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What Factors Facilitate Environmental Practices Through the Supply Chain? The Case of Scope 3

Hakaru Iguchi*, Faculty of Management, Atomi Univ.

Hajime Katayama†, Faculty of Commerce, Waseda Univ.

Toshi H. Arimura‡, Faculty of Political Science and Economics, Waseda Univ.

Abstract

Using data from a survey of Japanese manufacturing firms, we identified the determinants of a firm's choice to measure Scope 3 emissions, which are all indirect emissions that occur in the supply chain of firms, including both upstream and downstream emissions. Our result shows that the firms that were asked by stakeholders, such as investors and consumers, to reduce GHG emissions tend to measure more Scope 3 categories. Additionally, for these firms, requests for information disclosure from their customers have a stronger effect on measuring Scope 3 emissions. In the case of measuring Scope 3 emissions, which requires cooperation with suppliers and customers, requests from downstream of the supply chain play an important role. We also found that being subject to Carbon Disclosure Project (CDP) or answering to CDP questionnaire induces firms to measure Scope 3 emissions.

1 Introduction

Until recently, firms have focused their attention on emissions from their own operations, but they are increasingly coming to understand the need to manage GHG-related risks and opportunities through their supply chains (Greenhouse Gas

* Faculty of Management, Atomi University, 1-9-6, Nakano, Niza-shi, Saitama, 352-8501, Japan. E-mail: igchhkr@gmail.com

† Faculty of Commerce, Waseda University.

‡ Faculty of Political Science and Economics, Waseda University.

Protocol, 2012). A complete GHG inventory, including emissions through the supply chain, is classified into three types of scopes: all direct GHG emissions (Scope 1), indirect GHG emissions from consumption of purchased electricity, heat or steam (Scope 2), and other indirect emissions (Scope 3). Scope 3 emissions are composed of 15 distinct categories, which correspond to emissions within the supply chain. It is expected that measuring GHG emissions in Scope 3 will shed light on reduction opportunities and enable firms to carry out effective measures toward emission reduction (Kingsbury, et al., 2012). In developed countries, many large firms come to engage in this proactive environmental practice (Carbon Disclosure Project, 2013).

Studies on other proactive environmental practices have already been conducted. The determinants of these practices are examined in these studies by focusing on the following viewpoints: (1) pressure from the stakeholder; (2) environmental management system (EMS), and (3) requests from customers. First, from the view of stakeholder theory, the determinants of proactive environmental practices have been examined (Buysse & Verbeke, 2003, Murillo-Luna et al., 2008, Darnal et al., 2010). These studies suggested that as firms face more pressure from stakeholders, they more actively adopt environmental practices. Second, from the Resource Based View (RBV), it has been noted that EMS facilitates firms' proactive environmental practices. In particular, ISO 14001 certification is treated as a determinant of various proactive environmental practices. ISO 14001 follows a Plan - Do - Check - Action management cycle. Through this PDCA cycle, firms acquire firm-specific knowledge about environmental strategies. Therefore, it is considered that firms with ISO 14001 certification experience tend to adopt proactive environmental practices, such as assessing their suppliers' environmental performance (Arimura et al., 2011). In addition, some studies have found that requests from customers facilitate suppliers' proactive

environmental practices (Halkos & Evangelinos, 2002, Nishitani, 2010). Halkos & Evangelinos (2002) revealed that pressure from customers to improve environmental performance facilitates firms' proactive environmental practices, such as the adoption of EMS.

Additionally, in the case of firms' exercise of measuring Scope 3 emissions, there is a possibility that the Carbon Disclosure Project (CDP) affects these exercises. CDP is an international, not-for-profit organization that provides the only global system for firms and cities to measure, disclose, manage and share vital environmental information (CDP 2013). The CDP questionnaire includes a question asking to what extent firms calculate Scope 3 emissions[§]. Therefore, there is a possibility that firms that have experience with CDP or answering the CDP questionnaire tend to measure Scope 3 emissions more actively.

