How Does Carbon Footprint Influence Firm Performance

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Abstract
This study examines that carbon footprint from both scopes – direct and indirect – Greenhouse Gas (GHG) emissions influence the focal firm's financial performance. I argue that increasing GHG emissions positively impact short-term financial performance (ROA) however, it negatively impact long-term financial performance (Tobin's q). Empirical findings support this argument and further show that firms in stringent regulation have higher short-term financial returns from the emissions. By investigating two distinct scopes of carbon footprint, this study sheds new light on the importance of environmental performance not only from firms' own operation but also from their supply chain. Furthermore, this study contribute to the understanding that firms in stringent regulation face tradeoff between short-term and long-term returns.

Short-tern Financial Performance (Table 1)

- *H1A: An increase in direct GHG emissions is positively associated with short-term firm performance.*
- *H1B: An increase in indirect GHG emissions is positively associated with short-term firm performance.*
- *H1C:Within industries that face stringent regulations, the relationship between firms' increase in direct GHG emissions and short-term firm performance will be stronger. (Figure 2)*
- *H1D: Within industries that face stringent regulations, the relationship between firms' increase in indirect GHG emissions and short-term firm performance will be stronger. (Figure 3)*

- Firms procure their supply chain networks based on concern for core activities (e.g. cost, quality and faster time-to-market) to maximize efficiencies and achieve competitive advantage (Delmas & Nairn-Birch, 2011).
- In addition, concerns for supplier impacts to the natural environmental are eventually addressed only in the long-term once core-concerns are fulfilled (Vachon and Klassen, 2006).
- The increase in cost to the customer firm from the abatement efforts of its suppliers can compromise an integral part of a firm's advantage over competing firms at the supplier network level especially when the regulatory scrutiny is severe.

Long-term Financial Performance (Table 2)

- *H2A: An increase in direct GHG emissions is negatively associated with long-term firm performance.*
- *H2B: An increase in indirect GHG emissions is negatively associated with long-term firm performance.*

- Scholars have provided 'win-win' hypothesis that firms provide the social benefit by improving environmental performance as well as profit (Hart and Ahuja 1996; Dowell et al., 2002; King and Lenox, 2001, 2002).
- Firms can generate competitive advantage through proactive environmental strategies which decrease regulatory liabilities, mitigate business risks and appeal to important stakeholders (Porter and van der Linde, 1995; Reinhardt 1999; King and Lenox, 2002). King and Lenox (2002) found that only by preventing waste firms can uncover process inefficiencies, reduce unnecessary costs and profit from pollution reduction.
- While the size of a firm's carbon footprint does not harm short-term profitability, the threat of carbon regulation can harm a carbon intensive firm's credit rating and financial markets may similarly devalue firms according to their carbon emissions (Busch and Hoffman, 2007; Lash and Wellington, 2007; Busch and Hoffman, 2009).
- Green firms are better positioned to minimize future regulatory scrutiny and compliance costs, appeal to increasing consumer demand for environmentally friendly products and benefit from setting the industry standard that may act as a barrier to entry for competitors (Reinhardt, 1999).

Regression Model – GLS regression

- $ROA_{it} = a_i + b_{it}$ *(Direct GHG Emissions)* $+ c_{it}$ *(Supply Chain GHG Emissions)* $+ d_{it}$ *(Direct GHG Emissions*Stringent Regulation)* $+ e_{it}$ *(Supply Chain GHG Emissions*Stringent Regulation) + Industry + Time +* $e_{it,}$
- *Tobin's* $q_{it} = a_i + b_{it}$ *(Direct GHG Emissions)* $+ c_{it}$ *(Supply Chain GHG Emissions)* $+ d_{it}$ *(Direct GHG Emissions*Stringent Regulation) +* e_{it} *(Supply Chain GHG Emissions*Stringent Regulation) + Industry + Time +* $e_{it,}$

where *a* firm *i* belonging to industry *j* in year *t*.

Data

- Publicly trade U.S. companies (2002 – 2012)
- Trucost database
- Compustat North America
- KLD Research & Analytics, Inc. (KLD)

Independent variables - Greenhouse Gas (GHG) emissions

- I use two main independent variables from Trucost database to define a firm's carbon emissions: direct GHG emissions and supply chain emissions based on the Greenhouse Gas Protocal, which is the most widely accepted standard as an accounting tool (Ranganathan, Corbier, Bhatia, Schmitiz, Gage, and Oren, 2004).
- I calculate the direct and supply chain emissions in accordance with the GHG Protocol, which categorizes GHG emissions into three main categories: Scope 1, Scope 2, and Scope3. Scope 1 indicates GHG emissions emitted from sources directly owned or operated by the responsible firms. Scope 2 refers the indirect emissions emitted from purchased electricity, heat or steam. Lastly, Scope 3 includes emissions emitted from all other sources but captured in a focal firm's supply chain.
- In this study, I define *direct GHG emissions* as emissions from Scope 1. Also, I define *supply chain GHG emissions* as sum of both emissions from Scope 2 and 3.

