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Article

The Effects of Carbon Emissions and Agency Costs on Firm Performance

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Abstract: Carbon emissions and agency costs can have an impact on firms' financial performance. However, limited attention has been paid to the combined and gradual effects of these two factors on firms' performance. We explore the separate and combined effects of carbon emissions and agency costs on firms' financial performance by utilizing data from 2323 US firms that disclosed their environmental information to CDP from 2007 to 2016. The results indicate that firms with higher carbon emissions experience lower performance as the market reacts negatively. Further, firms with both higher carbon emissions and higher agency costs have lower performance. We also investigated year-on-year change in firm performance and found that, keeping agency costs constant, a change in carbon emissions leads to lower performance. Overall, the findings suggest that when the market responds negatively to firms' environmental decisions, high agency costs exacerbate the adverse effect of high carbon emissions on firm performance.

Keywords: agency costs; carbon emissions; firm performance; CDP

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1. Introduction

In recent years, climate change has become a leading issue in business and political agendas, and the focus has been placed on greenhouse gas emissions (GHGE). The Carbon Disclosure Project (CDP 2017) discloses that about 100 active fossil fuel producers account for about 71% of the global industrial GHGE. Some of the popular names associated with the highest emitting companies since 1988 are investor-owned, such as ExxonMobil, Shell, BP, Chevron, Peabody, Total, and BHP. Others are state-owned companies, such as China Coal, Saudi Aramco, Gazprom, National Iranian Oil, Coal India, Pemex, and the China National Petroleum Corporation. The Union of Concerned Scientists reports that China (28%) and the US (16%) account for about 44% of carbon emissions in the world. Lee et al. (2015) report that firms in the United States, Japan, China, and Korea emit carbons mostly from production activities. Whereas all of the reporting entities are expected to find ways to reduce their GHGEs, the high carbon emission-intensive firms are feeling the most pressure (CDP 2017).

The demand for GHGE-related disclosures has increased owing to increased climate change disasters in recent years. The financial impact of climate change disasters is huge for firms. For example, BP Plc's explosion, fire, and, eventually, the sinking of their Deepwater Horizon oil platform in the Gulf of Mexico became the largest marine oil spill recorded in US history. BP Plc suffered an initial dip in the share price of 2.62%, and a further decline of 6.04% two months later (Sabet et al. 2012). The consequences of the oil spill were suffered not only by BP Plc but by its four major subcontractors (Anadarko, Halliburton, Transocean and Cameron International), which also reported a decline in share prices by 1.8%, 1.61%, 3.38% and 4.01%, respectively. The problems for BP Plc and its subcontractors were not limited to the plummeting share price but included several lawsuits filed against the firm. The US government also launched several investigations into the oil spill, which resulted in environmental damage of US$20.8 billion (Noaa.gov 2017). It is, thus, obvious that the oil spill resulted in a huge financial loss for BP Plc. These events are consistent with the argument that a firm's environmental activities are associated with the level of litigation risk (Bui et al. 2020).

It is important to understand the financial implications that firms face in reporting their carbon emissions. First, countries such as the UK have come up with a carbon tax as a compliance requirement (CarbonTax.org n.d.; Lee et al. 2015). Second, the Kyoto Protocol, which includes countries, such as Australia, China, Japan, New Zealand, Singapore, the UK, and the US (Treaties.un.org n.d.), binds industrialized countries to reduce their GHGE. Third, the Paris Agreement involves GHGE mitigation (Unfccc.int n.d.). Finally, some other countries have Emissions Trading Schemes, rules, and regulations designed to reduce GHGE. For example, there is the Clean Water Act and Clean Air Act in the US (EPA.gov n.d.) and the Australian National Greenhouse and Energy Reporting (NGER) Act 2007 in Australia. There is also pressure from firms' stakeholders to increase disclosure of their GHGEs. (Kolk et al. 2008). A number of the firms, mostly from high-intensive emission industries, have taken a voluntary approach to disclose their GHGE. Some firms have also made substantial R&D investments, aimed at finding more efficient and innovative ways of operating while reducing their carbon footprint.

As more firms are voluntarily disclosing their carbon emissions, academic researchers have also examined the impact of these activities on firms' financial performance. While some research papers have found a positive and statistically significant association between climate change performance and firm performance (Borghei et al. 2018; Moyo and Wingard 2015; Wang et al. 2014), others have found neutral or negative results (Alvarez 2012; Lioui and Sharma 2012). Therefore, we studied the impact of carbon emissions on firms' financial performance by drawing upon CDP data from 2007 to 2016.

In addition, another factor that can have a negative influence on the financial performance of a firm is the agency costs that arise owing to differences in the interests of firms' managers and owners (Ang et al. 2000; Jensen and Meckling 1976). Agency costs, in the presence of carbon emissions, may affect the financial performance of a firm. Carbon emissions and agency costs are related since managers may shirk or behave opportunistically, and such actions and behaviors of managers may affect carbon emissions as well as the financial performance of a firm. The impact of carbon emissions may be magnified in the presence of agency costs. Interestingly, the combined impact of both carbon emissions and agency costs remains uninvestigated. Thus, we study the joint impact of these two factors on the financial performance of firms.

The CDP database has been utilized, as it is perceived to be one of the largest and most comprehensive databases recording voluntary reporting of carbon-related performance and activities of large firms around the world (Luo and Tang 2014; Matsumura et al. 2014). This study uses actual carbon emissions instead of carbon scores/indices (Luo and Tang 2014; Velte 2020) to understand the impact of carbon emissions on firm performance. The findings of this paper suggest that firms with higher carbon emissions have lower financial performance and that higher agency costs exacerbate this effect of carbon emissions on firms' financial performance.

