ORIGINAL ARTICLE

Motivation of Japanese companies to take environmental action to reduce their greenhouse gas emissions: an econometric analysis

Seiji Ikkatai · Daisuke Ishikawa · Shuichi Ohori · Kengo Sasaki

Abstract To analyze the motivations of Japanese companies to take environmental actions to reduce their greenhouse gas (GHG) emissions, we used FY2006 research data and questioned Japanese industries regarding their reduction of GHG emissions. Empirical investigations revealed that voluntary targets set by industry organizations, government requirements, and advance responses to possible future regulations can positively influence environmental actions for GHG emission reduction; however, cost reductions and corporate social responsibility fulfillment cannot.

Keywords Greenhouse gas emissions ·
Japanese companies · Kyoto protocol ·
Econometric analysis

Introduction

After the coming into effect of the Kyoto Protocol in February 2005, the Japanese government established an "Action Plan for Achieving the Kyoto Protocol Target" based on the "Law Concerning the Promotion of Measures to Cope with Global Warming" and sought to achieve the stipulated target reduction of 6% through the implementation of various policy measures. However, there has been

no improvement in performance in various Japanese sectors with regard to the reduction of greenhouse gas (GHG) emissions. Private sector entities such as businesses and households have displayed a tendency to increase GHG emissions. In particular, the industrial sector—which should be key to achieving the Kyoto Protocol target—has been unable to reduce its GHG emission levels sufficiently. Despite the seriousness of this situation, the Japanese government is seeking to achieve the requisite reduction in GHG emissions primarily through voluntary measures adopted by companies; these measures depend on a companies' internally motivated efforts rather than on mandatory measures such as the carbon tax and emissions trading scheme.

The case of GHG emissions typifies a situation involving external environmental factors. From an economic perspective, policy intervention is required to ameliorate negative externalities and achieve the goal of GHG emission reduction. However, in some developed countries, including Japan, several voluntary approaches also exist.[1] For instance, the Netherlands, Denmark, and the United Kingdom implement negotiated agreements, while the Japan Business Federation implements unilateral commitment (in the form of the Voluntary Action Plan) to reduce GHG emissions.[2] In Japan, companies reduce their GHG emissions in pursuit of self-motivated targets.[3] This type of

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[1] OECD (1999) classifies voluntary approaches into (1) public voluntary programs, (2) negotiated agreements, (3) unilateral commitments, and (4) private agreements.

[2] In addition, many European countries have introduced explicit policy measures to reduce GHG emissions, such as the carbon tax and the emissions trading scheme.

[3] As mentioned above, however, it is very likely that the reduction of GHG emissions in the Japanese industrial sector will not be sufficient to meet the Kyoto Protocol target.

self-regulation, upon which the government relies, is based on the presumption that companies can voluntarily achieve their GHG emission reduction targets by incorporating their reduction plans into the production process. However, the validity of this presumption has not yet been effectively examined.

Therefore, to obtain information on the key factors for improvement with regard to GHG emission reduction by Japanese companies, it is essential to study the internal motivations of private companies to reduce their GHG emissions in the absence of any explicitly mandated policy measures.

In recent times, there has been an increase in the literature on environmental self-regulation; this demonstrates that companies may have some incentives to intrinsically and voluntarily improve their environmental performance. Khanna (2001) summarized companies' incentives for environmental self-regulation thus: (1) preempting the threat of mandatory regulations; (2) shaping future regulations; (3) technical assistance and/or financial subsidies that lower the cost of abatement of emissions; (4) cost efficiency; and (5) better relations with the government and stakeholders including consumers, investors, communities, and other companies in the industry.

In the field of empirical analysis, Henriques and Sadorsky (1996) demonstrate that customer pressure, shareholder pressure, government regulatory pressure, and neighborhood and community group pressure positively correlate with a company's formulation of an environmental plan. For instance, Khanna and Damon (1999) examine the motivations for companies to participate in the voluntary 33/50 Program of the United States chemical industry. The results of their estimation suggest that the benefits—from public recognition and avoidance of the potential costs of liabilities and compliance with environmental regulations—lead to positive participation incentives. Videras and Alberni (2000) demonstrate that participation in the Environmental Protection Agency's voluntary environmental programs has a statistically significant correlation with publicity, a companies' poor track record in highly regulated pollutants, and technology transfer potential. Moreover, in the field of environmental management, Khanna and Anton (2002) show that the threat of environmental liabilities, the high cost of compliance, market pressure, and public pressure on companies with high on-site toxic emissions per unit output create incentives for companies to adopt a more comprehensive environmental management approach. In addition, Anton et al. (2004) demonstrate that liability threats and pressure from consumers, investors, and the public emphasize the need to adopt an environmental management system.

Also in the case of Japanese companies, there are some empirical results on the determinants of voluntary environmental actions. Nakamura et al. (2001) indicate that the degree of institutionalization of environmental corporate policies and the acquisition of ISO 14001 certification are positively associated with the environmental values, beliefs, and attitudes of managers. Arimura et al. (2007) show that the acquisition of ISO 14001 certification and the publication of environmental reports are positively correlated with reductions in environmental impact. In addition, assistance programs offered by local governments promote the adoption by companies of ISO 14001.