Moderator - Stringent regulation

- Following the prior studies (e.g., Cho and Patten, 2007; Chatterji and Toffel, 2010), I identified firms that operate in a stringent regulatory in terms of environment based on a standard industrial classification (SIC). A dichotomous variable, *stringent regulation*, was coded '1' for companies with a primary SIC code of mining (10), oil exploration (13), paper (26), chemical and allied products (28), petroleum refining (29), metals (33), or utilities (49), and '0' for otherwise.

Results & Conclusions

- Empirical findings support all hypotheses.
- I found that increasing GHG emissions positively impact short-term returns however, it negatively impact long-term firm performance.
- Importantly, GHG emissions from firms' supply chain influence firm performance as significantly as the emissions from firms' own operations.
- Firms under stringent regulation have higher incentive to emitting GHG, which in turn makes firms face trade off situation between the short-term and long-term benefit.

Figure 1. Greenhouse Gas Emissions by Industry in North America 2002-2012 (Average)

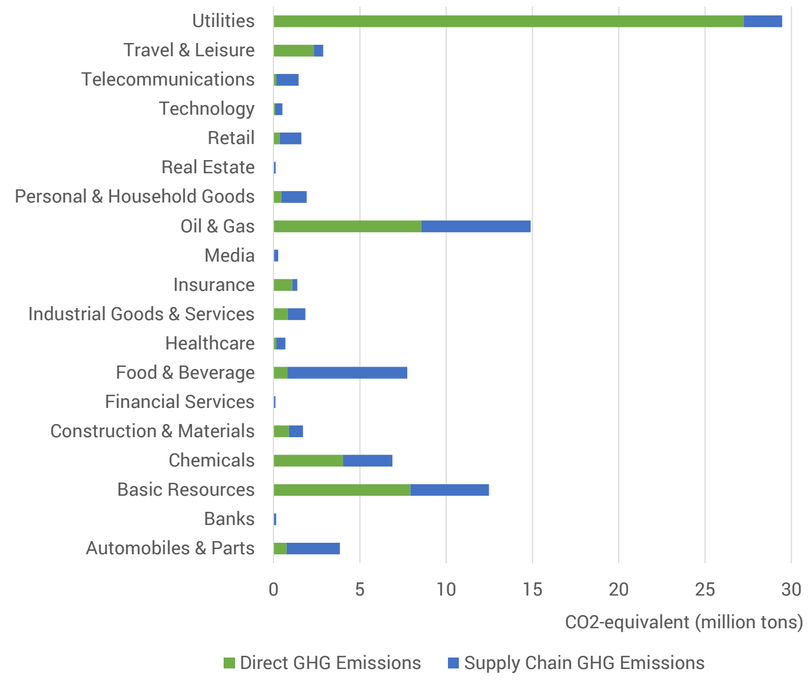

Table 1. The random effects regression model of ROA

	Model 1	Model 2	Model 3	Model 4	Model 5
KLD Environmental Concerns	-0.025	-0.156	-0.492***	-0.478***	-0.517***
	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
KLD Environmental Strengths	-0.070	-0.166	-0.194	-0.204*	-0.205*
	(0.110)	(0.110)	(0.100)	(0.100)	(0.100)
Other Environmental Impacts	Controlled (water abstraction, general waste, land and water pollutant, air pollutant, and natural resource use)				
	0.000	0.000	0.000	0.000	0.000
Firm Size	0.481***	-0.907***	-0.743***	-0.617***	-0.627***
	(0.110)	(0.150)	(0.150)	(0.150)	(0.150)
Leverage	-0.049	-0.046	0.033	0.063	0.067
	(0.080)	(0.080)	(0.080)	(0.080)	(0.080)
Growth	0.126	0.170*	0.192**	0.189**	0.193**
	(0.070)	(0.070)	(0.060)	(0.060)	(0.060)
Capital Intensity	-1.308***	-1.008***	-0.797***	-0.718***	-0.712***
	(0.110)	(0.120)	(0.120)	(0.120)	(0.120)
Disclosure	-0.069	-0.200	-0.536*	-0.393	-0.457*
	(0.230)	(0.230)	(0.230)	(0.230)	(0.230)
Industry dummy included	Yes	Yes	Yes	Yes	Yes
Year dummy included	Yes	Yes	Yes	Yes	Yes
Stringent Regulation	-0.262	-0.997*	-26.860***	-45.445***	-45.743***
	(0.480)	(0.500)	(1.820)	(2.510)	(2.520)
Direct GHG Emissions		0.308**	-0.377***	0.295**	0.098
		(0.100)	(0.110)	(0.100)	(0.120)
Supply Chain GHG Emissions		1.478***	1.584***	0.585***	0.775***
		(0.160)	(0.160)	(0.170)	(0.180)
Direct GHG Emissions*Stringent Regulation			2.106***		0.614**
			(0.140)		(0.210)
Supply Chain GHG Emissions*Stringent Regulation				3.231***	2.704***
				(0.180)	(0.260)
Constant	-7.668***	-19.807***	-13.213***	-6.562***	-6.944***
	(1.400)	(1.730)	(1.770)	(1.880)	(1.890)
Observation	4881	4879	4879	4879	4879
R-sq	0.028	0.047	0.078	0.089	0.090
Wald Chi-sq	193.55***	373.34***	612.18***	737.11***	750.25***