This study has the following important implications. First, the firms need to have effective governance mechanisms in place as the impact of carbon emissions on firm performance intensifies in the presence of agency costs. Second, the environmental performance (carbon emissions) has consequences in terms of firm performance. Thus, the firms need to reduce carbon emissions or face a penalty from the market. Focus on reducing carbon risk can add value for shareholders (Bose et al. 2021). This study points to the importance of environmental expectations of firms by the stakeholders/society.

The rest of the paper is organized as follows. Section 2 reviews prior literature and develops hypotheses. Section 3 discusses the research method. Sections 4–6 detail the empirical results, robustness tests and additional analyses, respectively. Finally, Section 7 concludes the paper.

2. Literature Review and Hypotheses

2.1. Carbon Emissions and Firm Performance

Disclosure of corporate-related carbon emissions can have either a win-lose effect or a win-win effect on firms' financial performance. A win-lose effect occurs where efforts made to reduce carbon emissions increase cost, thus, negatively affecting firms' competitiveness in the market. However, firms' climate change-related disclosures can have a win-win effect when efforts made to reduce emissions help improve market competitiveness (Boiral et al. 2012).

Lioui and Sharma (2012) show that environmental corporate social responsibility (ECSR) disclosures have a negative and statistically significant correlation with corporate financial performance (CFP). Using both ROA and Tobin's Q, they have shown that firms with climate change-related disclosures report a lower financial performance. Specifically, their ROA results revealed that "almost a quarter of the average ROA is absorbed by Environmental Corporate Social Responsibility (ECSR)", and thus ECSR is costly. Similarly, Tobin's Q results have revealed that environmental strengths, on their own, decrease a firm's Tobin's Q by 10%, which means that a firm loses its market growth opportunities by almost half. In terms of ECSR concerns, their result shows an almost 90% loss of market valuation of future growth opportunities. Lioui and Sharma's (2012) ECSR-related environmental strengths included beneficial products and services, pollution prevention, recycling, clean energy, and other strengths, whereas the environmental concerns included hazardous waste, regulatory problems, ozone-depleting chemicals, substantial emissions, agricultural chemicals, climate change, and other concerns.

Borghei et al. (2018) suggest that registered GHG firms disclose their carbon emissions information due to the regulations and social pressure to build legitimacy, rather than by managers' discretion. They investigate how climate change-related disclosures affect the cost-benefit framework in non-GHG-registered firms. The authors analyzed carbon emission disclosure information for the years 2009 to 2011 for 146 Australian-listed non-GHG-registered firms. Borghei et al. (2018) first investigated whether the previous year's higher corporate financial performance is a determinant of the present year's GHG reporting in firms. As they could not find enough evidence to say that ROA in the previous year was positively associated with the present year's GHG disclosure, then they analyzed that to see if the present year's GHG disclosures have a positive impact on the subsequent year's corporate financial performance. Here, Borghei et al. (2018) find a significantly positive association and conclude that the present year's climate change-related GHGE disclosures increase firms' financial performance (ROA) in the subsequent year. Thus, firms with "more verifiable and forward-looking GHG disclosure items and a higher level of GHG disclosure achieve the accounting-based benefits of GHG disclosure" (Borghei et al. 2018, p. 336).

Similarly, Gallego-Álvarez et al. (2014) employed the CDP platform and analyzed 855 companies from the multinational Forbes Global 2000 index to investigate the climate performance and financial performance using ROA. Their results did not find any synergistic relationship between the two. However, when they tested whether firms perform better if they care for the environment in times of economic crisis, a higher synergy between environmental and financial performance was found, as investing in sustainable projects during crisis enhances relations with their stakeholders, resulting in greater economic benefits (Gallego-Álvarez et al. 2014).

Alvarez (2012) studied the GHGE data for large international companies worldwide from the Fortune 500. This was for the periods 2006, 2007, and 2008 and, thus, the investigation was for the three periods immediately before the global financial crisis. Results revealed that, although firms were reducing their carbon dioxide in these three years, their ROA was having a significantly negative effect on their firm performance. Alvarez (2012) suggests that decreasing carbon emissions might reduce ROA if some time needs to pass between a firm's first efforts at reducing GHGE and making a financial gain. Alvarez (2012) explains that the assessment of financial performance from GHGE impacts should be made in periods subsequent to the initial efforts.

To illustrate the effects of GHG disclosures on the stock market, Griffin et al. (2017) report that disclosure of GHG emissions decreases a company's stock performance. They further report that the market responds significantly when investors receive fresh emissions-related information, and the stock market responds more significantly to the emissions-related information from other channels, such as K-8 filing with SEC, compared with CDP (Griffin et al. 2017).

As climate change disclosures and corporate social performance is attracting more and more attention from stakeholders, Wang et al. (2014) used the Australian market to measure the association between GHGE and corporate financial performance from the stock market perspective. They used 69 Australian listed companies from ASX200 that had made their GHGE disclosures to the CDP in the years 2010 and 2011, and using Tobin's Q, they measured their market based financial performance. Wang et al.'s (2014) investigation revealed that Tobin's Q is positively related to GHGEs and, hence, Australian firms with GHGE disclosures report higher CFP. Wang et al. (2014) explain that the current structure of the Australian economy is such that they strongly rely on the resource industry, and this industry, on its own, accounts for 89% of the direct and indirect emissions that are either owned or controlled by the entity. Of this 89% emissions, most are produced by two metal and mining sector giants, Rio Tinto and BHP, and, while their GHGE related disclosures show these two companies are high-intensity GHGE producers, they have also been showing strong financial performance and high growth in their CFP.

