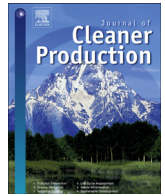




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The effect of carbon risk on the cost of equity capital

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ABSTRACT

This study uses greenhouse gas (GHG) emissions data to investigate the effect of carbon risk on the cost of equity capital. The Korean government launched the GHG Energy Target Management Scheme in 2010 and required designated companies to report GHG data verified by third-party sources. An empirical analysis of a sample of 379 firms from the period 2007 to 2011 suggests the following: carbon intensity (proxy for carbon risk) is positively related to the cost of equity capital. Additionally, the effect of carbon intensity on the cost of equity capital is no different between companies that voluntarily disclosed sustainability reports and those that did not. Finally, the effect of carbon intensity on the cost of equity capital is lower for individual firms that belong to industrial sectors with large GHG emissions in terms of volume. This result has an important implication for the companies' CEOs, management, policymakers, and investors. Companies' efforts to improve carbon productivity are suggestively compensated by the reduction in the cost of capital, which then increases the firm's value. The results are also indicative of how the effective management of GHG lessens the negative effect of carbon risk on the cost of equity capital.

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1. Introduction

Accounting literature has documented various factors that determine the cost of equity capital.¹ Among them, market beta (Fama and French, 1993; Gorden and Gorden, 1997; Fernando et al., 2008; Ahmed et al., 2008; hope et al., 2009), financial leverage (Modigliani and Miller, 1958; Fernando et al., 2008; Ahmed et al., 2008), and operating leverage (Barth et al., 1999; Gode and Mohanram, 2003) are the most prominent measures that determine the cost of equity capital. Additionally, the book-to-market ratio (Fama and French, 1992, 1995; Dhaliwal et al., 2008), variance of financial analysts' earnings forecasts (Chen et al., 2004; Botosan and Plumlee, 2005), return-on-assets (Dhaliwal et al., 2008; Hope et al., 2009; Pittman and Fortin, 2004), and firm size (Amihud and Mendelson, 1986) have been used to explain the cross-sectional differences in the cost of equity capital.

While those variables account for financial and operational risks and other firm characteristics that are correlated with a firm's

various risks, few studies have explored the correlation between climate change-related risk (hereafter called carbon risk) and the cost of equity capital. Carbon risk represents future potential losses or current, although mostly off-balance sheet, debts due to increasingly severe regulations on the emission of greenhouse gas (GHG) across the globe. The Kyoto Protocol came into effect in 2007 and required all Annex I countries to reduce their GHG emissions to an average of 5.2% below 1990 levels by 2012. The specific reduction targets differ between countries depending on their degree of economic development and level of technology.²

Coupled with the market trading of emissions rights, the regulation imposed greater costs on less energy-efficient companies because they had to purchase CER (Certified Emission Reduction) in the market from their more energy-efficient counterparts. In addition to the global regulations, many country-level regulations have also imposed severe costs in the form of a CER trading scheme, carbon taxes, penalties, and so on. Thus, all of the firms that emit GHG will be obliged to reduce the GHG originating from their operations. Those with sizable GHG emissions will face a serious deterioration in their cost-competitiveness and the aggravation of growth potential and profitability.

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¹ In finance literature, the cost of capital for a company is defined as the weighted average of the cost of equity capital and the cost of debt. The equity capital represents capital raised from the owners, while the cost of debt is capital raised from lenders.

² The Kyoto Protocol is a modified version of Kyoto Protocol to the United Nations Framework Convention on Climate Change ((UNFCCC) in 1997. Member countries are obligated to reduce GHG (CO₂, Methane, N₂O, PFC, hydrofluorocarbon, SF₆) or have a non-tariff barrier imposed on their country.

Korea signed the Kyoto Protocol but was exempt from the compulsory GHG reduction obligation because it is a non-Annex I Party. The country's short history of industrialization and its relatively under-developed economic status were considered in the decision; however, Korea will certainly have to undergo a mandatory reduction in the second round of the Kyoto Protocol, although negotiations on how to construct a post-Kyoto mechanism and when to resume the second round remain unresolved.

Carbon risk takes various forms in the actual operation of a company. IPCC (2007) has articulated the types of carbon risk³: physical risk, regulation risk, litigation risk, competition risk, production risk, and reputation risk. In addition to the regulation risk, the other types of risks also render heavy GHG-emitters more vulnerable to the future development of labor, financial, and product and service markets. Thus, carbon risk will increase a firm's overall risk and the cost of equity capital. In other words, capital providers will require a higher return from their investment from firms with higher carbon risk.

