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How do firms' climate-related management and strategy affect
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Abstract

Climate change is an international environmental issue that has increasingly attracted business attention in the past decade because of its actual or potential strategic impact on many companies. This study aims to examine how risk and opportunity awareness is correlated with corporate management and strategy. This study obtains firm data from a questionnaire survey of CDP in 2013, and the data includes 899 observations for risk awareness and 827 observations for opportunity awareness in 64 countries and 20 industry groups. Using the data, this study empirically examines how firms' management and strategy affect risk and opportunity awareness related to climate change in the regression analysis. By regression analysis, we find some types of corporate climate-related governances and strategies are related to risk and opportunity awareness. The regression result also shows that there seems to be few differences between the effectiveness of firms' climate-related management on their business risk and opportunity awareness related to climate change. Corporate strategies such as setting emissions reduction targets, launching emissions reduction initiatives, participating emissions trading schemes, and originating/purchasing carbon credits are proved found to be beneficial for increasing the corporate risk and opportunity awareness

Key words: climate change; risk and opportunity awareness; CDP; corporate governance; supply chain activities

JEL classification: M14, Q54, Q56

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1. Introduction

While climate change has become a center-stage focus, companies worldwide are getting more interested in mitigating risks and seeking opportunities related to greenhouse gas (GHG) emissions reduction. The relationship among environmental performance, risk, and risk management is considered to be increasingly important and crucial for business success (Dobler et al., 2014). However, there is little evidence about this relationship. Regarding risk management, there are often various corporate strategies and corresponding information asymmetry. To avoid risk and encounter greater opportunity, companies often adopt multiple actions in combination, such as stakeholder engagement and corporate policy implementation. In addition, business risk and opportunity awareness (i.e., recognition) related to climate change vary among companies and often differ between companies and stakeholders such as investors (Solomon et al., 2011). Hence, this study aims to examine how risk and opportunity awareness is correlated with corporate governance and strategy and engagements with other organizations. This study especially focuses on risk and opportunity awareness related to climate change, which has increasingly become of interest among companies and stakeholders using the CDP dataset for worldwide firms in 2013.

Understanding how companies tend to respond to risk or opportunity affords a clue to improve environmental performance among whole industries. This understanding also helps us to form expectations about corporate behavior related to climate change and will contribute to the risk management literature as an evidence-based study.

Managers are already working on a range of business risks and opportunities, and climate change adds a new dimension for managers to consider. It is generally recognized that climate change creates potential risks and opportunities for businesses as following various forms: physical climate effects, GHG emission regulations, consumption attitudes of customers, investment concepts of shareholders, and evolving product or service markets. Business is vulnerable to climate change due to the fact that their operational behaviors have a high probability of negative impact associated with the physical and regulatory effectiveness of climate change (Jira and Toffel, 2013). From a positive

perspective, management of GHG emissions is not only beneficial for building brand image but also for expanding market share (Hopkins, 2010). In order to mitigate risks and pursue opportunities, managers should have a better and deeper understanding of not only the corporation's own status but also other organizations' conditions and reactions regarding climate change.

The paper is structured as follows. Section 2 introduces the literature review about risk management and corporate governance and explains CDP. Section 3 discusses research methodology, explaining the empirical model and our data. Section 4 presents the research results based on the regression model, identifying determinants respectively for risk and opportunity awareness. Section 5 concludes, mentioning implications for business, limitations of this research, and dimensions for further study.

2. Backgrounds

2.1 Risk management and corporate governance

In the risk management literature, companies are considered to often face risks that are categorized into several types. Dobler et al. (2014) classify environmental risks into three types: regulations, operations, and nature. As a consistent pattern across industries, risk from regulations is the type that has the highest frequency and largest scale, risk from operations is most likely to have a catastrophic impact upon the firm, and risk from nature is the type that is least likely to be subject to active risk management. Controlling for inter-industry differences, the authors demonstrate a negative relationship between environmental performance and environmental risks at the firm level. More particularly, the relationship appears to be significant for total environmental risks and strongest for risks from operations, while risks from nature tend to be not relevant.