Lee et al. (2015) investigate climate change and its impacts on both corporate environmental performance and corporate financial performance. The findings revealed that GHG emissions persistently decreased firm value. They stated that firms' negative environmental performance is more consistently penalized by the market than their positive financial performance, as people see the emission of carbon dioxide into the atmosphere as something affecting their health and wellbeing. Lee et al. (2015) had obtained data from 362 manufacturing firms from the Japanese market for this research. As the data they used were from 2003 to 2010, two events were seen as overlaying this sample period. The first was the implementation of the Kyoto Protocol, and the other was the financial crisis of 2008–2010. Lee et al.'s (2015) further analysis of the data, after controlling for these events, reveals that "corporate efforts to comply with international environmental agreements such as the Kyoto protocol, vis-à-vis the global financial crisis, is not a binding constraint on firm performance".

Summing up, carbon emissions and emission reductions can impact firm performance. Firm value can decline with carbon emissions, and the market penalizes firms that do not disclose carbon emissions (Ganda and Milondzo 2018; Matsumura et al. 2014; Nguyen 2018). On the one hand, the spending and initiatives on reducing carbon emissions affect profitability negatively (Alvarez 2012). On the other hand, the reduction of carbon emissions can also increase firm performance (profitability), since customers buy, and stakeholders support, such firms (Lee et al. 2015; Ganda and Milondzo 2018). Further, the stock price of the company can also rise as firms with strong market discipline imposed by stockholders/investors are more likely to reduce GHGE and, consequently, firms that reduce GHGE are more likely to have enhanced firm value (Nishitani and Kokubu 2012). Thus, we propose the following hypothesis:

H1. *Carbon emissions have a negative effect on firm performance.*

2.2. Agency Costs and Firm Performance

Misalignment of interests between firm's managers and firm's owners results in costs to owners/shareholders, called agency costs, and such costs manifest themselves in various forms, such as on-the-job perks, shirking, and making self-interested and entrenched decisions (Ang et al. 2000; Jensen and Meckling 1976). Agency costs affect firm performance and shareholders' wealth negatively. Firms design and implement various corporate governance mechanisms to reduce agency costs (e.g., board characteristics, such as board composition, size and independence may be refined; audit and remuneration committees established, and the ownership structure changed and managed (Allam 2018)). Prior literature suggests that agency costs and firm performance are negatively related (e.g., Ching et al. 2006; Khan et al. 2020; Khidmat and Rehman 2014; Lang et al. 1995) and not all governance mechanisms lead to lower agency conflicts and/or higher firm performance (Allam 2018). Thus, our second hypothesis is as follows:

H2. *Agency costs have a negative impact on firm performance.*

2.3. Carbon Emissions, Agency Costs and Firm Performance

As discussed extensively in hypothesis 1, prior studies of the relationship between carbon emissions (and environmental corporate performance in general) and financial performance have generated conflicting results (Wang et al. 2014). There are examples of positive impacts (e.g., Borghei et al. 2018; Gallego-Álvarez et al. 2014; Wang et al. 2014) as well as negative impacts (e.g., Alvarez 2012; Griffin et al. 2017; Lee et al. 2015; Lioui and Sharma 2012; Matsumura et al. 2014; Nishitani and Kokubu 2012; Nguyen 2018). In addition, agency costs, as discussed in Hypothesis 2, can affect firms' performance negatively (e.g., Allam 2018; Ang et al. 2000; Ching et al. 2006). Both carbon emissions and agency costs can affect the firm's value substantially, and existing studies have not paid attention to the combined effects of these two variables on the financial performance of the firm. Further, the managers may shirk or behave opportunistically, and such actions and behaviors of managers may affect carbon emissions as well as the financial performance of a firm. Thus, we study the impact of both carbon emissions and agency costs on financial performance, and propose as follows:

H3. *Carbon emissions and agency costs have a negative impact on firm performance.*

3. Research Method

3.1. Sample

The sample for this research comprises an initial sample of 3902 US firms for the period 2007 to 2016 that disclose their carbon emissions. We identified firms that disclose their carbon emissions from the Carbon Disclosure Project (CDP), which provides voluntary disclosure of carbon activities (Luo and Tang 2014; Matsumura et al. 2014). The financial data were obtained from Compustat. Firms that have missing variables were excluded. This resulted in a final sample of 2323 firm-year observations that have carbon and financial information. Table 1 reports the sample distribution by industry (panel A) and by year (panel B).

Table 1. Panel A, sample distribution by industry; Panel B, sample distribution by year.

