650,000	70,300,000	8,037,899
SALE	2,322	797,860	9,185	115,809	261,989	733,505	26,289,200	1,786,951
CO_2	2,322	2.344	0.025	0.187	0.463	1.531	75.677	6.624
EI	2,322	−2.165	−33.173	−1.531	−0.463	−0.187	−0.037	5.278
RECC	2,322	11,279	15	844	2,453	7,831	2,888	28,632
TECC	2,322	0.014	0.001	0.005	0.009	0.017	0.096	0.015
TA	2,322	589,981	3,301	107,991	209,296	495,135	10,661,169	1,119,861
SIZE	2,322	12.397	9.546	11.590	12.252	13.113	15.638	1.267
LEV	2,322	0.486	0.101	0.348	0.482	0.646	0.860	0.190
VA	1,928	91,251	308	17,763	37,414	74,625	2,269,618	183,448
CP	1,928	0.544	0.003	0.065	0.253	0.784	3.608	0.685
OI	1,892	33,184	−629,078	3,872	10,533	29,399	1,060,644	89,191
ROC	1,892	0.196	−0.240	0.013	0.063	0.196	2.544	0.382

Notes: Variable definitions: RCO_2 = CO_2 emissions in year *t* (ton); SALE = Firm's revenue sales in year *t* (¥m); CO_2 = CO_2 emissions (ton) divided by sales (¥m); EI = (CO_2 emissions (ton) divided by sales (¥m) × −1; RECC = Environmental conservation costs (¥m) (Environmental Investments + Environmental Expenses); TECC = Total environmental conservation costs (¥m) divided by sales (¥m); TA = Firm's total assets (¥m); SIZE = Natural logarithm of total assets; LEV = Total liability (¥m) divided by total assets (¥m); VA = Firm's value added (¥m); CP = Carbon Productivity, measured by value added (¥m)/CO_2 emissions (ton); OI = Firm's operating income (¥m); ROC = Return on Carbon, measured by operating Income (¥m)/CO_2 emissions (ton)

SIZE or LEV is in excess of 0.4, and values for variance inflation factors (non-tabulated) are all below two, suggesting that multicollinearity does not appear to be a problem.

*4.2 Environmental conservation costs and eco-efficiency (*H1a *and* H1b*)*

Tables IV-VI present regression results for the association between ECCs and eco-efficiency. As reported in Tables IV-VI, the coefficients of our three eco-efficiency measures are all significantly negative under both OLS and 2SLS estimations[20]. We find similar results when using lagged test variables (the three measures of eco-efficiency)[21]. Results of firm fixed-effect estimation (not tabulated) show that coefficients of EI and ROC are significantly negative, whereas the coefficient of CP, although negative, is not statistically significant at conventional levels.

Overall, our results suggest that firms with worse eco-efficiency (all three measures of eco-efficiency), on average, disclose a greater magnitude of ECCs. The findings are inconsistent with the predictions of voluntary disclosure theory (Dye, 1985; Clarkson *et al.*, 2008), but consistent with the predictions of legitimacy theory (Patten, 2002; Cho *et al.*, 2012a), thus supporting *H1b*. Interestingly, large firms and low-levered firms generally do not disclose higher levels of ECC than small firms and high-levered firms (insignificant coefficients of SIZE and LEV).

Table VII presents the results of our investigation of the association between value chain ECC and eco-efficiency. Similar to the findings on the relation between TECC and eco-efficiency, CECC is negatively associated with all three measures of eco-efficiency (EI, CP and ROC), again supporting *H1b*.