To avoid or mitigate corporate risks, an organization often must implement risk management adequately. In terms of how efficient risk management of companies is, it is well known in the corporate governance literature that corporate governance has a key role in managing corporate risk, such as climate change issues. Especially, in Galbreath (2010), it is found that

corporate performance is largely affected by corporate governance. The author conducts an exploratory study on corporate governance practices, addressing climate change in 98 firms inside and outside the U.S. Overall, the study indicated that non-US firms appear to demonstrate higher performance than U.S. firms due to institutional pressure. Furthermore, firms with larger boards, separate CEO–board chair roles, younger directors, and a higher percentage of inside directors seem to have a structure that brings about higher performance across governance practices that address climate change.

As Galbreath notes, to make risk management effective, stakeholder (e.g., institutions or investors) pressures or dialogues are considered to be important. Peters and Romi (2014) examine the association between the voluntary disclosure of GHG information and corporate governance mechanisms based on data from the CDP (see the next sub-section) from 2002 until 2006. The authors claim that the existence of environmental committees on boards of directors and corporate sustainability officers (CSOs) has a positive relationship with the likelihood and transparency of GHG disclosures. Additionally, among several characteristics of the board such as committee size and number of committee meetings, only expertise of the environmental committee members and CSO confirms a positive correlation with GHG disclosure transparency, while committee size tends to be negatively correlated.

In addition, in terms of the risk management and corporate governance, some theoretical models are constructed to examine how the corporate governance works in terms of mitigating corporate risks such as in Brown et al. (2009). The authors put forward a new risk management model that aims at enhancing the management and oversight of corporate risk in a highly complex and dynamic risk environment. The model suggests that an appropriate governance mechanism lies in the creation of a separate risk management committee utilizing enterprise risk management. This risk management committee would include members drawn from the audit committee and from operational management that engages regularly with the board and the audit committee.

Based on the discussion about the relationship between risk management and corporate governance, this study hypothesizes that risk and opportunity awareness and corporate governance

are highly correlated with each other. That is, corporate governance or strategy is characterized by certain degrees of risk (or opportunity) awareness. This idea originates from the discussion that there are some gaps between investors and companies in terms of determinants that influence corporate risk and opportunity awareness from climate change in Solomon et al. (2011).

According to the authors, because societal anxiety surrounds climate change risk, institutional investors (as the primary financial stakeholders of corporation) tend to be highly concerned about how climate change affects their investment return. As a consequence, companies are starting to disclose information on climate change impacts through public climate change reporting. Corporate climate change reporting is defined as mechanisms by which organizations position themselves as engaging in dialogue about their social and environmental impacts and a means by which managers make sense of sustainable development themselves. Just as disclosure of climate-related risks, corporate climate change reporting is evolving to disclose opportunities with institutional investors identifying potential financial benefits from corporate climate change strategies and investment in green products and technologies. As discussed above, this study hypothesizes that risk and opportunity awareness is related to types of corporate governance or strategy, and we empirically examine the proposed hypotheses based on the CDP dataset.

2.2 CDP

The CDP is an independent, non-profit organization based in the United Kingdom that works with shareholders and corporations to disclose the GHG emissions of major corporations. In 2000, the CDP was established to accomplish two goals: to inform managers about investors' concerns about climate change and to inform investors about firms' risks associated with climate change. The first target is achieved by sending a questionnaire to the largest global public firms. The second target is achieved by producing reports that aggregated responses available online (Stanny and Ely, 2008). It is generally acknowledged that CDP is the most important source of information on GHG emissions. Participation in the CDP questionnaire allows us to capture the firms' information relevant to investors relating to the business risks and opportunities from climate change

(Kolk et al., 2008).

According to the report produced by CDP and 2050 (2014), CDP recognizes three types of risk and opportunity that are driven by changes in regulation, changes in physical climate parameters, and changes in other climate-related developments. Moreover, risks and opportunities are relative situations rather than absolute ones depending on different companies. Where one company confirms a risk generated from climate change, another company may identify a business opportunity in the same circumstance. When considering changes in regulation, companies primarily concentrate on the potential increased operational costs caused by emission limits and added taxation.

Additionally, risks and opportunities can also arise from other aspects such as emission reporting obligations, regulations, and international agreements. Changes in physical climate parameters have the greatest influence on business activities. Generally, companies identify plenty of risks driven by physical effects of climate change, which mainly include damage to corporate infrastructure and disruption to supply chains. On the other hand, companies can also recognize massive business opportunities by developing and innovating new products and services that adapt to climate change. There are also risks and opportunities driven by other climate-related developments. Since investors, consumers, and supply chain partners will be more willing to work with climate-responsible companies due to their positive reputation, companies tend to be motivated to work actively with climate change. Moreover, an eco-conscious corporate culture within companies may help managers motivate, attract, and retain talented employees.