Panel A		
Industry	Observations	Frequency
Consumer Non-Durables	172	7.40
Consumer Durables	45	1.94
Manufacturing	392	16.87
Oil, Gas, and Coal Extraction and Production	101	4.35
Business Equipment	403	17.35
Telephone and Television Transmission	41	1.76
Wholesale, Retail, and Some Services	188	8.09
Healthcare, Medical Equipment, and Drug	154	6.63
Utilities	195	8.39
Other	632	27.21
Total	2323	100.00

Table 1. *Cont.*

Panel B		
Year	Observations	Frequency
2007	116	4.99
2008	156	6.72
2009	196	8.44
2010	215	9.26
2011	232	9.99
2012	267	11.49
2013	279	12.01
2014	247	10.63
2015	292	13.00
2016	323	13.90
Total	2323	100.00

3.2. Regression Model

The equations below show the regression models used to test the hypotheses. This is similar to previous studies such as Albertini (2013) and Matsumura et al. (2014). The dependent variable in both Equations (1) and (2) is financial performance and change in financial performance, respectively. Equation (1) examines the impact of carbon emissions (*CE*) and agency cost (*AC*) on firm performance. Equation (2) examines the impact of the relative change in carbon emissions. Appendix A provides the list and definition of the variables.

$$FP_{it} = \alpha_0 + \alpha_1 CE_{it} + \alpha_2 AC_{it} + \alpha_3 CExAC + \sum\nolimits_{j=4}^{n} \alpha_j Controls_{jit} + FE + \varepsilon \quad (1)$$

$$\Delta FP_{it} = \rho_0 + \rho_1 \Delta CE_{it} + \rho_2 AC_{it} + \rho_3 \Delta CExAC + \sum\nolimits_{j=4}^{n} \rho_j Controls_{jit} + FE + \varepsilon \quad (2)$$

Variables *CE* and *AC* in the above equations are our main interest in this study and are expected to have a negative association with financial performance.

3.3. Measurement of Variables

3.3.1. Financial Performance

Financial performance can be measured using either internal or external performance measures. The internal performance measures are calculated using accounting measures, such as return on assets, return on shareholders' equity, or return on sales. However, accounting measures are subject to manipulations and, hence, we focus on external measures, such as Tobin's Q and market-to-book ratio, which reflect the market response to a firm's environmental activities. This is consistent with previous research such as Nishitani and Kokubu (2012) and Wang et al. (2014) while investigating the association between the reduction of carbon emission and firm value. Following Demsetz and Lehn (1985), Lee et al. (2015) Nishitani and Kokubu (2012) and Wang et al. (2014), we calculate Tobin's Q as the market value of equity plus the book value of liabilities divided by the book value of assets. Market-to-book is calculated as the market value of equity divided by the book value of equity.

3.3.2. Carbon Emissions

We use two alternative measures for carbon emissions. Our first measure calculates carbon emissions as the natural logarithm of absolute emissions, which is the aggregate of Scope 1 and Scope 2 carbon emissions. Prior literature such as Bui et al. (2020), Chapple et al. (2013), and Luo and Tang (2014) measure carbon emissions as total carbon emissions divided by sales revenue. However, this measure creates a significant number of outliers, which may bias the results. Following Bui et al. (2020), our second measure is the change in carbon emissions over time. This is calculated by the difference in carbon emissions between the current year and the previous year.

3.3.3. Agency Costs

Following Ang et al. (2000), we measure agency cost (*AC*) as the ratio of sales revenue to total assets (asset turnover). This is an efficiency ratio (asset turnover), which measures the efficient utilization of assets. Poor deployment of assets may result in a loss of revenue. Also, self-interested management might exert insufficient effort to generate revenue. We multiply the asset turnover by −1 so that higher values will reflect higher agency costs.

3.3.4. Control Variables

Consistent with prior studies on performance, we include several control variables at the firm and industry levels. The firm-level controls include firm size (*SIZE*), leverage (*LEV*), growth (*GWTH*), market capitalization (*MC*), capital expenditure (*CAPEX*), tangibility (*TANG*), and *BIG4*. The literature shows a strong relationship between firm size and financial performance (Clarkson et al. 2008; Cormier et al. 2005; Freedman and Jaggi 2005; Liu and Anbumozhi 2009; Stanny and Ely 2008). Prado-Lorenzo et al. (2009) show that a firm's size is positively associated with carbon emission. Firms with high leverage are more likely to report detailed information about their carbon emissions and climate change-related risks and opportunities (Clarkson et al. 2008; Freedman and Jaggi 2005; Siddique 2018). Similar to previous studies, we argue that growth (*GWTH*) is positively related to environmental performance (Al-Tuwaijri et al. 2004; Siddique 2018). Consistent with Clarkson et al. (2008), we argue that firms with high market capitalization, capital intensity, and tangibility are likely to have superior environmental performance and, hence, their underlying market value and performance will be affected (Bui et al. 2020). Firms with *BIG4* auditors are likely to face scrutiny and to provide quality financial and carbon information and this will have a positive impact on their performance (Datt et al. 2020). Similar to Bui et al. (2020), we control for whether a firm is from a highly litigious industry (*LIT*) or an environmentally sensitive industry (*IEI*). Firms in highly litigious industries spend extra funds and effort on legal suits, and this may have a negative impact on their performance. Firms that operate in environmentally sensitive industries require more expenditure to control their environmental impact.

To capture industry characteristics on firm performance other than carbon emissions, we include industry-fixed effects. Further, we include year-fixed effects to control for macroeconomic factors that may affect firm performance. We provide definitions of all variables in the Appendix A.

4. Empirical Results

4.1. Descriptive Statistics

Table 2 provides descriptive statistics. The average firm performance measured by *TOBQ* is 2.15 and by *MTB*, 3.20. The average firm-level *CE* is 13.47 and the *AC* is −0.75. The results also show that on average, firms reduce the carbon emissions over the sample period by −0.004. For the firm-level control variables, the average *SIZE* is 9.93, *LEV* is 27%, *GWTH* is 3%, *MC* is 9.69, *CAPEX* is 4%, *TANG* is 55%, and almost all of the firms are audited by a BIG4 audit firm. For the industry-level control variables, 24% are from highly litigious industries and 16% are from environmentally sensitive industries.