*4.3 The ecological-economic impact of the Kyoto Protocol (*H2*)*

Table VIII presents the results of the tests for differences in the association between ECC and eco-efficiency during the first commitment period of the Kyoto Protocol. As shown in Table VIII, the coefficients of eco-efficiency and the Kyoto Protocol dummy (KYOTO) are significantly negative using all three eco-efficiency measures. The negative coefficient on KYOTO indicates that Japanese firms reduced their investment in ECC during the first commitment period of the Kyoto Protocol (2008-2012). We believe that this is likely because of a focus on achieving financial goals when the Japanese economy was severely affected by the global financial crisis which hit in 2008. However, the table also provides some evidence that the relation between eco-efficiency and the disclosure of ECC differed during the Kyoto Protocol period. Coefficients of the interaction variable between eco-efficiency and KYOTO are significant and negative when eco-efficiency is measured by EI or ROC, although insignificant (and positively signed) when eco-efficiency is measured by CP. These results suggest that the Japanese firms performing more poorly with respect to eco-efficiency increased their legitimation efforts over the Kyoto Protocol period, perhaps in an attempt to

Variable	TECC	EI	CP	ROC	SIZE
TECC					
EI	*−0.560*				
CP	*−0.310*	*0.635*			
ROC	*−0.247*	*0.475*	*0.834*		
SIZE	*0.076*	*−0.127*	*−0.103*	*−0.015*	
LEV	*0.131*	*−0.137*	*−0.152*	*−0.201*	*0.301*

Notes: Coefficients in italic indicate significance at $p < 0.01$; all variables are defined in Table II

Table III.
Spearman correlation coefficients

Table IV.
Environmental conservation costs and environmental performance: environmental conservation costs and environmental intensity

		Dependent variable: $TECC_t$ (Total environmental conservation costs)					
		EI_t		EI_{t-1}		EI_{t-2}	
Variable	Expected sign	OLS	2SLS	OLS	2SLS	OLS	2SLS
Intercept	?	0.064 (5.10***)	0.071 (4.77***)	0.046 (5.55***)	0.060 (5.30***)	0.044 (5.40***)	0.058 (5.23***)
EI	?	*−0.001 (−3.27***)*	*−0.006 (−4.78***)*	*−0.001 (−3.29***)*	*−0.006 (−4.80***)*	*−0.001 (−3.32***)*	*−0.006 (−4.76***)*
SIZE	+	−0.001 (−1.97)	−0.002 (−2.73)	−0.001 (−1.82)	−0.002 (−2.62)	−0.001 (−1.74)	−0.002 (−2.60)
LEV	−	−0.0007 (−0.25)	−0.017 (−3.51***)	0.0004 (−0.15)	−0.017 (−3.47***)	−0.0002 (−0.09)	−0.017 (−3.41***)
Industry dummies		Included		Included		Included	
Year dummies		Included		Included		Included	
Adjusted R^2		0.49	0.43	0.48	0.42	0.49	0.43
N		2,322	2,322	2,135	2,135	1,909	1,909

Notes: ***, **, * Significant at the 1, 5, and 10% levels, respectively (one-tailed where signs are predicted, two-tailed otherwise). Standard errors are clustered by firm. Variable definitions: EI (Environmental Intensity) = (CO_2 emissions (ton) divided by sales (¥m) × −1; TECC (Total ECC) = (Environmental Investments + Environmental Expenses) divided by sales (¥m); other variables are defined in Table I

Table V. Environmental conservation costs and environmental performance: environmental conservation costs and carbon productivity

		Dependent variable: TECC (Total environmental conservation costs)					
		CP_t		CP_{t-1}		CP_{t-2}	
Variable	Expected sign	OLS	2SLS	OLS	2SLS	OLS	2SLS
Intercept	?	0.081 (5.33***)	0.091 (5.87***)	0.045 (3.90***)	0.050 (4.42***)	0.044 (3.86***)	0.050 (4.40***)
CP	?	*−0.003 (−4.76***)*	*−0.006 (−5.21***)*	*−0.004 (−4.90***)*	*−0.006 (−5.27***)*	*−0.004 (−4.93***)*	*−0.006 (−4.81***)*
SIZE	+	−0.001 (−1.30)	−0.002 (−1.97)	−0.001 (−1.49)	−0.002 (−1.87)	−0.001 (−1.50)	−0.002 (−1.90)
LEV	−	−0.0005 (−0.61)	−0.002 (−0.63)	−0.001 (−0.38)	−0.003 (−0.86)	−0.002 (−0.44)	−0.004 (−1.03)
Industry dummies		Included		Included		Included	
Year dummies		Included		Included		Included	
Adjusted R^2		0.44	0.44	0.44	0.43	0.43	0.43
N		1,928	1,928	1,777	1,777	1,594	1,594

