

The Correlation between Climate Change and Corporate Performance

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Received 13 September 2018; revised 17 August 2019; accepted 22 October 2019

The purpose of the study is to verify the correlation of the climate change risk focusing on the influence of carbon emission on the corporate performance and discriminative response of corporate contingent upon the publication of Sustainability Report. The results of this study show that there is a negative (-) relationship between Carbon emission intensity and corporate performance. And the negative influence of carbon emission intensity on corporate performance was found to be smaller for companies that published sustainability reports than for those that did not. This study provided empirical evidences on why corporate's active reactive activities according to the climate change is essential for sustainable development.

Keywords: Climate Change, Carbon Emission, Voluntary Disclosure, Sustainability Report, Corporate Performance

Introduction

The international community has put much effort into establishing a new international climate order since the Kyoto Protocol, which was agreed in 1997, its expiration in 2020. And, under the Paris Agreement, which came into force in 2015, countries around the world are making active changes with sympathy on carbon reductions (forced greenhouse gas emissions reductions etc.). The main contents of the 'Paris Agreement' is to reduce greenhouse gas emissions in stages so that the average global temperature does not rise by more than 2 degrees Celsius compared to before industrialization. To this end, many countries around the world restrict greenhouse gas emissions through climate policies such as carbon taxes, carbon trading system, and emission and technology regulations. After all, the realization of the climate risk issue is taken to the survival of businesses, there is a growing interest of various stakeholders, including the investors about the environmental performance management capabilities of enterprises to respond to climate change. As such, companies faced with the most important challenges of the 21st century across the political, economic and social about climate change are the core management

activities^{1, 2, 3, 4, 5, 6}. The purpose of this study was to verify whether carbon emission of companies affect the corporate performance. In addition, this study further examined the effect of the publication of sustainability report on the relationship between carbon emission and corporate performance.

Hypotheses

Previous studies have been conducted on the impact of environmental risk management on corporate performance. Many studies have measured the corporate performance of a company such as PER(Price Earnings Ratio) in the stock market or accounting performance such as ROA. In the meantime, however, studies have continued until recently, it showed conflicting views each other. Russo and Fouts⁷, Konar and Cohen⁸, King and Lenox⁹ etc. argued for a positive (+) relationship between environmental risk management and corporate performance. On the contrary, Sakis and Cordeiro¹⁰ and Rassier and Earnhar¹¹ argued that there is a negative (-) relationship. These conflicting results were reported due to differences in company or industry characteristics, analytical methods, targets, duration etc. In general, when companies invest in facilities and equipment to comply with environmental regulations, it is inevitable to invest funds, but prior investments to reduce environmental

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risks result in cost reduction by reducing pollutant emissions in the production process¹². And, there are significant potential benefits such as increased sales and improved firm value due to corporate image improvement for environmental responsibility^{13, 14}. In the long run, however, management of environmental risks can improve the corporate performance. However, some studies have reported that corporate performance may be higher in the short term by not investing in environmental risk management. This is therefore an empirical question. But, institutional investors, which are the main source of corporate funding, are evaluating the company's response to climate change as the main item, and environmental risk management along with the change of the times emphasizing corporate social responsibility (CSR), the pressure of stakeholders for environmental risk management has been constantly growing. Therefore, environmental risk management activities, including carbon emission reductions in corporate management, can lead to additional costs, can be a constraint on production activities, and can influence investors' decisions to prevent future losses; relationship between carbon risk and corporate performance needs to be verified accordingly by the following hypothesis 1.

Hypothesis 1: Companies with higher carbon emission intensity (carbon emission compared to sales) have lower corporate performance.

There have been a variety of previous studies on the relationship between environmental performance and corporate performance of companies including carbon emission information. Matsumura *et al.*¹⁵ utilized CDP information to analyze the correlation between voluntary disclosure of carbon emission and firm value. As a result, the firm value decreased whenever the carbon emission of the company increased, firm value of companies disclose carbon emission information was shown to be higher than the company does not disclose which a certain penalty for the carbon emission of companies in the market. If you give a disclosure of the information and mitigate carbon emission, it said the results suggest that in assessing the firm value that considers both whether a voluntary disclosure of carbon emission and carbon emission information. Saka and Oshika¹⁶, in a study analyzing the correlation between carbon emission and firm value of Japanese companies, there was a negative(-) correlation between carbon emission and stock prices. Sustainability report published conduct

of companies is a voluntary disclosure to stakeholders through not only be seen as a voluntary management of the environmental performance, but can be seen as an effort to notify their performance positively. Therefore, companies that publish sustainability reports will have relatively good environmental performance, and this behavior is expected to ultimately reduce environmental risks and have a positive impact on corporate performance. In conclusion, it was expected that the disclosure activities through the sustainability report of companies with excellent environmental performance would mitigate the effects of environmental risks on corporate performance. Thus, hypothesis 2 as follows was set.