Table 2. Descriptive statistics.

Variable	N	Mean	Median	Std. Dev	Min	Max	Perc (25)	Perc (75)
TOBQ	2323	2.15	1.12	2.80	0.35	12.92	0.65	2.11
MTB	2323	3.20	2.37	2.46	0.51	9.64	1.48	4.05
CE	2323	13.47	13.38	2.08	10.04	17.27	11.74	15.08
ΔCE	2207	−0.01	−0.00	0.25	−2.47	2.75	−0.07	0.04
AC	2323	−0.75	−0.63	0.54	−2.07	−0.06	−1.03	−0.35
SIZE	2323	9.93	9.86	1.28	7.80	12.49	8.93	10.74
LEV	2323	0.27	0.26	0.15	0.03	0.62	0.15	0.36
GWTH	2323	0.03	0.03	0.12	−0.22	0.40	−0.03	0.09
MC	2323	9.69	9.65	1.20	6.92	11.82	8.91	10.46
CAPEX	2323	0.04	0.03	0.03	0.00	0.13	0.01	0.06
TANG	2323	0.55	0.47	0.38	0.02	1.35	0.23	0.88
BIG4	2323	1.00	1.00	0.06	0.00	1.00	1.00	1.00
LIT	2323	0.24	0.00	0.43	0.00	1.00	0.00	0.00
IEI	2323	0.16	0.00	0.37	0.00	1.00	0.00	0.00

All variables are defined in Appendix A.

Table 3 reports the Pearson correlation matrix between all of the variables. It shows a significant negative relationship between *CE* and both *TOBQ* (r = −0.09, $p < 0.1$) and *MTB* (r = −0.09, $p < 0.1$), suggesting that higher carbon emissions are associated with lower firm performance, consistent with our H1. The Δ*CE* does not have any significant relation with both *TOBQ* (r = −0.02, $p > 0.1$) and *MTB* (r = 0.00, $p > 0.1$). *AC* has a significant negative relationship with *TOBQ* (r = −0.39, $p < 0.01$) and *MTB* (r = −0.31, $p < 0.01$), suggesting that firms with high agency costs have lower performance. This is consistent with our H2 that agency costs have a negative impact on firm performance. In general, the correlation matrix does not show any potential serious multicollinearity problems. There is high correlation between *MC* and *SIZE* (r = 0.73, $p < 0.01$), *TANG* and *CE* (r = 0.70, $p < 0.01$), and *TANG* and *CAPEX* (r = 0.77, $p < 0.01$). This is not surprising as both *MC* and *SIZE* are used in the literature as a measure of firm size. Also, *TANG* and *CAPEX* have their underlying value from fixed assets while firms with more tangible assets are associated with heavy polluting firms.

Table 3. Pearson correlation matrix.

Variables	−1	−2	−3	−4	−5	−6	−7	−8	−9	−10	−11	−12	−13	−14
1. TOBQ	1													
2. MTB	−0.41 ***	1												
3. CE	−0.09 *	−0.09 *	1											
4. ΔCE	−0.02	0	0.05 *	1										
5. AC	−0.39 ***	−0.31 ***	−0.02	−0.04	1									
6. SIZE	0.50 ***	−0.22 ***	0.31 ***	−0.01	0.39 ***	1								
7. LEV	−0.08 ***	0.18 ***	0.25 ***	−0.04	0.06 ***	−0.13 ***	1							
8. GWTH	−0.12 ***	0.09 ***	−0.07 ***	0.20 *	−0.02	−0.02	−0.09 ***	1						
9. MC	−0.08 ***	0.21 ***	0.27 ***	0.02	0.14 ***	0.73 ***	−0.13 ***	0.10 ***	1					
10. CAPEX	−0.27 ***	0.01	0.55 ***	0.07 *	−0.19 ***	−0.12 ***	0.09 ***	0.01	−0.02	1				
11. TANG	−0.06 ***	−0.10 ***	0.70 ***	−0.01	−0.04 *	−0.01	0.23 ***	−0.12 ***	−0.10 ***	0.77 ***	1			
12. BIG4	−0.01	−0.04 *	0.04 *	0.03	0.03	0.10 ***	−0.08 ***	0.02	0.13 ***	−0.07 ***	−0.07 ***	1		
13. LIT	−0.23 ***	0.13 ***	−0.16 ***	0.06 *	−0.24 ***	−0.12 ***	−0.18 ***	0.09 ***	0.09 ***	0.04 *	−0.15 ***	0.03	1	
14. IEI	−0.18 ***	0.07 ***	0.22 ***	−0.02	−0.03	0.03	−0.02	−0.01	0.18 ***	0.21 ***	0.19 ***	0.03	−0.01	1

All variables are defined in Appendix A. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2. Main Results

To examine the relationship between carbon emissions and firm performance, we focus on the coefficient on *CE* in Columns 1 and 2 of Table 4. Columns (1) and (2) of Table 4 report results from estimation of Equations (1). The results show that the coefficient on *CE* is negative and significant at the 5% level in both Columns 1 and 2 (Coefficient = −0.28, $p < 0.05$ in Column 1 and Coefficient = −0.18, $p < 0.05$ in Column 2). This indicates that firms with higher carbon emissions experience lower firm performance, as the market reacts negatively, and firms need to spend more on their environmental expenditure. Our results are consistent with those of Lee et al. (2015) and support H1. The coefficient on *AC* is negative and significant at the 1% level in both Columns 1 and 2 (Coefficient = −1.91, $p < 0.01$ in Column 1 and Coefficient = −1.45, $p < 0.01$ in Column 2). This indicates that high agency costs are associated with low firm performance, consistent with Khan et al.