Notes: ***, **, * Significant at the 1, 5, and 10% levels, respectively (one-tailed where signs are predicted, two-tailed otherwise). Standard errors are clustered by firm. Variable definitions: CP (Carbon Productivity) = Value Added (¥m) divided by CO_2 Emissions (ton); TECC (Total ECC) = (Environmental Investments + Environmental Expenses) divided by sales (¥m); other variables are defined in Table I

Table VI.
Environmental conservation costs and environmental performance: environmental conservation costs and return on carbon

		Dependent variable: TECC (Total environmental conservation costs)					
		ROC_t		ROC_{t-1}		ROC_{t-2}	
Variable	Expected sign	OLS	2SLS	OLS	2SLS	OLS	2SLS
Intercept	?	0.079 (5.22***)	0.081 (5.26***)	0.036 (3.36***)	0.039 (3.55***)	0.036 (3.38***)	0.038 (3.49***)
ROC	?	*−0.006 (−5.27***)*	*−0.011 (−5.01***)*	*−0.005 (−4.69***)*	*−0.012 (−4.97***)*	*−0.006 (−4.51***)*	*−0.013 (−5.02***)*
SIZE	+	−0.0006 (−0.84)	−0.0006 (−0.80)	−0.0006 (−0.74)	−0.0005 (−0.65)	−0.0006 (−0.74)	−0.0005 (−0.60)
LEV	−	−0.003 (−0.75)	−0.007 (−1.73*)	−0.002 (−0.57)	−0.009 (−2.18**)	−0.003 (−0.84)	−0.011 (−2.55**)
Industry dummies		Included		Included		Included	
Year dummies		Included		Included		Included	
Adjusted R^2		0.45	0.45	0.44	0.45	0.44	0.45
N		1,892	1,892	1,745	1,745	1,565	1,565

Notes: ***, **, * Significant at the 1, 5, and 10% levels, respectively (one-tailed where signs are predicted, two-tailed otherwise). Standard errors are clustered by firm. Variable definitions: ROC (Return on Carbon) = Operating Income (¥m) divided by CO_2 Emissions (ton); TECC (Total ECC) = (Environmental Investments + Environmental Expenses) divided by sales (¥m); other variables are defined in Table I

Table VII.
Current ECC and eco-efficiency

		Dependent variable: CECC (Current environmental conservation costs)					
		EI_t		CP_t		ROC_t	
Variable	Expected sign	OLS	2SLS	OLS	2SLS	OLS	2SLS
Intercept	?	0.057 (4.44***)	0.063 (4.15***)	0.080 (5.33***)	0.084 (5.65***)	0.074 (5.09***)	0.076 (5.14***)
EE	?	*−0.001 (−3.45***)*	*−0.006 (−4.99***)*	*−0.003 (−4.76***)*	*−0.005 (−4.78***)*	*−0.005 (−4.91***)*	*−0.010 (−4.87***)*
SIZE	+	−0.0009 (−1.81)	−0.002 (−2.49)	−0.0001 (−1.30)	−0.001 (−1.56)	−0.0005 (−0.63)	−0.0004 (−0.59)
LEV	−	−0.0008 (−0.37)	−0.015 (−3.66***)	−0.0005 (−0.16)	−0.001 (−0.44)	−0.002 (−0.53)	−0.006 (−1.69*)
Industry dummies		Included		Included		Included	
Year dummies		Included		Included		Included	
Adjusted R^2		0.55	0.47	0.53	0.48	0.53	0.50
N		2,322	2,322	1,928	1,928	1,892	1,892

Notes: ***, **, * Significant at the 1, 5, and 10% levels, respectively (one-tailed where signs are predicted, two-tailed otherwise). Standard errors are clustered by firm. Variable definitions: EE (eco-efficiency) = EI (Environmental Intensity), CP (Carbon Productivity) and ROC (Return on Carbon); CECC (Current ECC) = (Environmental Investments + Environmental Expenses − Environmental R&D costs) divided by sales (¥m); other variables are defined in Table I