However, very few studies have investigated the extent to which companies' motivations lead to actual behaviors toward the achievement of their GHG emission reduction goals. In this context, we analyzed the motivations of Japanese companies to take environmental actions to reduce their GHG emissions. This was done using FY2006 research data and through an examination of the state of Japanese industries with regard to their reduction of GHG emissions. This paper also attempts to clarify the extent to which various types of motivation affect companies' actual behaviors toward GHG emission reduction. Our analysis will have implications not only for governments when they design public policy schemes but also for companies when they set GHG reduction targets in response to the implementation of voluntary targets by their respective sectors. The next section describes the empirical investigations we conducted for this purpose.

Empirical investigations

Logic of the investigation

We hypothesized the following motivations for companies to reduce their GHG emissions:

Hypothesis 1: The establishment of a voluntary target in each industry group positively impacts environmental actions taken to reduce GHG emissions.

Most Japanese industry groups set their own GHG emission reduction targets. Companies belonging to a particular industry organization have incentives to monitor their mutual GHG emission reduction performance since the voluntary target is based on agreement within the group. If a company fails to uphold the agreement, its declining reputation can worsen its business environment. Thus, a company's incentive to free-ride is diminished. In this regard, Arimura et al. (2007) verify that the influence of industrial associations positively correlates with publication of a companies' environmental reports.

Hypothesis 2: Cost-cutting factors will induce environmental actions to reduce GHG emissions.

The reduction of GHG emissions implies the possibility of cost efficiency improvement through energy

conservation. This suggests that some cost-cutting factors will induce environmental actions, as stated by Khanna (2001).

Hypothesis 3: Preferential treatment from the government or financial institutions will promote environmental actions to reduce GHG emissions.

As empirically demonstrated by Videras and Alberni (2000), preferential treatment from the government or financial institutions (e.g., tax reduction, subsidies, technology transfer, and low-interest loans) will promote environmental action. In addition, Arimura et al. (2007) revealed that assistance programs offered by local governments can promote facilities' adoption of ISO 14001.

Hypothesis 4: Regulations such as the Act Concerning the Rational Use of Energy (hereafter referred to as the energy conservation law) will enhance environmental action to reduce GHG emissions.

The Japanese government has implemented an energy conservation law to rationalize the use of industrial energy. This act requires that companies of a certain size notify the government of their energy consumption and their plans for energy conservation. Moreover, the law adopts the leading runner approach in order to make companies use their energy resources more efficiently. It is possible that this energy conservation law will encourage environmental action to reduce GHG emissions.

Hypothesis 5: Business connections with counterparties and consumers will positively affect environmental action to reduce GHG emissions.

Henriques and Sadorsky (1996) demonstrate that a company's formulation of an environmental plan is positively correlated with customer pressure. Furthermore, Khanna (2001) indicates that better relations with stakeholders, including consumers and other companies in the same industry, are among a company's incentives for environmental self-regulation. This suggests that securing customers can serve as an incentive for related environmental actions to reduce GHG emissions.

Hypothesis 6: The possibility of future regulations on GHG emissions will spur related ex-ante environmental actions to reduce GHG emissions.

According to Khanna (2001), one of a company's motivations for voluntary environmental action involves preempting the threat of mandatory regulations. For companies, an ex-ante response to possible future regulations can lessen the opportunity cost of responding to regulations by public entities.

Hypothesis 7: Corporate social responsibility (CSR) can trigger environmental actions to reduce GHG emissions.

Khanna and Damon (1999) show that avoidance of the potential costs of liabilities and compliance with environmental regulations can lead to positive participation incentives for the voluntary 33/50 Program of the United States chemical industry. Similarly, Videras and Alberni (2000), Khanna and Anton (2002), Anton et al. (2004), and Nakamura et al. (2001) demonstrate that public pressure is positively correlated with environmental self-regulation, including participation in voluntary environmental programs and the introduction of environmental management systems.

According to each of these hypotheses, we constructed a set of explanatory variables that reflect the extent of a company's motivation to reduce GHG emissions. In the model postulated, the explanatory variables that are expected to affect a companies' efforts to reduce GHG emissions include the following: establishment of a voluntary target in each industry group (*vol_target*, Hypothesis 1); cost reduction (*cost_cut*, Hypothesis 2); preferential treatment from the government or financial institutions (*pref_treat*, Hypothesis 3); government requirements such as the energy conservation law (*law*, Hypothesis 4); securing customers (*custm*, Hypothesis 5); advance responses to possible future mandatory environmental regulations (*future_reg*, Hypothesis 6); and CSR (*csr*, Hypothesis 7).