In this study, we analyze the determinants of a firm's choice to measure Scope 3 emissions using data from a survey of Japanese manufacturing firms. The key contribution of this study is that it focuses on a state-of-the-art environmental practice, which is popular worldwide, and there is little, if any, empirical research on Scope 3 emissions.

This paper is organized as follows. Section 2 provides the econometric model and methodology used for the analysis. Section 3 describes the data, and Section 4 discusses the result. Section 5 presents the conclusions and implications of this study.

2 Empirical Model

We modeled the firms' behavior of measuring Scope 3 emissions. The

[§] The climate change information questionnaire has been sent to 500 of the largest firms since 2009 based on market capitalization. In the CDP report, which is published each year, various firm information regarding climate change is reported.

controlled variable, *NUMACT*, represents the number of Scope 3 categories that the companies measured. *NUMACT* is a nonnegative integer, its maximum value is 15, and it is a count variable. If the controlled variable is a count variable, the Poisson regression model has been widely used. However, we use an alternative approach, a negative binomial model, to model over-dispersion. A negative binomial model can relax the Poisson assumption that the mean equals the variance. It is used to start from a Poisson regression model.

$$P(n_i) = \frac{\lambda_i^{n_i} \exp(-\lambda_i)}{n_i!}$$

where n_i is the observed number of counts for 1, 2,…, n and λ_i is the mean of the Poisson distribution. The most common formulation for λ_i is the exponential model.

$$\lambda_i = E(n_i) = \exp(\beta X_i)$$

where X_i is a vector of independent variables and β_i is a vector of regression parameters. The Poisson estimates $\hat{\beta}_i$ are easy to obtain after maximizing the log-likelihood function:

$$L(\beta) = \prod_i \frac{\exp\left[-\exp(\beta X_i)\right] \left[\exp(\beta X_i)\right]^{n_i}}{n_i!}$$

The negative binomial model relaxes the equidispersion restriction of the Poisson model by introducing latent heterogeneity in the conditional mean of the Poisson model (Greene, 2008)

$$\lambda_i = \exp(\beta X_i + \varepsilon_i)$$

where $\exp(\varepsilon_i)$ is assumed to have a one-parameter gamma distribution. Thus, we estimate the conditional probability density from the following equation:

$$P(n_i \mid \varepsilon) = \frac{\exp\left[-\lambda_i \exp(\varepsilon_i)\right] \left[\lambda_i \exp(\varepsilon_i)\right]^{n_i}}{n_i!}$$

From the above formula, subject to the condition that ε_i is constant, we can calculate the probability density function:

$$P(n_i) = \frac{\Gamma(\theta + n_i)}{[\Gamma(\theta) \cdot n_i!]} \cdot u_i^{\theta} (1 - u_i)^{n_i}$$

where $u_i = \theta / (\theta + \lambda_i)$, $\theta = 1/\alpha$, and $\Gamma(\cdot)$ is the gamma function. The corresponding log-likelihood function is

$$L(\lambda_i) = \prod_i^N \frac{\Gamma(\theta + n_i)}{\Gamma(\theta) n_i!} \left[\frac{\theta}{\theta + \lambda_i} \right]^{\theta} \left[\frac{\lambda_i}{\theta + \lambda_i} \right]^{n_i}$$

where N denotes sample size. We can relax the Poisson assumption that the mean equals the variance as follows:

$$\mathrm{var}(n_i) = E[n_i] \, [1 + \alpha E[n_i]]$$

where α denotes the variance of error term that follows gamma distribution and the over-dispersion parameter. If the null hypothesis that α is 0 is accepted, $\mathrm{var}(n_i) = E[n_i]$, then we should choice the Poisson regression model. Conversely, if we reject the null hypothesis, we choose the Negative Binomial Model.