		Dependent variable: TECC (Total environmental conservation costs)					
		EI_t		CP_t		ROC_t align="center"	
Variable	Expected sign	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Intercept	?	0.083	6.65***	0.087	5.47***	0.079	5.21***
EE	−	*−0.001*	*−3.21***	*−0.004*	*−4.80***	*−0.006*	*−4.67***
KYOTO	?	−0.040	−3.85***	−0.040	−4.17***	−0.041	−4.22***
EEKYOTO	?	*−0.0002*	*−1.97***	*−0.0006*	*−1.13*	*−0.002*	*−1.66**
SIZE	+	−0.001	−1.98	−0.001	−1.62	−0.0006	−0.84
LEV	−	−0.0007	−0.27	−0.0008	−0.23	−0.003	−0.73
Industry dummies		Included		Included		Included	
Year dummies		Included		Included		Included	
Adjusted R^2		0.49		0.44		0.45	
N		2,322		1,928		1,892	

Notes: ***, **, *Significant at the 1, 5, and 10% levels, respectively (one-tailed where signs are predicted, two-tailed otherwise). Standard errors are clustered by firm. Variable definitions: EE (eco-efficiency) = EI (Environmental Intensity), CP (Carbon Productivity) and ROC (Return on Carbon); KYOTO = 1 if fiscal year covers 2008 through 2012, 0 otherwise; EEKYOTO = The interaction variable between EE and KYOTO; TECC (Total ECC) = (Environmental Investments + Environmental Expenses) divided by sales (¥m); other variables are defined in Table I

Table VIII.
The effect of Kyoto protocol

appear even more committed to pursuing the Kyoto targets. However, the lack of consistency across the eco-efficiency measures suggests that these arguments should be interpreted with caution.

4.4 Additional analyses

To ensure that our results are robust to method choices, we run several additional sensitivity tests. First, we re-estimate our primary regressions using each separate component of ECCs (environmental investment and environmental expense). Results (not tabulated) on the separated spending measures remain consistent with the primary findings.

In a second set of sensitivity tests, we replace our individual industry controls with an environmentally sensitive industry (ESI) binary variable. Patten (2002) notes that almost all studies of corporate environmental disclosure find that companies in industries with greater exposure to environmental issues exhibit higher levels of environmental disclosure. Following prior studies (Cho *et al.*, 2015), we classify firms from the chemical, metals, paper, petroleum and utility industries as environmentally sensitive. Results of all tests (not tabulated) remain qualitatively unchanged. In addition, regressions estimated across sub-groups (ESI and non-ESI) show that the negative relation between ECC and our eco-efficiency measures remains significantly negative for both groups of firms.

Next, we test for differences in inferences across firms in industries with higher levels of energy consumption, as these firms may have higher concerns with carbon emissions. We divide the sample into energy-intensive and non-energy-intensive subsamples and estimate our primary regressions for each group[22]. Results (not tabulated) generally show that ECC and eco-efficiency measures are negatively associated in both subsamples.

Finally, we more specifically focus on elements of ECC related to preventing global warming and ozone depletion, energy conservation costs and costs for other global environmental activities (Guideline 3.2), because these can have a direct relation with the reduction of CO_2 emissions. We label these as global ECC (GECC). Regression results using GECC are not as consistent as with the other ECC specifications. While GECC is significantly

and negatively related to the CP eco-efficiency measure, associations with the other eco-efficiency metrics are not statistically significant at conventional levels. This may be because of the small magnitude of GECC and the large difference by year for GECC.

In general, the results of our additional analyses suggest that our primary findings appear to be relatively robust to alternative specifications.

5. Conclusion

Using empirical data on Japanese manufacturing firms across the period from 2002-2012, we investigate the relationship between ECC and eco-efficiency. We also examine firms' disclosure strategies on ECC in relation to their eco-efficiency during the first commitment period of the Kyoto Protocol. We find that controlling for size and leverage, ECC was negatively associated with three eco-efficiency measures (EI, CP and ROC), and these results largely hold using alternative specifications within the analysis. With respect to the second aspect of our investigation, we find some evidence that Japanese firms changed their disclosure strategies on ECC in relation to eco-efficiency during the Kyoto Protocol period, with worse eco-efficiency performers increasing their disclosed ECC more than better performers during this time frame.