Model

We employed a probability model (logistic regression model) to identify the nexus between companies' motivations and their actions to reduce GHG emissions:

$$
y = \begin{cases} 0 & \text{w.p.} \quad \Pr[y=0] = 1 - F(\beta'X) \\ 1 & \text{w.p.} \quad \Pr[y=1] = F(\beta'X) \end{cases}
$$

$$
\beta'X = a_1 \times emp + a_2 \times profit \tag{1}
$$
$$
+ \sum_j a_j \times motive\_j + \sum_k a_k \times dm\_k,
$$

$$
F(z) = \frac{\exp(z)}{1 + \exp(z)},
$$

where a binary explained variable y denotes whether ($y = 1$) or not ($y = 0$) a company takes environmental action to reduce GHG emissions. β is a coefficient vector, X is a matrix encompassing the explanatory variables, and ε is an i.i.d. error term that follows logistic distribution with mean zero. $\Pr[y = n]$ is the probability that the explained variable y takes value n (=0, 1). $F(\cdot)$ is the cumulative density function of the logistic distribution; emp denotes the number of employees; *profit* denotes the amount of ordinary profit or loss (in million yen); *motive_j* represents the extent to which the company's motivation j for reducing GHG emissions is serious; *motive_j* can take the discrete values of 1, 2, 3, or 4; dm_k is the dummy variable of industry k; and a is the coefficient of the explanatory variable i.

Data and empirical strategy

We conducted a survey in October 2006 to obtain data that is compatible with the empirical model described above. We sent questionnaires to the companies listed in the first and second sections of the Tokyo Stock Exchange and Osaka Stock Exchange. The total number of listed companies was 2,443, and the number of effective responses was 589; thus the response rate was 24.1%.

In the questionnaire, we queried companies regarding: (1) the company profile for 2005 (industry, capital, sales, ordinary profit or loss, and number of employees); (2) whether or not the company takes environmental action to reduce GHG emissions; and (3) the company's motivation for reducing GHG emissions and the extent to which its motivations are serious. The studies referred to in the Introduction were used to identify the motivations about which companies were queried in the questionnaire.

In Fig. 1, we juxtapose the sector distribution of our sample and that of the companies listed in the Tokyo and Osaka stock exchanges. On examining Fig. 1, these two distributions appear to be similar; however, the component percentages of the "Commerce" and "Service, Information, Communication" sectors in our sample are lower than those for the listed companies. This disparity would suggest that companies belonging to these two sectors, which are essentially non-manufacturing companies, are not very interested in our survey and are less responsive because they consume less energy than companies in other, energy-intensive manufacturing industries. In Fig. 2, we compare the distribution of company sizes (number of employees) in our sample and that of the companies listed in the stock exchanges; these two distributions appear to be similar. In Fig. 3, we collate the distribution of ordinary profits obtained in our sample and that of the companies listed in the stock exchanges; here again, we find that the two distributions are similar. Based on these findings, we conclude that the sample in our study can effectively represent the entire listing of the two stock exchanges.

Detailed definitions of the variables y, extent of motivation ($motive\_j$), and industry dummy (dm_k) are shown in Tables 1, 2, and 3. The descriptive statistics of these variables are shown in Table 4.

We estimated Eq. 1 by the maximum likelihood method. We utilized the robust standard error proposed by White (1980), although the possible heteroskedasticity of the error term may be slight due to the inclusion of the scale variable, namely the number of employees (emp). It is worth emphasizing that an endogeneity problem between the explanatory variable $motive\_j$ and the explained variable y may not arise because the motivations by themselves can predetermine the actions.

Results of empirical estimation

Estimation results are shown in Tables 5 and 6. Table 5 shows the estimated coefficients of Eq. 1, while Table 6 shows their marginal effects, which are evaluated at the
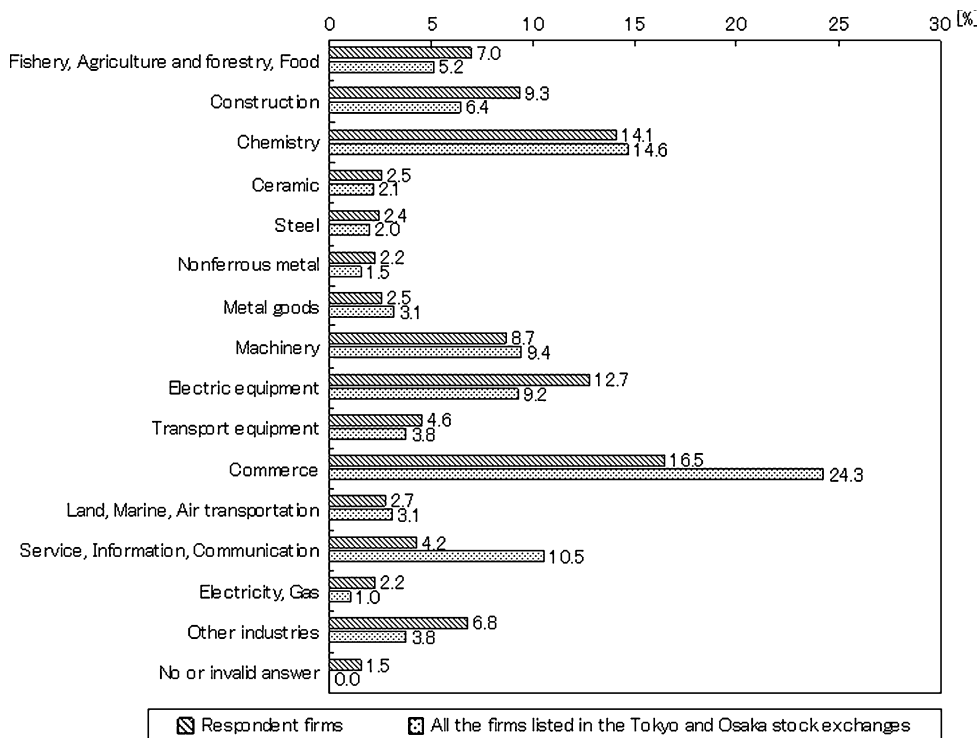