The CDP also asks companies about associated corporate GHG management. The questions mainly focus on corporate climate-related governance, strategy, and targets. This dataset is used in the empirical way in the following three studies. Weinhofer and Hoffmann (2010) perform a content analysis on 91 electricity producers' answers to CDP in order to investigate whether and how companies adjust their business operations with a goal to lower CO₂ emissions. They find that half of the companies take parallel emission management measures that target strategic objectives including CO₂ compensation, CO₂ reduction, and carbon independence. They also find that

companies with different CO₂ strategies significantly differ in terms of regional affiliation, company size, and absolute amount of CO₂ emissions. Rankin et al. (2011) investigate the relationship between GHG emission disclosure and corporate GHG management and find that firms that voluntarily disclose GHGs to CDP are more likely to have better environmental management systems and higher corporate governance quality. Reid and Toffel (2009) examine the rate of corporate's response to the CDP questionnaire and find that companies which have already dealt with shareholder actions in terms of environmental issues show a higher probability of public information disclosure to CDP. The authors also find that companies operate within the bounds of carbon emission trading laws are more likely to disclose GHG emission information.

3. Methodology

This study obtains firm data from a questionnaire survey of CDP in 2013. Using the data, this study empirically examines how firms' management and strategy affect risk and opportunity awareness related to climate change in the regression analysis. Descriptive statistics of these data are shown in Table 1. The data include 64 countries and 20 industry groups. The number of observations is 899 for risk awareness and 827 for opportunity awareness.

The dependent variables are the degree of risk and opportunity awareness. These two variables take a value from 0 to 3 when certain firms answer that they recognize risk or opportunity in terms of the following three points: changes in regulation, physical climate parameters, and other climate-related developments. If firms recognize all three elements in terms of risk, the risk value is 3. The average values of risk and opportunity awareness are 2.16 and 2.15, respectively.

Meanwhile, independent variables consist of dummy variables based on ten questions, which are divided into two categories: corporate management and strategy (Questions 1 to 6) and environmental activities with other organizations (Questions 7 to 10). This study examines whether these determinants are statistically correlated with risk and opportunity awareness. Regarding corporate governance (management and strategy) (Questions 1 to 6), Question 1 asks where the

highest level of direct responsibility for climate change is within a company (1: Individual/sub-set of the board; 2: Other manager/officer; 3: Senior manager/officer; Baseline: None). Question 2 asks the respondent to best describe the company's risk management procedures with regard to climate change risks and opportunities (1: Specific climate change risk management process; 2: Integrated risk management processes; Baseline: None). Question 3 asks whether a company engages in activities that could either directly or indirectly influence policy on climate change with policy makers (1: Direct engagement; 2: Funding research organizations; 3: Trade associations; 4: Other; Baseline: None). Question 4 asks whether there is an emissions reduction target (1: Absolute and intensity targets; 2: Absolute target; 3: Intensity target, Baseline: None). Q5 asks whether the use of company's goods and/or services directly enables GHG emissions to be avoided (1: Yes; 2: No). Q6 asks whether there are emission reduction initiatives in place, including those in the planning and/or implementation phases (1: Yes; 2: No). In addition, we control for country- and industry-fixed effects in the model.

On the other hand, regarding environmental activities with other organizations (Questions 7 to 10), Question 7 asks whether a company participates in any emissions trading schemes (1: Currently in participation; 2: Anticipating to participate in 2 years; Baseline: Not anticipating to participate in 2 years). Question 8 asks whether a company originated or purchased any project-based carbon credits within the reporting period (1: Yes; 2: No). Question 9 asks what elements indicate the verification/assurance status that applies to the company's scope 3 emissions (1: Third-party verification or assurance underway but not yet complete – last year's statement available; 2: Third-party verification or assurance underway but not yet complete – first year it has taken place; 3: Third-party verification or assurance complete; Baseline: No third-party verification or assurance). Question 10 asks whether a company engages with any of the elements of value chain on GHG emissions and climate change strategies (1: Suppliers; 2: Customers; 3: Other partners; Baseline: None).