(2020) and supports our H2. The coefficient on *CE*AC* is negative and significant at the 1% level (Coefficient = −0.13, $p < 0.01$ in Column 1 and Coefficient = −0.10, $p < 0.01$ in Column 2), suggesting that firms with higher carbon emissions and higher agency costs have lower firm performance, supporting our H3.

Table 4. The effect of carbon emissions and agency costs on firm performance.

	(1)	(2)	(3)	(4)
	TOBQ	**MTB**	**ΔTOBQ**	**ΔMTB**
CE	−0.28 **	−0.18 **		
	(−2.53)	(−2.26)		
AC	−1.91 ***	−1.45 ***	0.03	0.04
	(−3.99)	(−3.75)	(0.62)	(0.75)
CE*AC	−0.13 ***	−0.10 ***		
	(−3.77)	(−3.50)		
ΔCE			−0.02	−0.02
			(1.01)	(1.03)
ΔCE*AC			−0.28 **	−0.21 *
			(−2.05)	(−1.78)
SIZE	1.44 ***	1.24 ***	0.00	0.01
	(16.52)	(19.05)	(0.11)	(0.38)
LEV	1.98 ***	1.78 ***	0.01	0.07
	(5.65)	(6.25)	(0.04)	(0.43)
GWTH	−1.74 ***	−1.46 ***	0.15	0.24
	(−5.59)	(−5.69)	(0.82)	(1.36)
MC	−0.00 ***	−0.00 ***	−0.00	−0.00
	(−20.63)	(−24.11)	(−1.62)	(−1.60)
CAPEX	−5.75 ***	−5.65 ***	4.19 ***	4.13 ***
	(−3.09)	(−3.28)	(2.79)	(2.93)
TANG	0.30	0.22	−0.32 **	−0.34 ***
	(1.61)	(1.33)	(−2.48)	(−2.73)
BIG4	−1.97 ***	−1.93 ***	0.27	0.26
	(−4.04)	(−4.03)	(0.99)	(0.96)
LIT	0.38 ***	0.36 ***	−0.02	−0.02
	(4.38)	(4.66)	(−0.28)	(−0.35)
IEI	0.14	0.07	0.07	0.07
	(1.61)	(0.86)	(1.32)	(1.35)
Constant	−4.69 ***	−4.29 ***	0.28	0.14
	(−5.56)	(−5.77)	(0.72)	(0.40)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2323	2323	2207	2207
Adj R^2	0.52	0.54	0.16	0.15

All variables are defined in Appendix A. Robust *t*-statistics are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, based on two-tailed tests.

Columns 3 and 4 report on the results for the estimation of Equation (2) for the year-on-year change in firm performance as a result of a change in carbon emissions. We find that the relationship between carbon emissions and firm performance weakens. Thus, change in carbon emissions is not significantly associated with change in performance. The coefficient on *ΔCE*AC* is negative and significant at the 5% level in Column 3 (Coefficient = −0.28, $p < 0.05$) and at the 10% level in Column 4 (Coefficient = −0.121, $p < 0.1$). The negative and significant association between the interaction term *ΔCE*AC* shows that keeping *AC* constant, a change in carbon emissions leads to a change in firm performance. Thus, an increase in carbon emissions year-on-year will lead to a decrease in firm performance year-on-year, while keeping agency costs constant. This result confirms our expectations that higher agency cost exacerbates the negative impact of carbon emissions on firm performance.

Overall, our findings suggest that higher agency costs exacerbate the adverse effect of higher carbon emissions, as the market responds negatively to firms' environmental decisions, particularly in firms with high agency costs.

5. Robustness Tests

First, we use a different measure of carbon emissions to corroborate our main findings. This alternative measure is the industry-adjusted emission intensity and is calculated as a firm's emission intensity minus the industry median emission intensity. Following Bui et al. (2020), and Chapple et al. (2013), we measure emission intensity as absolute emissions in metric tons divided by sales revenue. Absolute emissions is the aggregate of Scope 1 and Scope 2 carbon emissions. We then re-estimate Equation (1) and report the results in Table 5. Columns 1 and 2 show that the coefficient on *CE* is negative and significant at the 5% level, suggesting that higher carbon emissions led to lower firm performance. The coefficient on *CE*AC* is negative and significant at the 1% level, indicating that firms with higher carbon emissions and higher agency costs have lower firm performance. Overall, our results are consistent with our main findings.

Second, following Ang et al. (2000), we use the expense ratio, which appears frequently in the finance and accounting literatures, as an alternative measure of agency cost. The expense ratio is calculated as the ratio of operating expenses to sales revenue. This measure captures how effectively operating expenses are managed, and reflects managerial excessive spending on perquisites and nonessential consumption. A higher value of expense ratio, thus, indicates a higher agency cost. We re-estimate Equation (1) and report the results in Columns 3 and 4 of Table 5, Panel A. The results show that the coefficient on *CE* is not significant. The coefficient on *AC* remains negative and significant, although the level of significance drops to the 5% level in comparison to our main results. The coefficient on *CE*AC* is negative and significant at the 10% level when firm performance is measured as *TOBQ*, but not significant when measured by *MTB*.

Third, we develop a fixed-effects estimation model to solve any endogeneity problems concerning omitted variables (Wooldridge 2010). We re-estimate Equation (1) using a fixed effect panel regression model, and the results are reported in Columns 4 and 5. Our main results still hold, as the coefficient on *CE* remains negative and significant and the coefficient on *CE*AC* is negative and significant at the 1% level.