Fig. 1 Sector distributions

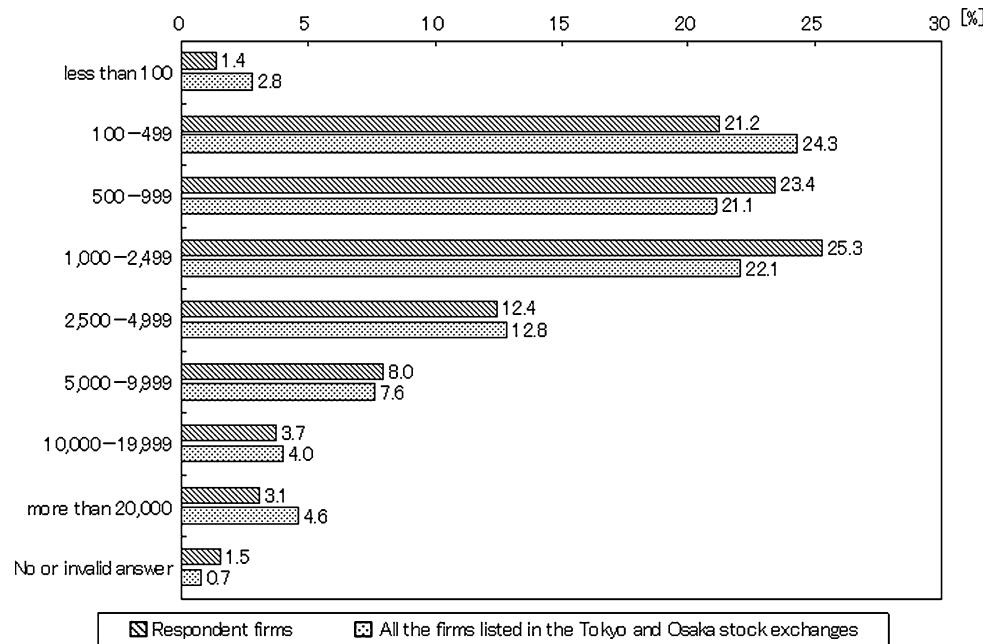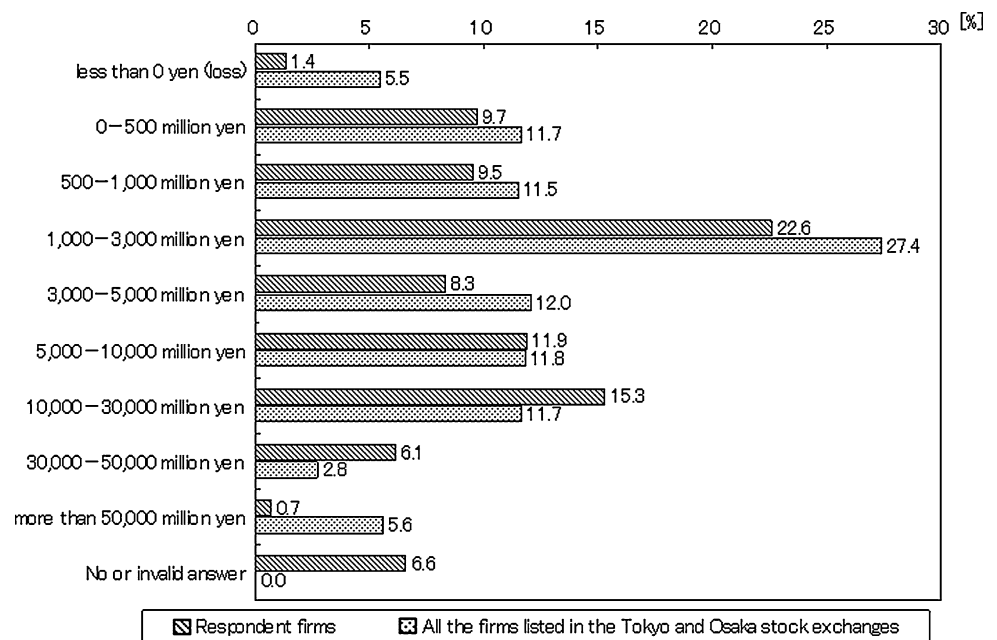**Fig. 2** Distribution of number of employees

Fig. 3 Distribution of the amount of ordinary profits or losses

mean values of the independent variables. The results referred to in the following are the estimated marginal effects.