Our investigation extends the voluntary disclosure versus legitimacy theory debate on the environmental performance–environmental disclosure relation by focusing more specifically on the nature of the information being disclosed as opposed to a disclosure-non-disclosure differentiation. Our findings are more consistent with the legitimacy theory arguments, in that worse performing firms tend to report higher levels of ECC. Although it is possible that, for at least some sample firms, other aspects of environmental performance could be driving the management choice to classify costs as ECCs, our findings that relations hold across different industry groupings, as well as the more pronounced effect for worse performers during the Kyoto period of greater governmental pressure, suggest that concerns with carbon performance appear to have influence management choice.

Ultimately, our results provide additional evidence supporting concerns with voluntary environmental disclosure. We show that, even when firms make the choice to disclose environmental information, in our case, ECC, the flexibility in how costs get classified into that designation allows for potential manipulation. Gray and Bebbington (2000, p. 16) argue that as long as environmental reporting remains a voluntary activity, it will "only be a legitimation device and not an accountability mechanism", and following this line of thought, Patten (2014, p. 212) argues that:

> […] that to transform corporate environmental reporting into a tool of transparency and accountability we need to establish a framework that, like financial reporting, requires organizations to disclose a collective set of information on environmental performance and related issues where the data are defined and measured in a similar way.

Our results add credence to the need for such transformation.

There are several limitations to our study. First, even though many firms disclosed their methodologies for measuring CO_2 emissions, each methodology could be different by firm, and different methodologies can affect the determination of the amount of CO_2 emissions (Martinov-Bennie, 2012; Liesen *et al.*, 2015). Hence, the reliability of disclosed information should be enhanced to increase the comparability of CO_2 emissions (Matsumura *et al.*, 2014). Second, it would be difficult to generalize the results of this study to different countries, as Japanese firms likely differ from those in other locations with respect to corporate culture or governance structure, policies and regulations of government and/or environmental

accounting standards and guidance. Comparative studies in different countries and industries are promising areas for future research.

Finally, it should be noted that the theoretical background on sustainability is quite limited, and more theories should be developed so that research results can be interpreted and communicated effectively. Unerman (2012) states that the theoretical foundation of much sustainability accounting research to date has been fairly narrow and that theories to support robust work on accountability need to move beyond the fairly basic formulations of legitimacy theory.

Notes

1. We use Japanese firms as our sample for several reasons. First, few countries in the world have official environmental accounting standards, and, as far as we know, Japan is one of the few countries where a substantial number of firms periodically report detailed and itemized data on ECC following similar standards. Second, Japanese firms have been one of the largest manufacturing producers, while, at the same time, being one of world's largest carbon emitters (Nishitani and Kokubu 2012). Hence, it is meaningful to examine Japanese firms concerning their environmental performance. Third, Japan has experienced a substantial change in environmental policies, changing from a passive position to an active one. For example, the Kyoto Protocol was initiated with a view to reduce carbon emissions. As a result, Japanese firms likely have a different business environment compared to firms from the Anglo-American economy, where policies toward climate change have been passive (Lee *et al.*, 2015).
2. "Eco-efficiency" is an abridgement of "ecological-economic efficiency", a construct that indicates increased productivity and reduced costs simultaneous with improved environmental performance (Bebbington, 2001; Lehman, 2002). This term, which was first used by the World Business Council for Sustainable Development in 1992 in its publication and at the Earth Summit, has been used interchangeably with "resource productivity", "carbon productivity" and "environmental productivity".
3. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The Kyoto Protocol was adopted in Kyoto, Japan, on December 11, 1997 and was effective on February 16, 2005. During the first commitment period (2008-2012), 37 countries committed to reduce GHG emissions to an average of 5 per cent against 1990 levels. During the second commitment period (2013-2020), 42 countries committed to reduce GHG emissions by at least 18 per cent below 1990 levels; however, the composition of ratified countries in the second commitment period is different from the first (United Nations Framework Convention on Climate Change; http://unfccc.int/kyoto_protocol/items/2830.php). The Kyoto Protocol, particularly the first commitment period, was greatly influenced by the leadership of Japan, and the Japanese Government may have attempted to induce firms to expand their environmental investments. Also, the Japanese economy was affected after 2008 by the global financial crisis. Japanese firms may have passively complied with environmental legislation and regulations after 2008. Hence, this first commitment period (2008-2012) allows us to observe how incentives for environmental management of Japanese firms changed and how these changes affected Japanese firms' disclosure choice on ECC in relation to their eco-efficiency.
4. In 2003, Japan's Ministry of Environment set an ambitious objective of having 50 per cent of Japanese firms disclose environmental reports by 2010, but recent statistics show that only 30.6 per cent of companies listed in the Tokyo Stock Exchange comply with the guidelines (Ministry of Environment in Japan, 2012).
5. The mandatory GHG (greenhouse gas) accounting and reporting system of the Ministry of the Environment was introduced in 2006. Under the system, firms with a minimum of 21 employees and a minimum of 3,000 t-CO_2 GHG emissions, or energy consumption at facilities with a minimum of 1,500 kL of oil equivalent must report the quantities annually to the government (Saka and Oshika, 2014). The Environmental Consideration Law stipulates that large enterprises must endeavor to publish environmental reports and disclose the status of their environmental