4. Results

The regression result with questionnaires of corporate management and strategy (Questions 1 to 6) and questionnaires of environmental activities with other organizations (Questions 7 to 10) are shown in Table 2 and Table 3, respectively. In Table 2, columns 1 and 2 show the result using risk and opportunity awareness as dependent variables, respectively. Regarding Question 1, the coefficient of the individual/sub-set of the board is statistically significantly positive for opportunity awareness and not statistically significant for risk awareness. On the other hand, the coefficients of other manager/officer and senior manager/officer are not statistically significant in both columns. Regarding Question 2, the coefficient of integrated risk management process is statistically significantly positive for risk and opportunity awareness. On the other hand, the coefficient of specific risk management process is not statistically significant in both columns. Regarding Question 3, when referring to engagement with policy makers, the coefficient of trade associations is statistically significantly positive for both risk and opportunity awareness. In contrast, the coefficient of funding research organizations is statistically significantly positive for risk awareness and not significant for opportunity awareness. On the other hand, the coefficients of direct engagement and other are statistically significantly positive for opportunity awareness and not significant for risk awareness. Regarding Question 4, in regard to the emissions reduction target, the coefficients of all types of targets are statistically significantly positive for both risk and opportunity awareness. Regarding Question 5, the coefficient of goods/services enabling GHG emissions avoidance is statistically significantly positive for both risk and opportunity awareness. Regarding Question 6, the coefficient of emissions reduction initiatives, including those in the planning and/or implementation phases, is statistically significantly positive for both risk and opportunity awareness.

In Table 3, columns 1 and 2 show the result of using risk and opportunity awareness as dependent variables, respectively. Regarding Question 7, the coefficient of currently in participation is statistically significantly positive for both risk and opportunity awareness, while the coefficient of anticipating participation within 2 years is statistically insignificant in both columns. Regarding

Question 8, the coefficient of originated/purchased carbon credits is statistically significantly positive for both risk and opportunity awareness. Regarding Question 9, the coefficient of complete third-party v/a is statistically significantly positive for both risk and opportunity awareness, and the coefficient of incomplete third-party v/a: last year's statement available is statistically insignificant in both columns. However, the coefficient of incomplete third-party v/a: first year it has taken place is statistically significantly positive for risk awareness and not significant for opportunity awareness. Regarding Question 10, the coefficients of suppliers and customers are statistically significantly positive for both risk and opportunity awareness, while the coefficient of other partners is statistically significantly positive for opportunity awareness and not significant for risk awareness.

5. Conclusion

The purpose of the study is to examine the effectiveness of firms' climate-related management on their business risk and opportunity awareness and to analyze the relationship between activities with other organizations and risk and opportunity awareness. Regarding the corporate management and strategy, risk awareness is likely to correlate with the following items: Q2) integrated risk management process with regard to climate change, Q3) engagement in activities influencing policy through funding research organizations and trade associations, Q4) absolute and intensity targets and absolute target and intensity target active in a company's GHG management, Q5) goods/services enabling GHG emissions avoidance, Q6) emissions reduction initiatives, Q7) current participation in emissions trading schemes, Q8) originated or purchased carbon credits, Q9) complete third-party verification or assurance applying to the company's scope-3 emissions, and Q10) engagement with suppliers and customers of value chain on GHG emissions and climate change strategies. On the other hand, opportunity awareness is related to the following items: Q1) individual/sub-set of the board or other committee appointed by the board acting as the highest level of direct responsibility for climate change, Q2) integrated risk management process with regard to climate change, Q3) engagement in activities influencing policy through trade associations, other, or

direct engagement, Q4) absolute and intensity targets, absolute target, and intensity target active in a company's GHG management, Q5) goods/services enabling GHG emissions avoidance, Q6) emissions reduction initiatives, Q7) current participation in emissions trading schemes, Q8) originated or purchased carbon credits, Q9) complete third-party verification or assurance applying to the company's scope-3 emissions or incomplete but available for last year's statement, and Q10) engagement with suppliers, customers, or other partners of value chain on GHG emissions and climate change strategies.