Examination of Table 6 reveals that five out of the seven hypotheses presented above agreed with our empirical results. First, as predicted in Hypothesis 1, the motivation to achieve the voluntary target in each industry organization (*vol_target*) is positively and significantly correlated with the actual behaviors of the companies, with the exception of the introduction of environmental management systems

(*ems*) and environmental reports (*eco_report*). Second, as stated in Hypothesis 3, the motivation of receiving preferential treatment from the government or financial institutions (*pref_treat*) is positively and significantly correlated with the introduction of environmental accounting (*eco_accounting*) and calculation of the marginal abatement cost associated with the reduction of GHG emissions (*cal_mac*). Third, as in Hypothesis 4, the motivation of dealing with governmental requirements such as the energy conservation law (*law*) is positively and significantly

Table 1 Explained variable y [whether or not a company takes environmental action to reduce greenhouse gas (GHG) emissions]

Description of explained variable y: *symbol*. Definition: *0* No, *1* Yes
Introduction of an environmental management system: *ems*
Publication of an environmental report: *eco_report*
Introduction of environmental accounting: *eco_accounting*
Companies setting their own targets for the reduction of GHG emissions: *target*
Calculation of GHG emission reduction data: *cal_emission*[a]
Calculation of the cost associated with GHG emission reduction: *cal_cost*
Calculation of the marginal cost associated with GHG emission reduction: *cal_mac*

[a] *cal_emission* = 1 (*cal_cost* = 1, *cal_mac* = 1) includes cases in which the company has prepared to calculate GHG emission reduction data (cost associated with GHG emission reduction, marginal cost associated with GHG emission reduction)

Table 2 Explanatory variable *motive_j* (the extent to which a company's motivation j for reducing GHG emissions is serious). Definition: *1* No concern, *2* not so concerned, *3* serious, *4* very serious. *CSR* Corporate social responsibility

Description of the explanatory variable *motive_j*: *symbol*
To achieve the voluntary target in each industry group: *vol_target*
To cut costs: *cost_cut*
To receive preferential treatment from the government or financial institutions: *pref_treat*
To deal with government requirements (the energy conservation law, etc.): *law*
To secure customers: *custm*
To respond in advance to possible future mandatory environmental regulations: *future_reg*
To fulfill CSR: *csr*

Table 3 Industry dummy variable (*dm_k*)

Dm_foods	Fishery, agriculture and forestry, food = 1	Otherwise = 0
dm_const	Construction = 1	Otherwise = 0
dm_chem	Chemical = 1	Otherwise = 0
dm_ceramic	Ceramic = 1	Otherwise = 0
dm_steel	Steel = 1	Otherwise = 0
dm_noferr	Non-ferrous metal = 1	Otherwise = 0
dm_mtlgoods	Metal goods = 1	Otherwise = 0
dm_machine	Machinery = 1	Otherwise = 0
dm_elect	Electric equipment = 1	Otherwise = 0
dm_car	Transport equipment = 1	Otherwise = 0
dm_commerce	Commerce = 1	Otherwise = 0
dm_transport	Land, marine, air transportation = 1	Otherwise = 0
dm_info	Service, information, communication = 1	Otherwise = 0
dm_energ	Electricity, gas = 1	Otherwise = 0
dm_ot	Other industries = 1	Otherwise = 0

correlated with the following four environmental actions: *ems*, *eco_accounting*, companies setting their own reduction targets for GHG emissions (*target*), and the calculation of emission reduction data (*cal_emission*). Fourth, as in Hypothesis 5, the motivation of securing customers (*custm*) is positively and significantly correlated with *ems*. Fifth, as stated in Hypothesis 6, the motivation of responding in advance to possible future mandatory environmental regulations (*future_reg*) is positively and significantly associated with *eco_accounting* and *cal_mac*.

By contrast, it is interesting to note that two hypotheses—Hypotheses 2 and 7—do not agree with our empirical findings. The motivations of cutting costs (*cost_cut*) and fulfilling CSR (*csr*) do not drive companies to the environmental actions listed here. Does this result from the less volatile features of *cost_cut* and *csr*? Inspections and

comparisons of the standard deviations of the explanatory variables in Table 4 do not clearly validate this inference; the standard deviations of *cost_cut* and *csr* are 0.6595 and 0.5250, respectively, while those of *law* and *future_reg* are 0.6600 and 0.6616, respectively, that is, they have very similar magnitudes.

The number of employees (*emp*), which is a proxy for the scale of a company, has a positive and significant correlation with the environment actions of *eco_report*, *target*, *cal_emission*, and *cal_cost*. The earned profit (*profit*) exerts positive and significant effects on the environmental practices of *eco_accounting* and *cal_emission*. In other words, large and profitable companies are more eager to engage in environmental actions, which is intuitively reasonable.

With regard to the industry dummies, it is very interesting to note that the dummy variable of commerce sector, *dm_commerce*, has negative and significant correlations with the environmental actions of *eco_accounting*, *target*, *cal_emission*, *cal_cost*, and *cal_mac*. This would suggest that companies in the commerce sector, which comprise essentially non-manufacturing companies, are not very interested in environmental actions to reduce GHG emissions because they consume less energy than companies in some other energy-intensive manufacturing industries.