Table 2. The random effects regression model of Tobin's q

	Model 1	Model 2	Model 3	Model 4	Model 5
KLD Environmental Concerns	-0.141	-0.136	-0.155	-0.133	-0.111
	(0.190)	(0.190)	(0.190)	(0.190)	(0.180)
KLD Environmental Strengths	0.004	0.002	0.001	0.002	0.095
	(0.130)	(0.130)	(0.130)	(0.130)	(0.120)
Other Environmental Impacts	Controlled (water abstraction, general waste, land and water pollutant, air pollutant, and natural resource use)				
	0.000	0.000	0.000	0.000	0.000
Firm Size	1.309***	2.289***	2.328***	2.274***	1.889***
	(0.250)	(0.320)	(0.320)	(0.320)	(0.320)
Leverage	-0.079	-0.095	-0.090	-0.097	-0.137
	(0.110)	(0.110)	(0.110)	(0.110)	(0.110)
Growth	0.012	0.018	0.018	0.019	-0.001
	(0.080)	(0.080)	(0.080)	(0.080)	(0.070)
Capital Intensity	-0.825***	-1.049***	-1.019***	-1.060***	-0.663***
	(0.200)	(0.200)	(0.200)	(0.210)	(0.200)
Disclosure	0.071	0.026	-0.013	0.025	-0.032
	(0.280)	(0.290)	(0.290)	(0.290)	(0.260)
Industry dummy included	Yes	Yes	Yes	Yes	Yes
Year dummy included	Yes	Yes	Yes	Yes	Yes
Stringent Regulation	-1.258	-0.106	-6.084	2.058	1.146
	(2.470)	(2.460)	(4.490)	(6.340)	(6.400)
Direct GHG Emissions		-0.524**	-0.684***	-0.527**	-0.715***
		(0.180)	(0.200)	(0.180)	(0.200)
Supply Chain GHG Emissions		-0.908**	-0.915**	-0.846*	-0.227
		(0.330)	(0.330)	(0.370)	(0.370)
Direct GHG Emissions* Stringent Regulation			0.486		0.712*
			(0.310)		(0.340)
Supply Chain GHG Emissions* Stringent Regulation				-0.158	-0.767
				(0.430)	(0.500)
Constant	-13.496***	-3.712	-1.990	-4.495	-6.761
	(3.990)	(4.540)	(4.660)	(5.010)	(5.000)
Observation	4881	4879	4879	4879	4352
R-sq	0.0621	0.0753	0.0754	0.075	0.0653
Wald Chi-sq	102.71	134.5	137.05	134.61	109.32

Figure 2. Moderating Effect of Stringent Regulation on Direct GHG Emissions

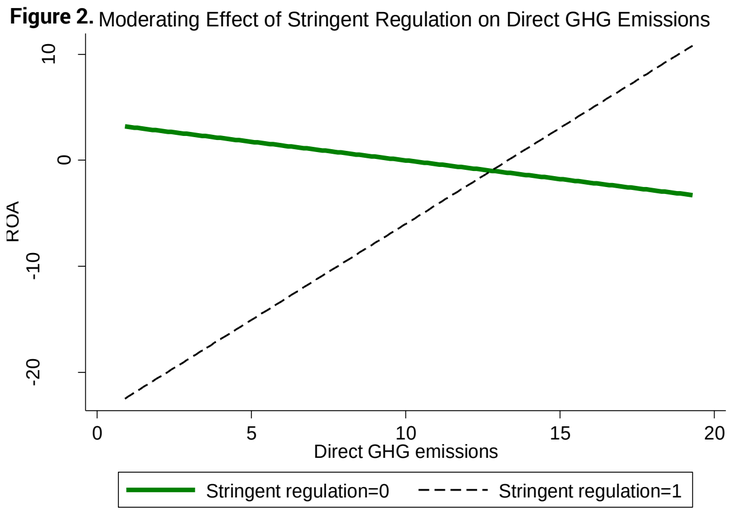

Figure 3. Moderating Effect of Stringent Regulation on Indirect GHG Emissions