Hypothesis 2: The publication of the Sustainability Report serves as a modulator to mitigate (offset) the negative impact of carbon emissions on corporate performance.

Methodology

Sample and Data

This study does not belong to the financial industry among companies submitting 'GHG / Energy Target Management Statement' of all companies listed in Korea's stocks market (KOSPI and KOSDAQ) from 2012 to 2017. A total of 552 panel data (92 companies, 6 years) were analyzed empirically. In the case of companies belonging to the financial industry was excluded from the data, because the form of financial statements and the nature of accounting subjects are different from the general manufacturing industry, and thus they cannot be compared and analyzed. In order to remove the influence of the extreme values included in each variable on the analysis results, the analysis was performed after the observations of the samples corresponding to extreme 1% of all variables were processed by the winsorization method.

Variable definition

ROE, the dependent variable in this study, is measured by dividing the net income as a variable representing the company's corporate performance as underlying assets. The independent variable *CARBON* is a proxy for climate change risk, meaning carbon emission intensity. It can be calculated by dividing carbon emission into sales. *REPORT* is a dummy variable that indicates whether to publish a sustainability report. It has a value of 1 for companies that publish sustainability reports and 0 for those that do not. As control variables, the variables including

corporate size (SIZE), debt ratio(LEV), operating cash flow(CFO), sales growth rate(GROWTH), and operating risk(RISK) were included. SIZE was measured as the natural logarithm of total assets, and LEV was calculated by dividing total liabilities by basic total capital. The CFO was calculated by dividing operating cash flows by basic assets, GROWTH by revenue growth compared to the previous year, and RISK by dividing the sum of inventory and trade receivables by basic assets. Internal and external governance factors are also expected to affect corporate performance, so the following variables are included as control variables. The size of the auditor(BIG4), foreign investor's share(FOR), maximum shareholder share(OWN), financial analyst(FOLLOW), board size(BDSIZE), and outside director ratio(OUTBD).BIG4 is a dummy variable that has a value of 1 for companies audited by BIG4 auditors and 0 otherwise. FOR and OWN were measured by the shareholding rate of foreigners and largest shareholders, respectively. BDSIZE was measured by the natural logarithm of the number of board members and OUTBD by the ratio of outside directors among all directors. MARKET is a dummy variable with a value of 1 for KOSPI market firms and 0 for KOSDAQ market firms to control the effects of market types. Finally, dummy variables by industry and year are included as control variables.

Model

Regression equations for hypothesis verification 1 as following equation (1).If the increase in carbon emissions deteriorates a corporate performance, α_1 is expected to have a negative(-) value.

$$ROE_t = \alpha_0 + \alpha_1 CARBON_t + \alpha_2 SIZE_t + \alpha_3 LEV_t + \alpha_4 CFO_t + \alpha_5 GROWTH_t + \alpha_6 RISK_t + \alpha_7 BIG4_t + \alpha_8 FOR_t + \alpha_9 OWN_t + \alpha_{10} FOLLOW_t + \alpha_{11} BDSIZE_t + \alpha_{12} OUTBD_t + \alpha_{13} MAEKET_t + \Sigma YEAR + \varepsilon \quad \dots (1)$$

Equation (2) is a regression equation for hypothesis 2.

$$ROE_t = \beta_0 + \beta_1 CARBON_t + \beta_2 REPORT_t + \beta_3 REPORT * CARBON_t + \beta_4 SIZE_t + \beta_5 LEV_t + \beta_6 CFO_t + \beta_7 GROWTH_t + \beta_8 RISK_t + \beta_9 BIG4_t + \beta_{10} FOR_t + \beta_{11} OWN_t + \beta_{12} FOLLOW_t + \beta_{13} BDSIZE_t + \beta_{14} OUTBD_t + \beta_{15} MAEKET_t + \Sigma IND + \Sigma YEAR + \varepsilon \quad \dots (2)$$

The model was established by adding *REPORT*, a dummy variable that indicates whether to publish a sustainability report in equation (1), and also combined the *REPORT* variable and the carbon emission intensity(*CARBON*) variable. Added the *REPORT*CARBON* variable. *REPORT*CARBON* is discriminatory effect as a variable that refers to the difference in whether published sustainability reports about the impact of carbon emission on the corporate performance, the incremental effect is a variable to analyze. If voluntary disclosure, the publication of a sustainability report, can mitigate the negative impact of carbon emission on a corporate performance, β_3 is expected to have a positive(+) value.