Implications and discussions

These results suggest five implications. First, voluntary targets for the reduction of GHG emissions, established by industry organizations, can motivate Japanese companies to act toward the reduction of GHG emissions. This is indicated by our finding that this motivation has positive

Table 4 Descriptive statistics. *Obs* Number of observations, *SD* standard deviation

Variables	Obs.	Mean	SD	Minimum	Maximum
Environmental actions to reduce GHG emissions *y* (explained variables)					
ems	583	0.8542	0.3532	0	1
eco_report	584	0.5839	0.4933	0	1
eco_accounting	587	0.4855	0.5002	0	1
target	560	0.6054	0.4892	0	1
cal_emission	555	0.7604	0.4272	0	1
cal_cost	553	0.4340	0.4961	0	1
cal_mac	553	0.3291	0.4703	0	1
Company profiles (explanatory variables)					
emp	580	4.15e + 3	1.74e + 4	13	3.34e + 5
profit	550	2.10e + 4	6.16e + 4	−6.43e + 4	8.48e + 5
Motives for GHG emission reduction *motive_j* (explanatory variables)					
vol_target	542	2.9539	0.8445	1	4
cost_cut	542	3.1956	0.6595	1	4
pref_treat	542	2.3137	0.7505	1	4
law	547	3.3876	0.6600	1	4
custm	538	2.4981	0.8102	1	4
future_reg	545	3.0844	0.6616	1	4
csr	546	3.5238	0.5250	2	4
Industry dummy variable *dm_k* (explanatory variables)					
dm_foods	579	0.0691	0.2538	0	1
dm_const	579	0.0950	0.2935	0	1
dm_chem	579	0.1434	0.3507	0	1
dm_ceramic	579	0.0259	0.1590	0	1
dm_steel	579	0.0242	0.1537	0	1
dm_noferr	579	0.0225	0.1483	0	1
dm_mtlgoods	579	0.0259	0.1590	0	1
dm_machine	579	0.0881	0.2837	0	1
dm_elect	579	0.1295	0.3361	0	1
dm_car	579	0.0466	0.2110	0	1
dm_commerce	579	0.1675	0.3738	0	1
dm_transport	579	0.0276	0.1641	0	1
dm_info	579	0.0432	0.2034	0	1
dm_energ	579	0.0225	0.1483	0	1
dm_ot	579	0.0691	0.2538	0	1

and significant correlations with five out of the seven actions for GHG emission reduction in the questionnaire. However, it should be noted that the voluntary targets presently adopted in Japan may not be sufficiently demanding. For example, the Japan Business Federation Voluntary Action Plan, which implements unilateral commitment to reducing GHG emissions, stipulates that, by 2010, Japanese companies should reduce their CO_2 emissions to below the level emitted in 1990; in addition, some industries have voluntarily committed themselves to unit-

based—and not absolute—targets, which seem rather weak when compared with the target stipulated by the Kyoto Protocol. Therefore, under present circumstances, it would seem difficult to expect companies to set stringent targets voluntarily in order to reduce their GHG emissions more intensively. In terms of comparison with previous studies conducted in Japan, Arimura et al. (2007) report that the influence of industrial associations has positive and significant effects on the publication of environmental reports; however, this result is not the main concern in their study. Since we were unable to find a significant correlation between the motivation of voluntary targets and the publication of environmental reports, the results of the two studies disagree. However, it would not be appropriate to directly compare our result with those of Arimura et al. (2007) because the unit of observation in their study is facilities, which include companies not listed in the stock exchanges; thus the coverage of their sample is broader than ours. In terms of comparison with studies conducted in the United States, our study is consistent with that of Khanna (2001).

Second, government requirements (e.g., the energy conservation law) can positively influence environmental actions to reduce GHG emissions in Japan. In contrast, in a previous empirical study in Japan, Nakamura et al. (2001) showed that a governmental pressure index had a negative and significant correlation with the acquisition of ISO 14001, implying that government pressure can jeopardize companies' voluntary efforts to enroll in an environmental management system. This result is entirely contrary to our findings. However, we should be aware that the results of the Nakamura study are not completely robust. If some dummy variables are excluded from the estimation equation, the statistical significance with regard to the government pressure index will easily disappear.

Third, the positive and significant correlation between the anticipation of future regulations and actual present behaviors implies that adopting a forward-looking path can be effective in Japan; in other words, setting a clear schedule for enacting a mandatory government policy in the near future can affect companies' present behaviors with regard to reducing GHG emissions. This is in relative agreement with previous studies conducted in the United States, such as that of Khanna (2001). To the best of our knowledge, there are no previous studies on this issue in Japan. Therefore, this finding may prove to be an important contribution to the literature in this field.