3 Data Description

3.1 Survey Data

We use data from a firm survey[**]. This survey collected information on energy efficiency and environmental practices in Japanese listed firms. Before the firm survey, we conducted interviews with major firms in the transport equipment industry and the steel industries and with one research institute. This survey covers the manufacturing and construction industries in Japan, and the number of target firms is 1,726. We sent

** This survey was supported by "Economic Analysis of the New Market Mechanisms and Bilateral Offset Credits Mechanisms", a project commissioned by the Ministry of Environment, Government of Japan.

the questionnaire to the targeted firms on November 16, 2012 and set the response deadline for December 7, 2012. Replies were received from 407 firms, which corresponded to a response rate of 23.6%, a relatively high rate given the detailed nature of the questionnaire.

3.2 Scope 3 and Disclosure Requirement

We constructed the variable *NUMACT,* which captures the number of Scope 3 categories that respond to the measure and the firms' Scope 3 measuring activities. The respondents were asked whether they measure emissions in each Scope 3 category. *NUMACT* is the sum of the number of categories to which respondents answered "Yes" or "Partially" from 4 choices ("Yes", "Partially", "Under consideration" and "No"). Table 1 shows the distribution of *NUMACT*.

Table 1: The distribution of *NUMACT*

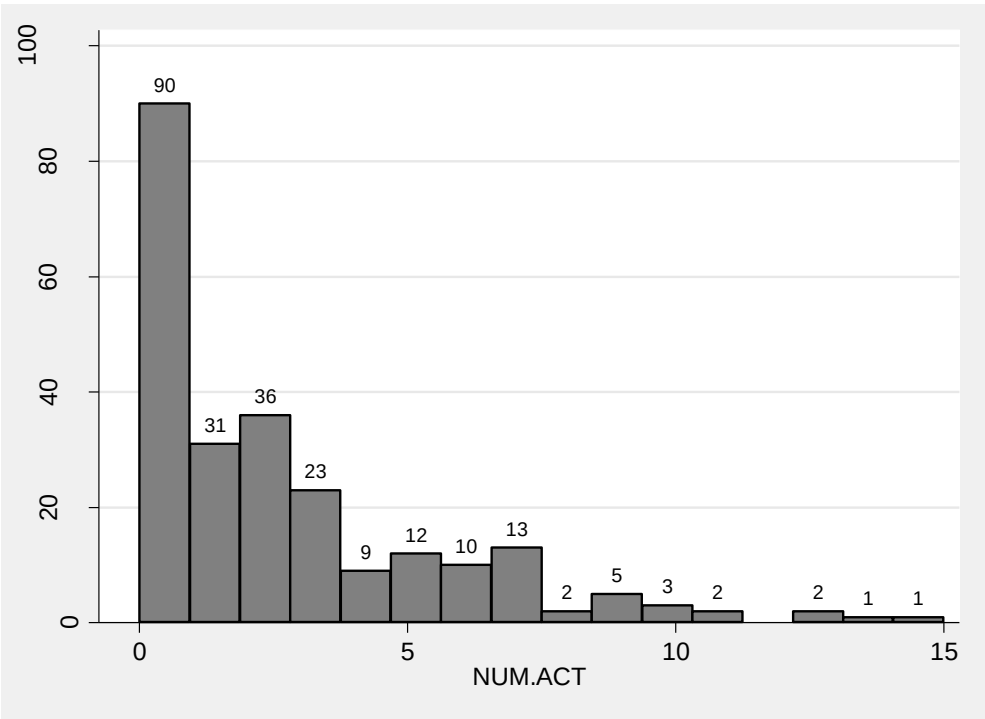
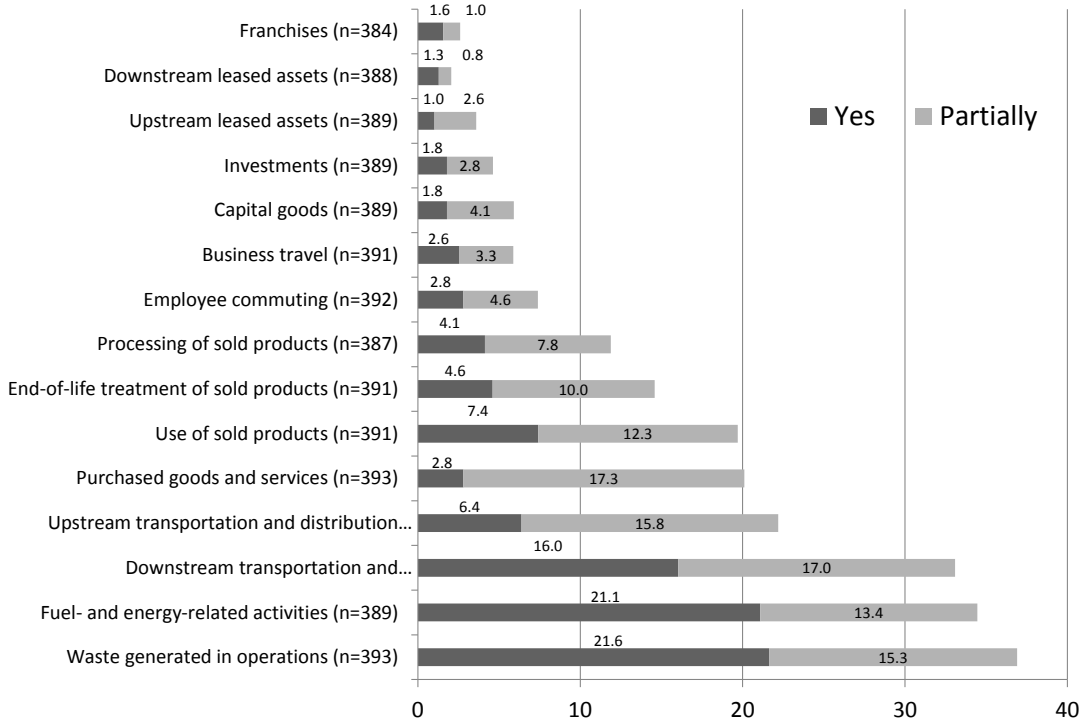