Finally, we use return on assets as an alternative measure of firm performance. This measure is an internal or accounting measure of performance, as opposed to the external measures of performance in our main tests. We measure return on assets as net income before extraordinary items divided by the beginning year's total assets. We re-estimate Equations (1) and (2) and the results are reported in Columns 1 and 2 of Table 5, Panel B. In Column 1, the results show that the coefficient on *CE* is not significant. The coefficient on *AC* remains negative and significant. The coefficient on *CE*AC* is positive and significant at the 5% level when firm performance is measured as *ROA*. This result is inconsistent with the main results. One possible explanation is that firms with high agency costs and high carbon emissions are more likely to manipulate their earnings and, hence, report a higher ROA to conceal their agency position. In Column 2, the coefficient on Δ*CE*AC* is negative and significant at the 10% level, consistent with our main results in Table 4.

Table 5. Robustness tests. Panel A, alternative measure for carbon emissions and agency costs; Panel B, alternative measure for firm performance.

Panel A						
	(1) TOBQ	(2) MTB	(3) TOBQ	(4) MTB	(5) TOBQ	(6) MTB
CE	−0.00 **	−0.00 **	−0.13	−0.15	−0.29 ***	−0.22 ***
	(−2.08)	(−2.10)	(−1.15)	(−1.61)	(−5.44)	(−4.82)
AC	−0.29 ***	−0.23 ***	−5.42 **	−3.61 **	−2.10 ***	−1.53 ***
	(−3.40)	(−3.10)	(−2.43)	(−1.99)	(−3.17)	(−2.69)
CE*AC	−0.00 ***	−0.00 ***	−0.26 *	−0.13	−0.17 ***	−0.12 ***
	(−2.83)	(−3.10)	(−1.71)	(−1.01)	(−3.57)	(−2.94)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2323	2323	2323	2323	2323	2323
Adj R^2 (R^2)	0.50	0.53	0.52	0.55	(0.43)	(0.46)

Panel B		
	(1) ROA	(2) ROA
CE	0.00	
	(0.12)	
AC	−0.04 ***	−0.01 **
	(−3.08)	(−2.12)
CE*AC	0.00 **	
	(2.20)	
ΔCE		−0.02 **
		(−2.53)
ΔCE*AC		−0.01 *
		(−1.93)
Constant	Yes	Yes
Controls	Yes	Yes
Industry FE	Yes	Yes
Year FE	Yes	Yes
Observations	2323	2207
Adj R^2	0.43	0.11

In Panel A, Columns 1 and 2 present the results for an alternative measure of carbon emission. *CE* in Columns 1 and 2 is industry adjusted emission intensity and is calculated as firms' emissions intensity minus industry median emission intensity. Columns 3 and 4 present the results for an alternative measure of agency cost. *AC* in Columns 3 and 4 is the expense ratio which is calculated as the ratio of operating expenses to sales. Columns 5 and 6 report results for fixed effects panel regression. *CE* in Columns 5 and 6 is the natural logarithm of absolute emissions of the aggregate of Scope 1 and Scope 2 emissions. Panel B reports the results for an alternative measure of firm performance. All other variables are defined in Appendix A. Robust *t*-statistics are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, based on two-tailed tests.

6. Additional Analyses

6.1. Regulatory Change

In 2009, the Environmental Protection Agency in the US established a mandatory reporting of greenhouse gas emissions for firms that produce 25,000 or more metric tons of carbon dioxide in a year. We use this regulatory change as an exogenous shock to test whether firms that emit more, experience lower performance post the mandatory reporting. To do this, we use a difference-in-difference design. We classify our sample into polluters and non-polluters.

Studies such as Balachandran and Nguyen (2018) used an industry-based classification of polluters, but we use a firm-based classification of polluters and non-polluters, as this approach is likely to capture the variation in firm-level carbon emission. A firm is, thus, classified as a polluter if it emits 25,000 or more metric tons of greenhouse gas in a year. These firms have higher emission intensities and are more like to face climate change and other environmental issues that may have negative financial impacts. Hence, polluters may incur higher clean-up costs, R&D costs, compliance and litigation costs, or reputation damage costs (Balachandran and Nguyen 2018; Barth and McNichols 1994; Karpoff et al. 2005). We estimate the following regression model:

$$FP_{it} = \beta_0 + \beta_1 POLL + \beta_2 AC_{it} + \sum_{j=3}^{n} \beta_j Controls_{jit} + FE + \varepsilon \quad (3)$$

$$FP_{it} = \delta_0 + \delta_1 POLL + \delta_2 POST + \delta_3 POLL * POST + \delta_4 AC_{it} + \sum_{j=5}^{n} \delta_j Controls_{jit} + FE + \varepsilon \quad (4)$$

$$FP_{it} = \sigma_0 + \sigma_1 POLL * POST + \sigma_2 AC_{it} + \sum_{j=3}^{n} \sigma_j Controls_{jit} + FE + \varepsilon \quad (5)$$

where *POLL* is a dummy variable which takes the value of 1 if the firm is a polluter (that is, it produces 25,000 or more metric tons of carbon emissions) and 0 otherwise. *POST* is a dummy variable which takes the value of 1 for periods after 2009. *POLL*POST* is an interaction term. *Controls* are the same as the control variables used in Equation (1). *POLL* in Equation (3) captures the difference in firm performance between polluters and non-polluters. We predict that polluters will have lower performance as compared with non-polluters. In Equation (4), *POST* and the interaction of *POLL*POST* are included to capture the difference-in-difference analysis. *POLL* in Equation (4) captures the difference in firm performance between polluters and non-polluters in the pre-regulation period, while *POST* captures the change in firm performance for non-polluters in the post-regulation period relative to the pre-regulation period

Our variable of interest in Equation (4) is the interaction term *POLL*POST* which captures the change in firm performance for polluters relative to the change in firm performance following the regulatory change. We predict a negative coefficient on this interaction term.