Results and Discussion

Table 1 shows the descriptive statistics of the main variables used in the empirical analysis for hypothesis

Table 1 — Descriptive Statistics for the Variables

Variables	Mean	Std. Dev.	Minimum	Q1	Median	Q3	Maximum
<i>ROE</i>	0.025	0.184	-1.033	0.006	0.045	0.088	0.549
<i>CARBON</i>	0.001	0.002	0.000	0.000	0.000	0.001	0.012
<i>REPORT</i>	0.272	0.445	0.000	0.000	0.000	1.000	1.000
<i>SIZE</i>	21.585	1.672	18.791	20.253	21.507	22.708	25.616
<i>LEV</i>	1.447	1.960	0.058	0.439	0.935	1.616	12.217
<i>CFO</i>	0.068	0.064	-0.079	0.029	0.062	0.104	0.256
<i>GROWTH</i>	0.005	0.148	-0.431	-0.072	-0.003	0.067	0.567
<i>RISK</i>	0.204	0.095	0.035	0.137	0.191	0.261	0.469
<i>BIG4</i>	0.868	0.339	0.000	1.000	1.000	1.000	1.000
<i>FOR</i>	0.162	0.165	0.001	0.038	0.107	0.226	0.752
<i>OWN</i>	0.425	0.162	0.083	0.301	0.413	0.540	0.775
<i>FOLLOW</i>	0.345	0.694	0.000	0.000	0.000	0.000	2.944
<i>BDSIZE</i>	1.967	0.370	1.099	1.792	1.946	2.197	2.773
<i>OUTBD</i>	0.435	0.180	0.000	0.333	0.500	0.571	0.857
<i>MK</i>	0.957	0.204	0.000	1.000	1.000	1.000	1.000

testing. Descriptive statistics were presented in order of mean, standard deviation, minimum, first quartile, median, third quartile, and maximum. From the suggested contents, the mean of *ROE*, the dependent variable, was 2.5%, the maximum value 55%, and the minimum value -103%. In the case of *CARBON*, the main explanatory variable, the average was 0.1% and the maximum value was 1.2%. About 27% of the total sample published sustainability reports, and about 87% of companies received audits from BIG4 auditors. The ratio of outside directors is 43% on average.

Table 2 presents the Pearson's correlation coefficients for the variables used in the hypothesis testing. As predicted in Hypothesis 1, *ROE* showed a significant negative(-) correlation with *CARBON* at 1% level. This suggests that the higher the amount of carbon emission, the lower the corporate performance. *LEV* also showed a significant negative(-) correlation with *ROE* at 1%. *REPORT*, *SIZE*, *CFO*, *GROWTH*, *FOR*, *FOLLOW* were found to have a significant positive(+) correlation with *ROE*.

Through these results, it was found that companies with sustainability reports, corporate cash flows, growth potential, foreign investor's equity ratio and financial analysts had higher corporate performance than those with relatively low sustainability reports.

Table 3 presents the regression analysis results for hypothesis testing. Model 1 in Table 3 is the test result of hypothesis 1. The F-value showed significant results at 1% level, and the Adjusted-R2 value, which represents the explanatory power of the model, was 0.292. As a result of the regression analysis, α_1 , which is the coefficient of carbon emission intensity on corporate performance, was -12.061 (t-value -2.49), which is a significant negative value at 1% level. This means that the more successful companies that reduce carbon emission through aggressive climate change activities, the better their corporate performance. In other words, reducing the cost burden on environmental costs due to the reduction of carbon emission not only has a positive effect on the company's profitability, but also positively improves the company's image, ultimately leading to improved

Table 2 — Pearson Correlation Coefficients

Variables	ROE	CARBON	REPORT	SIZE	LEV	OCF	GROWTH	RISK	BIG4	FOR	OWN	FOLLOW	BDSIZE	OUTBD	MK
ROE	1.000														
CARBON	-0.129	1.000													

REPORT	0.129	-0.156	1.000												
	***	***													
SIZE	0.147	-0.269	0.635	1.000											
	***	***	***												
LEV	-0.399	0.072	-0.010	-0.002	1.000										
	***	*													
CFO	0.318	0.072	0.184	0.179	-0.072	1.000									
	***	*	***	***	*										
GROWTH	0.171	0.022	0.018	0.007	-0.011	0.161	1.000								
	***					***									
RISK	-0.002	-0.065	-0.171	-0.345	-0.032	-0.052	0.070	1.000							
			***	***			*								
BIG4	-0.021	-0.208	0.238	0.367	0.014	0.004	-0.017	-0.008	1.000						
		***	***	***											
FOR	0.204	-0.206	0.444	0.663	-0.175	0.315	0.089	-0.220	0.186	1.000					
	***	***	***	***	***	***	**	***	***						
OWN	0.060	0.059	-0.394	-0.347	-0.109	-0.052	-0.019	0.078	-0.112	-0.336	1.000				
			***	***	***			*	***	***					
FOLLOW	0.088	-0.087	-0.150	0.007	-0.091	-0.012	-0.007	0.042	0.102	0.053	0.051	1.000			
	**	**	***		**			**							
BDSIZE	0.006	0.004	0.158	0.364	0.010	0.047	-0.073	-0.166	0.217	0.207	-0.079	0.155	1.000		
			***	***		*		***	***	***	*	***			
OUTBD	-0.047	-0.043	0.172	0.248	0.030	0.010	-0.144	-0.042	0.181	0.142	-0.108	0.143	0.577	1.000	
			***	***			***		***	***	***	***	***	***	
MK	-0.055	-0.379	0.130	0.199	0.047	-0.131	-0.062	0.139	-0.005	0.152	-0.074	-0.032	-0.022	0.066	1.000
		***	***	***		***		***	***	*					