Table 2: The percentage of firms measuring Scope 3 emissions in each category



The result for each category is presented in Table 2. Note that "Waste generated in operations" indicates that the GHG emissions resulting from waste disposal are measured by many firms. "Fuel- and energy-related activities" and "Downstream transportation and distribution" are also measured more than other categories. This result indicates that firms tend to measure the categories either that they are legally obligated to measure if the emissions exceed a certain threshold or the categories are on the line extended to environmental practices.

Using information from the survey, we construct a set of control variables. In this subsection, we explain the variables that are expected to affect the firms' activity measuring Scope 3. The influence of stakeholders is one of the important factors explaining business behavior and has been examined in the literature on the determinants of advanced environmental practices (Buysse & Verbeke, 2003,

Murillo-Luna et al., 2008, Darnal et al., 2010). Considering that resolving climate change is one of modern society's largest challenges, there seems to be an expectation from stakeholders about GHG emissions through the supply chain. Thus, stakeholders who have these expectations will directly/indirectly claim that firms measure Scope 3 emissions.

To construct the variable that captures stakeholder effect, we use the answer to the question that asked whether firms are requested to reduce GHG emissions by their stakeholders. If firms experienced these effects, they may measure Scope 3 emissions more than they did previously. We suppose that the stakeholders include administrators (*REQPRIGHG*), consumers (*REQCONGHG*), shareholders (*REQFUNGHG*), banks (*REQBANGHG*), industrial associations (*REQINDGHG*), pro-environmental groups (*REQENVGHG*), non-management employees (*REQNMEGHG*), management employees (*REQMEGHG*), and communities (*REQCOMGHG*).

In addition, we suppose that whether firms have received requests about climate change information from domestic customers more than legally required (*INFODISGHGD*) affects the firms' Scope 3 measuring activities. As mentioned above, Scope 3 emissions are all indirect emissions (not included in Scope 2) that occur in the supply chain of the reporting firm, including both upstream and downstream emissions. To measure Scope 3 emissions, it is necessary for the reporting firms to cooperate with their suppliers and customers. From this perspective, we examine whether requests to disclose climate change information facilitates suppliers' measuring scope 3 activity.