initiatives. However, Environmental Reporting Guidelines and Environmental Accounting Guidelines of Japan are not mandatory. Environmental Reporting Guidelines were published by Japan's Ministry of Environment in 2012 with the purpose of promoting environmental reporting.

6. Along with current and historical ECC information, the reporting firms are required to disclose current and historical information on CO_2 emissions (Guideline 4.1).
7. For instance, the guideline enables Japanese firms to measure and report ECC data reliably and consistently in capital and revenue expenditures (Guideline 3.1) and environmental R&D (Guideline 3.2). Rational allocation rules are also provided for complex costs that consist of environmental and other costs (Guideline 3.3). Murai *et al.* (2011) investigate the consistency of environmental accounting information, using text mining methods, and we conducted an e-mail survey to confirm the usefulness of ECC information.
8. According to Park and Kokubu (2010), 57 per cent of the sample firms included environmental costs in their target cost management system.
9. Cho *et al.* (2012b) explore the impacts of environmental performance and environmental disclosure on perceptions of environmental reputation, whereas Cho *et al.* (2015) examine whether environmental performance and environmental disclosure explain differences in firm value.
10. The magnitude of a firm's ECC can represent the financial input to achieve environmental performance, and it may be a major antecedent for environmental performance. For example, by lowering pollution production and raising expenditures on environmental protection, firms can improve their environmental and financial performance (King and Lenox, 2001; López-Gamero *et al.*, 2009). In this case, a positive association is expected between ECCs and environmental performance.
11. Previous studies (Johnston, 2005; Patten, 2005; Sueyoshi and Goto, 2009; Nakamura, 2011; Wang *et al.*, 2014) using ECC examine only the impact of ECC on financial performance, and studies examining the inter-relationships between ECC and environmental performance are rare. In a related study, López-Gamero *et al.* (2009) examine the relationship between environmental protection activities and environmental and financial performance. They find a positive effect of proactive environmental management on environmental performance via resources and competitive advantage, which also has positive consequences for financial performance. However, the proactive environmental management in their study is not an actual environmental expenditure, but an estimate measured using a questionnaire. In contrast, we examine the relationships between actual ECC and environmental performance using the eco-efficiency index, which can represent the environmental-financial performance pair simultaneously.
12. However, it must be acknowledged that eco-efficiency measures are capturing relative performance. Even with better eco-efficiency, continued production growth can potentially result in increases in absolute carbon emissions.
13. Of course, it must be noted that this period overlaps with the global financial crisis of 2008-2009. And while we assume the Japanese firms were affected by this crisis – we report, for example, reduced levels of ECC – it would not appear to have ramifications with respect to the relation between environmental performance and environmental disclosure.
14. In reality, many firms' operations are outsourced to suppliers, which implies that the firm's aggregate environmental impact also depends on the environmental impact of the members in its supply network (Tate *et al.*, 2012). McDonalds, for example, understands that their environmental impact through the supply chain is critical (Gunther, 2011). In 2012, the total cost of outsourced materials was about 59 per cent of the firm's revenue in the US manufacturing sector (US Census Bureau, 2012).
15. For example, in the case of Toyota Motor Corporation, approximately 80 per cent of ECC is for R&D.
16. CO_2 emissions are an important environmental performance measure because effective CO_2 management to improve energy efficiency and reduce GHGs is now becoming required around the world for continued business growth. As Matsumura *et al.* (2014) point out, accounting research on the value relevance of voluntarily disclosed carbon emissions is rare. We collect data on Scope1 emissions that arise directly from sources that are owned or controlled by the company. Scope2 is