From this point, we discuss the implication of the results and make suggestions for firms and policymakers. According to the regression results, there seem to be few differences between the effectiveness of firms' climate-related management on their business risk and opportunity awareness. The results verify the assumption that corporate risk and opportunity awareness are correlated and able to convert from/to each other. Therefore, it is possible for a company to develop some strategies that simultaneously increase corporate risk and opportunity awareness. Corporate strategies such as setting emissions reduction targets (Q4), launching emissions reduction initiatives (Q6), participating in emissions trading schemes (Q7), and originating/purchasing carbon credits (Q8) are found to be beneficial for increasing corporate risk and opportunity awareness related to climate change. Moreover, as Christopher (2011) points out, along with the rapid development of science and technology and the globalization of the market and economy, the nature of business competition in the future will be combat between supply chains rather than companies. In today's competitive business environment, the effectiveness and efficiency of a company's supply chain performance determines the difference between success and failure to a great extent. It is therefore essential for a company to cooperate and collaborate with supply chain partners to engage in GHG emissions and climate change strategies in order to identify potential business risks and opportunities and finally promote common development.

However, there are still some findings in the study that have drawn our attention. Firstly, it seems to be generally accepted that corporate risk awareness culture should start at the board level and extend all the way down to the shop floor. However, according to the regression result, an

individual/sub-set of the board or other committee appointed by the board acting as the highest level of direct responsibility for climate change (Q1) tends to be irrelevant to corporate risk awareness related to climate change. This indicates that, when becoming aware of opportunities for climate change rather than risk, companies are likely to authorize an individual/sub-set of the board to own the highest degree of controllability. Because opportunity awareness is more related to play-to-win strategy, which requires the selection and concentration of business resources as opposed to the not-to-lose strategy, it implies that authorizing the individual/sub-set of the board is compatible with focusing their business resources on the fields related to climate change. From the viewpoint of investors, when the individual/sub-set of the board has the highest responsibility for climate change issues, it implies that there is a good chance of taking competitive advantage in the market. Secondly, while a specific risk management process with regard to climate change (Q2) is not relevant to corporate risk or opportunity awareness related to climate change, an integrated risk management process (Q2) has a significant effect on both corporate risk and opportunity awareness. This might be due to the fact that managing climate-related opportunities and risks is an integral part of corporate governance system. In terms of scope, the integrated into multi-disciplinary company-wide risk management processes should cover both strategic and operational risks from the following areas: environment, economic and political frameworks, procurement, production/supply chain, sales and capital markets, information technology, product development, and human resources.

Finally, we identify some limitations of this study and dimensions for future research. Firstly, while our study empirically examines what firms' climate-related management and strategies are significantly related to corporate risk and opportunity awareness associated with climate change, the study fails to provide evidence to prove the causal relationship between both. Therefore, to further explore how organizational functions affect the formation of risk and opportunity awareness, inside analysis of the company is necessary. Secondly, the sample companies for which we obtain data from the questionnaire of the CDP are the companies have already completed the CDP survey. According to the main targets of the CDP (Stanny and Ely, 2008), to some extent, this means these companies are already more concerned about their business risks associated with climate change,

which may lead to sample bias. Finally, firms' climate-related management and strategy should have long-term effects on corporate risks and opportunities awareness associated with climate change. However, our ability to analyze the long-term effects is limited by the fact that only one year (2013) of responses to the CDP survey are investigated in our study. As the CDP intends to continue surveying this group of companies, future research might explore longer-term trends by incorporating the future survey responses of the CDP.

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Table 1. Descriptive statistics of all variables