The passed years since firms have certified ISO 14001 for the first time also affected *NUMACT*. ISO 14001 is a family of standards related to environmental management that exists to help organizations (a) minimize the effect of their operations

on the environment, (b) comply with the applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above (ISO Survey 2012). ISO 14001 establishes criteria for an environmental management system and can be certified to do so. It does not provide requirements for environmental performance but maps out a framework that a firm or organization can follow to establish an effective environmental management system. It can be used by any organization regardless of its activity or sector.

There were more than 20,000 ISO 14001-certified firms as of July 2013, which indicates that the standard is widely diffused in Japan. From the RBV, as more years pass since ISO 14001 certification, firms will acquire more certified firm-specific knowledge regarding environmental strategies through the PDCA cycle. We suppose that the firms with sufficient knowledge of and experience with ISO 14001 tend to engage in proactive environmental practices, such as measuring Scope 3 emissions.

To construct a variable that captures shareholder pressure, we use the foreign stock ownership ratio (*FRGN*), which is the ratio of the stocks that foreign investors have to the outstanding stocks. As mentioned above, although Japanese firms enhance their commitment to information disclosure regarding climate change, their level of information disclosure is still inferior to overseas firms. From this perspective, we suppose that as a firm's foreign stock ownership ratio increases, it will face more pressure from foreign investors to disclose information, thereby prompting it to measure Scope 3 emissions.

Using NEEDS-Cges[††], we construct a set of control variables that are expected to directly affect the measurement of Scope 3 emissions. These variables include the

[††] NEEDS-Cges is a database that contains detailed data and well-defined criteria that enables us to evaluate the corporate governance of the listed Japanese companies.

non-floating stock ratio (*NFLOAT*) and the outside director ratio (*IDRTO*). These variables indicate that the composition of shareholders and boards of directors has been examined in the environmental information disclosure literature (Roberts, 1992, Brammer & Pavelin 2008, Ghomi & Leung, 2013). We assumed that the activities measuring Scope 3 emissions also contain elements of information disclosure. Thus, we use these variables as independent variables.

As mentioned above, there is a possibility that CDP has an effect on Scope 3 measuring activities because CDP requests information about Scope 3. To capture the effect of CDP, we construct two variables: *CNTCDP*, which captures the number of times that firms were subject to CDP between 2008 and 2011, and *CNTANS*, which captures the number of times that firms answered the CDP questionnaire between 2008 and 2011. We suppose that a firm will measure more Scope 3 categories if a respondent is subject to CDP more frequently and if it answers the CDP questionnaire more often.

Other control variables, which indicate the basic properties of respondents, are created from the firm survey data and The Japan Company Handbook (Kaisha Shikiho). These variables measure whether a firm's primary product is the final product for general consumer or for firms, the government and municipal offices (*CONSPRO*, *PUBFPRO*)[‡‡]; the logarithm of the number of employees (ln*EMP*); and the capital stock (ln*CAP*). Descriptive statistics of the dependent variable and control variables are presented in Table 3.

4 Estimation Results

Table 4 presents the estimation results. As observed below, the coefficients of

‡‡ We set the case that firms' primary products are intermediate products as a reference group.

both *CNTCDP* and *CNTANS* are positive and significant. This result indicates that firms that have been subject to CDP or have answered CDP questionnaires tend to measure more Scope 3 categories. Furthermore, the coefficient of *REQCONGHG* and *REQFUNGHG* is positive and significant. Firms that have been asked by their stakeholders to reduce GHG emissions are more likely to measure Scope 3 categories, which is consistent with the stakeholder theory. As mentioned above, stakeholders, particularly investors, have recently begun to ask firms to reduce GHG emissions. This result indicates that stakeholders have important roles in facilitating the calculation of GHG emissions through the supply chain, which is a proactive environmental practice.