To reduce GHG emissions from Korean companies, the Korean government planned two important initiatives: the 'GHG·Energy Target Management Scheme,' which came into effect in 2011, and domestic emissions trading, scheduled to begin in 2015.⁴ Under the GHG·Energy Target Management Scheme, energy-intensive companies producing more than 125,000 tCO₂-eq and plants producing more than 25,000 tCO₂-eq annually are designated by the Korean government. The designated companies must report the amount of emissions and energy use for the last three years to the government with third-party verification by March of the second year. In September of the second year, the government negotiates with the companies to set a reduction target for the third year. Companies must submit a plan to meet that target by December of the second year. Throughout the third year, companies work on reducing emissions and energy use and submit the results to the government in March of the fourth year.

The GHG·Energy Target Management Scheme was first implemented fully as the Framework Act on Low Carbon, Green Growth came into effect in 2010. Under the GHG·Energy Target Management Scheme, the government sets the target for GHG emissions as well as energy use for designated companies. Companies are designated as controlled companies if their annual average GHG emission for the last three years exceeds the baseline volume of 125,000 tCO₂-eq as a whole, or if one of their plants emits more than 25,000 tCO₂-eq of GHG annually. For 2012, a total of 471 entities were designated. The GHG emissions of designated entities are approximately 70% of total emissions nationwide.

Table 1 reveals the number of designated companies and the portion of total emissions from the top ten emitting industries. Of the 425 companies that make up approximately 96% of total nationwide emissions, 48% come from the power generation and energy sector, almost half of the total, followed by the steel industry at 13.3%, the petro-chemical and chemical industry at 9.9%, the cement industry at 9.2%, the oil refinery industry at 5.9%, and the semi-conductor industry at 4.5%. The ranking remains the same in terms of the number of the designated companies.

Following the Korean government's announcement of a voluntary target of reducing GHG to 30% below the BAU (business as usual) projection by 2020 at the Copenhagen Climate Summit in

Table 1
Top 10 highest emitting industries (2011).

Ranking	GHG emission (in Mil. CO ₂ ton-eq)		
	Sub-sector	Number of firms	%
1	Power Generation & Energy	212	48
2	Steel	59	13.3
3	Petro & Chemical	44	9.9
4	Cement	41	9.2
5	Oil Refinery	26	5.9
6	Semi-Conductor	20	4.5
7	Waste	7	1.6
8	Pulp and paper	6	1.5
9	Ceramics	5	1.0
10	Transportation	4	0.9
	Total	425	96.0

2009, GHG reduction goals by sector, subsector, and year were set in July 2011. Although all entities were classified into seven sectors, this study focuses on the industrial and energy sectors. For each sub-sector, the reduction rate will accelerate until 2020, and regulation-related carbon risk for designated companies will therefore increase as time passes. Table 2 shows the accelerating reduction target rate for each sub-sector. The power generation, gas and heating sector, for instance, will set the target reduction rate at 1.5%, 3.0%, 6.1% and 26.7% for 2012, 2013, 2015, and 2020, respectively.

Given the target reduction rate for the industrial sector to which each company belongs, each company negotiates its individual reduction target for the following year with the Korean government. Companies that fail to meet the negotiated reduction target will be fined 10 million Korean Won (KRW).⁵ This relatively lenient penalty will be replaced by the obligatory purchase of CERs on the market as the Korean carbon trading market is scheduled to open in 2015. The costs of acquiring CERs on the market to make up the unattained emissions reduction goal are expected to greatly exceed the maximum fine of 10 mil. KRW.

These initiatives have two significant implications for this study: carbon risk has become more imminent for the operations of Korean companies, as failure to meet the reduction target will result in a financial penalty (i.e., fine) until 2014 and will force the purchase of CERs on the market after 2014. Additionally, carbon emissions data verified by third parties has become available, facilitating empirical analysis that was previously impossible or at best unreliable because few Korean companies voluntarily disclosed GHG emissions information, disclosing incomplete, inconsistent, and unreliable information due to the lack of a third-party verification process.

This study investigates whether carbon risk increases a firm's cost of equity capital. A total sample of 379 firm/years from 2007 to 2011 was used in the analysis. Consistent with our expectation, carbon intensity was positively correlated with the cost of equity capital. The positive relationship between carbon intensity and the cost of equity capital grew stronger for firms in low carbon emitting industries. The positive relationship, however, was not affected by the prior voluntary disclosure of GHG information via sustainability reports.⁶

The remainder of this paper is organized as follows: In Section 2, we review prior literature and the GHG·Energy Target Management Scheme in further detail in addition to discussing and developing hypotheses. Section 3 describes the research design and

³ IPCC (Inter-governmental panel on climate change), "Climate Change 2007: Impacts, Adaptation, and Vulnerability: The 4th Assessment Report, 2007.

⁴ Korea enacted the Korean Emission Trading and Allocation System in 2012, which will be enforced in 2015. It is a market based cap-and-trading system in which allocations will be based on grandfathering; emission rights will be allocated free of charge during the 1st planning period from 2015 to 2017.

⁵ 10 million KRW is equivalent to approximately 10 thousand US dollars as of the end of July 2014.

⁶ Some firms publish environmental reports instead of sustainability reports, in which case environmental reports were used.

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