Fourth, cutting costs cannot be viewed as sufficient incentive for environmental actions to reduce GHG emissions in Japan. This result is inconsistent with that of Khanna (2001). In our study, the reason for this could be that spurious correlations between the motivation of companies to cut costs and their actual behaviors for reducing

Table 5 Estimates of Eq. 1 (nexus between companies' motivations and environmental actions to reduce GHG emissions)

	ems	eco_report	eco_accounting	target	cal_emission	cal_cost	cal_mac
vol_target	−0.350	0.705***	0.825***	0.895***	0.715***	0.499***	0.705***
cost_cut	−0.205	−0.354	−0.314	0.084	−0.313	0.050	−0.051
pref_treat	0.312	0.497**	0.524**	−0.198	0.180	0.270	0.502**
law	0.755**	0.007	0.555**	0.645**	0.686**	0.176	0.175
custm	0.382*	−0.290	−0.358**	−0.184	−0.081	0.011	−0.027
future_reg	0.220	0.353	0.464**	0.140	0.129	0.312	0.508**
csr	0.124	0.598**	0.419	0.226	0.450	0.329	0.242
emp	−1.30e − 5	4.04e − 4*	2.75e − 6	2.25e − 4***	1.56e − 4*	1.97e − 4**	2.92e − 5
profit	8.11e − 6	3.23e − 5***	2.61e − 5**	1.30e − 5	2.56e − 5**	1.92e − 6	8.37e − 6
dm_foods	0.344	0.749	0.023	0.732	1.879	−0.347	−0.346
dm_const	0.399	−0.358	−0.440	−0.447	−1.216*	−0.936*	−1.176**
dm_chem	1.355*	0.939*	−0.318	0.864	0.753	−0.127	−0.427
dm_ceramic	0.049	−0.285	−0.108	0.693	1.397	−0.248	−0.322
dm_steel	0.602	−0.815	−1.200	0.600	−0.899	−0.033	−0.331
dm_noferr	–	1.485	0.089	0.389	–	−0.712	−1.064
dm_mtlgoods	–	−0.905	−2.084**	1.161	0.242	−1.122	−1.197
dm_machine	−0.492	−0.464	−0.749	0.413	−0.148	−0.024	−0.475
dm_elect	1.941**	0.835	0.399	1.216**	0.809	0.491	0.218
dm_car	–	−0.300	0.468	−0.100	0.231	0.185	0.421
dm_commerce	−0.442	−0.939*	−1.428**	−1.330**	−2.172***	−2.120***	−1.901***
dm_transport	−0.763	−0.398	−1.049	−1.124	−1.366	0.941	−2.143*
dm_info	0.257	−2.078***	−1.547**	0.038	−1.271*	−1.171	−0.066
dm_energ	–	–	−0.543	−1.088	–	−0.783	−0.879
constant	−1.864	−4.755***	−6.319***	−5.455***	−4.016***	−5.332***	−6.555***
Obs.	430	477	493	488	462	484	484
Log pseudo-likelihood	−141.949	−199.776	−228.877	−215.799	−151.689	−235.445	−226.503

The logistic regression model was employed. Explained variables are in the first row and explanatory variables are in the first column. The coefficient of *dm_ot* (dummy variable of other industries) cannot be estimated due to a multicolinearity problem. A minus value indicates that the corresponding coefficient of *dm_k* (dummy variable of industry *k*) cannot be reported because all of the realizations of the explained variable are the same within industry *k*; thus the samples belonging to industry *k* are excluded

***, **, * Variables significant at the 1, 5, and 10% levels, respectively

GHG emissions vanish due to the control of various factors such as the number of employees or the industry sector to which the company belongs. Another possible reason could be that a company has already reached the point at which they cannot make any further progress in simultaneously reducing GHG emissions and cutting costs. To the best of our knowledge, this paper is the first to provide an empirical investigation of this point in the context of Japanese firms; hence, it should contribute to the literature in the field also in this regard.

Fifth, the fulfillment of CSR cannot serve as a motivation to reduce GHG emissions in Japan. This result is consistent with that of Arimura et al. (2007), but not with that of Nakamura et al. (2001). Arimura et al. show that the influence of the community and the importance of the company's image do not have significant impacts on the acquisition of ISO 14001 and the publication of environmental reports.

Nakamura et al. (2001) demonstrate that a civil society pressure index is positively and significantly correlated with the acquisition of ISO 14001, a rather robust finding in this case. The main distinction between the work of Nakamura et al. and our study lies in the respondents to the questionnaire: Nakamura et al. chose one executive per company as the respondent, whereas we asked a person in charge of environmental affairs at each company for a response. One possibility is that executives tend to be more sensitive to demands from civil society. In comparison with previous studies in the United States, the results of our study are not in accordance with those of Khanna and Damon (1999), Videras and Alberni (2000), Khanna and Anton (2002), or Anton et al. (2004). These studies state that public pressure is positively and significantly correlated with environmental self-regulation, including participation in voluntary environmental programs and the introduction of environmental