The positive and significant coefficient on *INFODISGHGD* suggests that the firms that receive more requests from domestic customers tend to measure more Scope 3 categories than are legally required. From the perspective of a customer of the responding firms, this means that their requests to the supplier concerning GHG information disclosure facilitate the suppliers' measuring of Scope 3 activities. In other words, environmental practices create a chain reaction throughout the supply chain.

A high foreign stock ownership ratio promotes the measurement of Scope 3 categories, as indicated by the positive and significant coefficient of *FRGN2011*. This result suggests that as there are more foreign investors in a stock, the responding firms receive stronger requests for information disclosure, which prompts them to measure more Scope 3 categories.

The coefficient of *ISODUR* is positive and significant. This result is consistent with the theory of RBV. The firms that have certified ISO 14001 may accumulate tacit knowledge regarding environmental strategies by repeating the PDCA cycle.

The relationship between corporate governance and the quality of information

disclosure is well tested in the literature. In particular, the effect of the composition of boards of directors on the quality of information disclosure is tested in several studies, which suggest that a higher outsider director's rate allows directors to more effectively monitor firm behavior. However, our results show that the coefficients of *IDRTO* and *NFLOAT* are insignificant. This result means that measuring Scope 3 emissions does not always involve information disclosure. Kraft, which began measuring its Scope 3 emissions in 2008, chose not to use its emissions results in consumer communications to prevent the results from being misinterpreted or confusing consumers (Kingsbury et al, 2012). When we interviewed the persons in charge of climate change in several Japanese firms, they confirmed that some steps exist between the disclosure and the calculation of their Scope 3 emissions.

Based on the above estimation results, we calculate the marginal effect of *INFODISGHGD* on *NUMACT*. If the firms receive requests for information disclosure regarding climate change, the number of measured categories increases by 0.79. Moreover, if we add the condition that the firms are requested to reduce GHG emissions by their investors, the number of measured categories increases by 1.68.

5 Conclusion

In this article, we focused on the measurement of Scope 3 emissions as a proactive environmental practice and identified the determinant of the number of measured Scope 3 categories. The estimation results showed that the firms that were asked by stakeholders, such as investors and consumers, to reduce GHG emissions tend to measure more Scope 3 categories. In the case of these firms, requests for information disclosure have a stronger effect on measuring Scope 3 emissions. The literature on proactive environmental practices or voluntary information disclosure has focused on

the effect of pressure from stakeholders. In the case of measuring Scope 3 emissions, which requires cooperation with suppliers and customers, requests from downstream of the supply chain play an important role.

The estimation results also show the possibility that being subject to or answering to CDP induces firms to measure Scope 3 emissions. However, both variables associated with CDP may be endogenous. Future research may resolve this problem by using Instrumental Variables, such as the extent of information disclosure.

At present, the measurement of Scope 3 emissions is led by firms with proactive environmental strategies. Further emissions reduction among large firms in developed countries and greater attention to the amount of emissions in the supply chain are necessary. If these are implemented, the measurement of Scope 3 emissions may become an international standard, similar to ISO 14001, which is a de facto condition for doing business in certain sectors. It remains a challenge for future researchers to investigate the diffusion process of measuring Scope 3 among firms.

Table 3: Summary Statistics (N=240)