indirect GHG emissions from consumption of purchased electricity, heat or steam. Scope3 is other indirect emissions generated because of a facility's activities, but from sources not owned or controlled by the company (Simnett *et al.* 2009).

17. Total value added is computed by total labor expense plus cash operating profit (defined as operating profit + depreciation expense + interests + taxes). (www.toyokeizai.net/business/industrial/detail/AC/029e7130b51eedd1ef7d80bd5df6feb7/page/1).
18. We multiply −1 by CO_2 emissions/sales (EI) for the convenience of coefficient interpretation following prior studies (Clarkson *et al.*, 2008; Patten, 2002). Lower levels of CO_2 emissions indicate better environmental performance. Alternatively, we take the reverse of CO_2 emissions/sales and run the regressions. Results are not qualitatively changed.
19. Where there were discrepancies between the data in the firms' environmental reports and the annual summary reports of the ERP, we used the environmental report data.
20. We conduct the Hausman test to test the exogeneity of eco-efficiency measures and find that test results generally reject the null, indicating that the 2SLS estimate can be preferable to the OLS estimate. We generally find large partial F(24-60)/partial R^2 (0.39-0.69) to satisfy the relevance criterion. The Sargan tests for over-identifying restrictions generally reject the exogeneity of the instruments to satisfy the exclusion restriction criterion, suggesting that it may not satisfy the exclusion restriction.
21. In non-tabulated sensitivity tests, we take the logarithm form of ECC, CO_2, ROC and CP, and rerun OLS and 2SLS regressions. Results are qualitatively unchanged from those in Tables IV-VIII. In addition, we scale ECCs by total assets and rerun the regressions and results are similar.
22. We classify basic metals, beverage, ceramics, chemicals/pharmaceuticals, food, non-metallic, petroleum, plastics/resins, printing, pulp and paper, rubber, steel/metals, textile/apparels and utility/electricity as energy-intensive industries.

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Appendix

Definition	The goals of environmental accounting are achieving sustainable development, maintaining a favorable relationship with the community, and pursuing effective and efficient environmental conservation activities
Objective	The disclosure of environmental accounting related to environmental conservation activities of firms provides a means for stakeholders to understand, evaluate, and give their support to firms' such efforts
Issuing body	Environmental Accounting Guidelines Review Committee under Ministry of Environment in Japan
Compliance	In 2003, Japanese government set an ambitious objective of having 50% of Japanese firms to disclose environmental accounting by 2010, but recent statistics (Ministry of Environment in Japan 2012) show that 30.6% of companies listed in the Tokyo Stock Exchange do comply with the Guidelines
Revision history	Environmental Accounting Guidelines initially were promulgated in 2000 and subsequently revised in 2005, with the objective of promoting environmental accounting reporting.
Structural elements of environmental accounting	Environmental accounting consists of ECC, environmental conservation benefit and economic benefit associated with environmental conservation activities. Environmental conservation benefits are obtained from the prevention of environmental impact and restoration following a disaster. Economic benefits associated with environmental conservation activities are benefits to a firm's profit as a result of executing environmental conservation activities
Categories of ECC	ECC are categorized according to the relevant business activities, such as business area costs (pollution prevention, global environmental conservation costs and resource recycling costs), upstream/downstream costs, administration costs, R&D costs, social activity costs, environmental remediation costs and other costs

Table AI.
Environmental accounting guidelines in 2005

Notes: Ministry of Environment in Japan, 2005; Environmental Accounting Guideline