Variable	Obs.	Mean	S.D.	Min	Max
Dependent Variables					
Risk awareness	899	2.16	0.89	1	3
Opportunity Awareness	827	2.15	0.88	1	3
Independent Variables					
Corporate management and strategy					
Q1. Direct responsibility for climate change					
Individual/sub-set of the board	941	0.59	0.49	0	1
Other manager/officer	941	0.04	0.20	0	1
Senior manager/officer	941	0.29	0.45	0	1
Q2. Option of risk management approach:					
Specific risk management process	941	0.09	0.28	0	1
Integrated risk management process	941	0.62	0.49	0	1
Q3. Engagement with policy makers					
Direct engagement	941	0.34	0.47	0	1
Funding research organizations	941	0.15	0.36	0	1
Trade associations	941	0.45	0.50	0	1
Other	941	0.25	0.43	0	1
Q4. Emissions reduction target					
Absolute and intensity targets	941	0.13	0.33	0	1
Absolute target	941	0.24	0.43	0	1
Intensity target	941	0.25	0.43	0	1
Q5. Goods/services enabling GHG emissions avoidance					
Q6. Emissions reduction initiatives	941	0.56	0.50	0	1
Q6. Emissions reduction initiatives					
941	0.76	0.43	0	1	
Environmental activities with other organizations					
Q7. Emissions trading schemes:					
Currently in participation	917	0.20	0.40	0	1
Anticipating to participate in 2 years	917	0.8	0.27	0	1
Q8. Originated/purchased carbon credits					
911	0.14	0.34	0	1	
Q9. Scope 3 emissions verification/assurance status:					
Incomplete third-party v/a: last year's statement available	849	0.29	0.17	0	1
Incomplete third-party v/a: first year it has taken place	849	0.27	0.16	0	1
Complete third-party v/a	849	0.20	0.40	0	1
Q10. Engagement with elements in value chain					
Suppliers	836	0.42	0.49	0	1
Customers	836	0.44	0.50	0	1
Other partners	836	0.17	0.37	0	1

Table 2. Regression results of Questions 1 to 6

	(1)		(2)	
	<i>Risk awareness</i>		<i>Opportunity awareness</i>	
	Coef	S.E.	Coef	S.E.
Q1. Group and Individual Responsibility:				
Individual/sub-set of the board	0.177	(0.114)	0.341***	(0.130)
Other manager/officer	-0.074	(0.159)	-0.227	(0.179)
Senior manager/officer	0.028	(0.109)	0.101	(0.127)
Q2. Risk management approach:				
Specific risk management process	0.145	(0.103)	0.109	(0.107)
Integrated risk management process	0.307***	(0.074)	0.187**	(0.077)
Q3. Engagement with policy makers				
Direct engagement	0.054	(0.063)	0.142**	(0.063)
Funding research organizations	0.145*	(0.083)	0.103	(0.081)
Trade associations	0.227***	(0.061)	0.149**	(0.062)
Other	0.020	(0.061)	0.106*	(0.061)
Q4. Emissions reduction target				
Absolute and intensity targets	0.252**	(0.103)	0.270**	(0.104)
Absolute target	0.151*	(0.079)	0.215**	(0.083)
Intensity target	0.167**	(0.080)	0.227***	(0.084)
Q5. Goods/services enabling GHG emissions avoidance	0.182***	(0.062)	0.255***	(0.063)
Q6. Emissions reduction initiatives	0.320***	(0.078)	0.163*	(0.085)
Constant	1.377	(0.116)	1.175	(0.135)
Country dummy		Yes		Yes
Industry dummy		Yes		Yes
obs		899		827
year		2013		2013
R-squared		0.369		0.375

Note: ***, **, and * stand for statistically significant levels at 1%, 5%, and 10%, respectively.

Table 3. Regression results of Questions 7 to 10

	(1)		(2)	
	<i>Risk awareness</i>		<i>Opportunity awareness</i>	
	Coef	S.E.	Coef	S.E.
Q7. Emissions trading schemes:				
Currently in participation	0.182**	(0.078)	0.134**	(0.078)
Anticipating to participate in 2 years	0.090	(0.106)	0.138	(0.109)
Q8. Originated/purchased carbon credits	0.191**	(0.089)	0.222**	(0.088)
Q9. Scope 3 emissions verification/assurance status:				
Incomplete third-party v/a: last year's statement available	0.238	(0.164)	0.124	(0.163)
Incomplete third-party v/a: first year it has taken place	0.178	(0.167)	0.283**	(0.162)
Complete third-party v/a	0.354***	(0.079)	0.232***	(0.077)
Q10. Engagement with elements in value chain				
Suppliers	0.303***	(0.067)	0.273***	(0.067)
Customers	0.272***	(0.060)	0.175***	(0.062)
Other partners	0.043	(0.080)	0.137**	(0.079)
Constant	1.846	(0.086)	1.778	(0.092)
Country dummy		Yes		Yes
Industry dummy		Yes		Yes
Obs		788		743
Year		2013		2013
R-squared		0.308		0.299

Note: ***, **, and * stand for statistically significant levels at 1%, 5%, and 10%, respectively.

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