Variables	Definition	Mean	Std. Dev.
NUMACT	The number of measured categories in Scope 3	2.45	3.05
CNTANS	The number of times that firms answered the CDP questionnaire over four years (2008-2011)	0.44	1.07
CNTCDP	The number of times firms are subject to CDP for four years (2008-2011)	0.81	1.41
INFODISGHGD	If the firms have received any information disclosure requests about GHG from domestic customers, more than legally required: 1, otherwise: 0	0.28	0.45
INFODISGHGO	If the firms have received any information disclosure requests about GHG from oversea customers, more than legally required: 1, otherwise: 0	0.14	0.35
REQPRIGHG	If the firms have been required for GHG reduction activities from government: 1, otherwise: 0	0.62	0.49
REQCONGHG	If the firms have been required for GHG reduction activities from customer: 1, otherwise: 0	0.19	0.39
REQFUNGHG	If the firms have been required for GHG reduction activities from investors or funds: 1, otherwise: 0	0.19	0.39
REQBANGHG	If the firms have been required for GHG reduction activities from banks: 1, otherwise: 0	0.15	0.36
REQINDGHG	If the firms have been required for GHG reduction activities from industrial associations: 1, otherwise: 0	0.63	0.48
REQENVGHG	If the firms have been required for GHG reduction activities from pro-environmental groups: 1, otherwise: 0	0.15	0.35
CONSFPRO	If the firms' products are the final products for consumer: 1, otherwise: 0	0.27	0.45
PUBFPRO	If the firms' products are the final products for government: 1, otherwise: 0	0.28	0.45
INTERPRO	If the firms' product are intermediate products: 1 otherwise: 0	0.45	0.50
FRGN2011(%)	Foreign stock ownership ratio (based on financial reports)	10.71	11.71
NFLOAT2011(%)	Non-floating stock ratio (based on financial reports)	48.39	14.64
IDRTO2011(%)	Outside directors ratio (based on financial reports)	9.27	11.66
EXP	If the firm export their product: 1 otherwise: 0	0.68	0.47
AGE	Firm Age	68.43	17.82
ISODUR	Years passed since firms were ISO14001 certified for the first time	11.90	3.22
lnCAP	Capital (log)	8.89	1.50
lnEMP	Number of employees (log)	6.87	1.25

Table 4: Negative Binomial Estimation Results

	Coef.		
	(1)	(2)	(3)
CNTANS	0.132 **		
	(0.064)		
CNTCDP		0.107 *	
		(0.057)	
INFODISGHGD	0.486 **	0.494 **	0.398 **
	(0.200)	(0.200)	(0.203)
INFODISGHGO	- 0.138	- 0.128	- 0.223
	(0.216)	(0.217)	(0.233)
REQPRIGHG	- 0.039	- 0.111	- 0.196
	(0.187)	(0.182)	(0.186)
REQCONGHG	0.230	0.198	0.317 *
	(0.184)	(0.186)	(0.180)
REQFUNGHG	0.385 *	0.393 *	0.495 **
	(0.223)	(0.223)	(0.219)
REQBANGHG	- 0.453	- 0.436 *	- 0.462
	(0.238)	(0.242)	(0.243)
REQINDGHG	0.321	0.355 *	0.398 **
	(0.204)	(0.203)	(0.21)
REQENVGHG	0.330	0.342 *	0.256
	(0.207)	(0.207)	(0.215)
CONSFPRO	0.056	0.035	- 0.066
	(0.178)	(0.180)	(0.185)
PUBFPRO	- 0.126	- 0.121	- 0.031
	(0.19)	(0.193)	(0.208)
FRGN2011			0.023
			(0.007)
NFLOAT2011	0.002	0.002	0.007
	(0.005)	(0.005)	(0.006)
IDRTO2011			- 0.001
			(0.006)
EXP	0.008	- 0.038	
	(0.163)	(0.161)	
AGE	0.007 *	0.007	
	(0.004)	(0.004)	
ISODUR	0.062 **	0.061 **	0.059 **
	(0.026)	(0.026)	(0.026)
lnCAP			0.096
			(0.109)
lnEMP			0.096
			(0.126)
ENGINTSDUM	- 0.223	- 0.202	
	(0.183)	(0.184)	
Industrial Dummy	NO	NO	YES
_cons	- 0.991	- 0.965	- 1.871
	(0.533)	(0.533)	(0.742)
N	241	241	240

Note 1: Standard errors are shown in parentheses.

Note2: *,** and *** imply that the coefficient is significantly different from zero at the 10%, 5%, and 1% levels, respectively.

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