1) ***, **, * represents the significance level at 1, 5, and 10%, respectively

Table 3 — The Association between Climate Change Risk and Corporate Performance

Variables	model 1			model 2		
	Coeff.	t-stat		Coeff.	t-stat	
<i>Intercept</i>	-0.288	-1.88	*	-0.234	-1.40	
<i>CARBON</i>	-12.061	-2.49	***	-15.691	-3.14	***
<i>REPORT</i>				0.001	0.03	
<i>REPORT*CARBON</i>				23.855	2.67	***
<i>SIZE</i>	0.018	2.48	***	0.016	2.02	**
<i>LEV</i>	-0.036	-9.40	***	-0.035	-9.32	***
<i>CFO</i>	0.686	5.81	***	0.681	5.78	***
<i>GROWTH</i>	0.108	2.20	**	0.112	2.29	**
<i>RISK</i>	0.142	1.61	*	0.178	2.01	**
<i>BIG4</i>	-0.053	-2.39	**	-0.061	-2.76	***
<i>FOR</i>	-0.045	-0.72		-0.066	-1.06	
<i>OWN</i>	0.086	1.82	*	0.083	1.75	*
<i>FOLLOW</i>	0.020	1.80	*	0.019	1.75	*
<i>BDSIZE</i>	0.016	0.64		0.024	0.92	
<i>OUTBD</i>	-0.017	-0.31		-0.042	-0.76	
<i>MK</i>	-0.068	-1.71	*	-0.084	-2.11	**
$\sum IND$	<i>Included</i>			<i>Included</i>		
$\sum YEAR$	<i>Included</i>			<i>Included</i>		
F value	9.75***			9.45***		
Adjusted R^2	0.292			0.301		
N	552			552		

corporate performance. This is consistent with the results of previous studies (Griffin and Mahon, 1997¹¹; Clarkson et al., 2004¹²). On the other hand, *SIZE*, *CFO*, *GROWTH*, *RISK*, *OWN*, and *FOLLOW* are found to have a significant positive(+) value. The relatively high growth companies showed high corporate performance. Model 2 in Table 3 analyzes the effect of hypothesis 2, whether the sustainability report is published on the relationship between carbon emission intensity and corporate performance. The F-value was found to be significant at the 1% level, and the Adjusted-R2 value, which represents the explanatory power of the model, was 0.301. As a result of regression analysis, 23.855(t-value 2.67) of β_3 , which is a factor of *REPORT*CARBON*, representing the incremental effect of the publication of sustainability report on the relationship between carbon emission and corporate performance, was significant at 1%. These results indicate that the negative impact of carbon emission on corporate performance is relatively small in companies that publish sustainability reports. Companies that publish sustainability reports are expected to achieve better environmental performance than those that do not, and the reduction of climate risks, including carbon emission, has

been shown to improve corporate performance. Therefore, test results for Hypothesis 2 of the study, if the carbon emission management and publishing them sustainable, which is classified as a relatively environment and good companies, who are trying to inform the stakeholders report corporate carbon emission on the corporate performance.

Conclusion

The purpose of this study is to examine the effects of climate change risks, namely carbon emission, on the company's corporate performance, and to verify the differential responses of the sustainability report. As a result of the verification, the corporate performance of companies with high carbon emission intensity is relatively low, and it is confirmed that the level of response to climate change risk, that is, efforts to reduce carbon emission, is directly related to the corporate performance of companies. In addition, the negative impact of carbon emission intensity on the company's corporate performance was found to be smaller in the companies that published the Sustainability Report than in the unpublished companies. As a result, the disclosure of sustainability management performance through voluntary disclosure means that it partially offsets the negative effects of climate change risks. The result of this study is academically meaningful in that it shows that climate change risk factors also act as determinants of firm value in Korean capital markets. And the results of this study suggest that empirical evidence suggesting that the company's active response to climate change is essential for the sustainable development of the company, and provided useful information for decision making by various stakeholders of the company.

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