Table 6 Estimated marginal effects of Eq. 1 (nexus between companies' motivations and environmental actions to reduce GHG emissions)

	ems	eco_report	eco_accounting	target	cal_emission	cal_cost	cal_mac
vol_target	−0.028	0.061	0.201***	0.146***	0.044**	0.124***	0.149***
cost_cut	−0.016	−0.031	−0.076	0.014	−0.019	0.012	−0.011
pref_treat	0.025	0.043	0.127**	−0.032	0.011	0.067	0.106**
law	0.060**	6.00e−4	0.135**	0.105**	0.042*	0.043	0.037
custm	0.030*	−0.025	−0.087**	−0.030	−0.005	0.003	−0.006
future_reg	0.017	0.031	0.113**	0.023	0.008	0.078	0.107**
csr	0.010	0.052	0.102	0.037	0.027	0.082	0.051
emp	−9.95e − 7	3.51e − 5***	6.69e − 7	3.65e − 5***	9.52e − 6**	4.89e − 5**	6.16e − 6
profit	6.40e − 7	2.81e − 6	6.34e − 6***	2.11e − 6	1.56e − 6**	4.78e − 7	1.76e − 6
dm_foods	0.024	0.050	0.006	0.098	0.062**	−0.086	−0.068
dm_const	0.028	−0.035	−0.109	−0.081	−0.115	−0.226*	−0.195***
dm_chem	0.076**	0.063	−0.078	0.116*	0.037	−0.032	−0.084
dm_ceramic	0.004	−0.028	−0.026	0.092	0.050**	−0.062	−0.063
dm_steel	0.038	−0.096	−0.288	0.082	−0.080	−0.008	−0.065
dm_noferr	−	0.075	0.021	0.056	−	−0.175	−0.174*
dm_mtlgoods	−	−0.110	−0.441***	0.133**	0.013	−0.264	−0.190*
dm_machine	−0.046	−0.047	−0.185	0.061	−0.009	−0.006	−0.092
dm_elect	0.096***	0.058	0.094	0.150***	0.039	0.119	0.047
dm_car	−	−0.029	0.108	−0.017	0.013	0.046	0.095
dm_commerce	−0.039	−0.104	−0.341**	−0.267**	−0.250**	−0.457***	−0.291***
dm_transport	−0.081	−0.040	−0.255	−0.234	−0.145	0.214	−0.264***
dm_info	0.018	−0.348**	−0.357**	0.006	−0.129	−0.274	−0.014
dm_energ	−	−	−0.135	−0.226	−	−0.191	−0.152

These marginal effects are evaluated at the mean values of the explanatory variables (refer to notes in Table 5)

management systems. Although the previous US studies appear to arrive largely at a consensus on the effectiveness of CSR on environmental actions, the findings of Japanese studies on this point, including those of our study, are mixed and remain moot.

Conclusion

In this study, we have analyzed Japanese companies' motivations to take environmental action to reduce their GHG emissions, using FY2006 research data and inquiries on the state of Japanese industries with regard to their reduction of GHG emissions.

Our empirical investigations revealed five findings. First, voluntary targets for GHG emission reduction set by industry organizations can encourage Japanese companies to act on reducing their GHG emissions. Second, government requirements (e.g., the energy conservation law) can exert positive effects on environmental action to reduce GHG emissions. Third, advance responses to future regulations can affect companies' present behaviors with regard to reducing GHG emissions. Fourth, cost reductions cannot be viewed as a sufficient incentive to reduce GHG

emissions. Fifth, the fulfillment of CSR cannot provide motivation for reducing GHG emissions.

In particular, the third and fourth findings—the effectiveness of a forward-looking path and the ineffectiveness of the cost-cutting incentive for environmental actions to reduce GHG emissions—have not been referred to in previous studies conducted in Japan. Therefore, these findings represent an important contribution to the literature.

Based on our investigation, we conclude that the following measures will be effective in enhancing the performance of Japanese industries with regard to reduction of their GHG emissions: (1) Japanese industries should set more stringent voluntary targets for themselves; however, it may be difficult to realize these targets due to their voluntary nature; (2) the government should strengthen existing regulations; and (3) the government should set a concrete schedule for introducing regulations that can effectively reduce GHG emissions in the future.

References

Anton WRQ, Deltas G, Khanna M (2004) Incentives for environmental self-regulation and implications for environmental performance. J Environ Econ Manage 48(1):632–654

Arimura TH, Hibiki A, Katayama H (2007) Is a voluntary approach an effective environmental policy instrument? A case for environmental management systems. Discussion paper 07–31, Resources for the future (available from http://www.rff.org/rff/Publications/Discussion_Papers.cfm)

Henriques I, Sadorsky P (1996) The determinant of an environmentally responsive firm: an empirical approach. J Environ Econ Manage 30(3):381–395

Khanna M (2001) Non-mandatory approaches to environmental protection. J Econ Surv 15(3):291–324

Khanna M, Anton WRQ (2002) Corporate environmental management: regulatory and market-based incentives. Land Econ 78(4):539–558

Khanna M, Damon LA (1999) EPA's voluntary 33/50 program: impact on toxic releases and economic performance of companies. J Environ Econ Manage 37(1):1–25

Nakamura M, Takahashi T, Vertinsky I (2001) Why Japanese companies choose to certify: a study of managerial responses to environmental issues. J Environ Econ Manage 42(1):23–52

OECD (1999) Voluntary approaches for environmental policy: an assessment. OECD, Paris

Videras J, Alberni A (2000) The appeal of voluntary environmental programs: which companies participate and why? Contemp Econ Policy 18(4):449–461

White H (1980) A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48(4):817–838