The result of this analysis is presented in Columns 1 to 3 of Table 6. We use *TOBQ* as the dependent variable in Panel A, and *MTB* in Panel B. The negative and significant coefficient of *POLL* in Panels A and B indicates that polluters experience decreases in firm performance relative to non-polluters. The marginally significant negative coefficient on *POST* in Panel B indicates that non-polluters experience decreases in firm performance during the post-regulation period relative to the pre-regulation period. Further, the coefficient on *POLL*POST* is not significant in Column 2 for both Panels A and B. This suggests that the change in firm performance for polluters relative to non-polluters following the regulatory change is not statistically different. However, the coefficient on *POST*POLL* is negative and significant at the 5% level in Column 3 of Panel A and 10% level in Column 3 of Panel B. Overall, our results support the expectation that polluters experience a significant decrease in firm performance relative to non-polluters.

6.2. Role of Agency Costs after the Regulatory Change

We also examine the role of agency cost to determine whether firms that emit more and have higher agency costs experience lower performance after the regulatory change. We modify Equation (3) to include an interaction term, *POLL*AC*. We also modify Equation (4) to specify a triple-differences model. The modification of Equations (3) and (4) is specified as follows:

$$FP_{it} = \gamma_0 + \gamma_1 POLL + \gamma_2 AC_{it} + \gamma_3 POLL * AC_{it} + \sum_{j=4}^{n} \gamma_j Controls_{jit} + FE + \varepsilon \quad (6)$$

$$\begin{aligned} FP_{it} = \varphi_0 + \varphi_1 POLL + \varphi_2 POST + \varphi_3 POLL * POST + \varphi_4 AC_{it} + \varphi_5 POLL * AC_{it} + \\ \varphi_6 POST * AC_{it} + \varphi_7 POLL * POST * AC_{it} + \textstyle\sum_{j=8}^{n} \varphi_j Controls_{jit} + FE + \varepsilon \end{aligned} \quad (7)$$

Controls contain the same control variables as in previous equations. The variable of interest in Equation (6) is the interaction term *POLL*AC,* which captures the changes in financial performance for polluters who have high agency costs. The coefficient on this interaction term is expected to be negative. The variable of interest in Equation (7) is the interaction term *POLL*POST*AC,* which captures the difference in the impact of the interaction term *POLL*POST* on firm performance for firms with high agency costs. The coefficient on the triple interaction term is expected to be negative.

We present results for the estimation of Equations (6) and (7) in Panels A and B of Table 6, Columns 4 and 5. The results in Column 4 for both Panels A and B show that the coefficient on *POLL*AC* is negative and significant at the 1% level, indicating that polluters with high agency costs have lower firm performance. This result is consistent with our predictions. The result of our triple difference model in Column 5, from the estimation of Equation (7), shows that the coefficient on *POLL*POST*AC* is negative and significant at the 5% level for both Panels A and B. This indicates that the post-regulation reduction in firm performance is significantly greater for polluters with higher agency costs. Overall, our results support the expectations that polluters with higher agency costs experience significant decreases in their financial performance.

Table 6. Panel A, the role of regulatory change on the effect of carbon emissions and agency costs on firm performance (Dep. var. = TOBQ); Panel B, the role of regulatory change on the effect of carbon emissions and agency costs on firm performance (Dep. var. = MTB).

Panel A					
	(1)	(2)	(3)	(4)	(5)
POLL	−0.74 ***	−1.12 *		−1.51 ***	−1.03 *
	(−2.78)	(−1.85)		(−2.91)	(−1.67)
POST		−1.04			−0.29
		(−1.51)			(−0.33)
AC				1.75 ***	0.12
				(3.25)	(0.50)
POLL*POST		0.47	−0.63 **		−0.26
		(0.70)	(−2.15)		(−0.31)
POLL*AC				−1.53 ***	−0.10
				(−2.75)	(−1.16)
POST*AC					1.45 **
					(2.32)
POLL*POST*AC					−1.39 **
					(−2.38)
Constant/Controls	Yes	Yes	Yes	Yes	Yes
Industry/Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2323	2323	2323	2323	2323
Adj R^2	0.51	0.51	0.5	0.51	0.51
Panel B					
	(1)	(2)	(3)	(4)	(5)
POLL	−0.49 **	−0.83 *		−0.99 ***	−0.74
	(−2.45)	(−1.77)		(−2.71)	(−1.57)
POST		−0.88 *			−0.38
		(−1.66)			(−0.59)
AC				1.21 ***	0.12
				(3.21)	(0.61)
POLL*POST		0.41	−0.40 *		−0.09
		(0.80)	(−1.83)		(−0.15)
POLL*AC				−1.02 ***	−0.10
				(−2.61)	(−1.24)
POST*AC					0.97 **
					(2.16)
POLL*POST*AC					−0.94 **
					(−2.29)
Constant/Controls	Yes	Yes	Yes	Yes	Yes
Industry/Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2323	2323	2323	2323	2323
Adj R^2	0.53	0.53	0.53	0.54	0.54

All variables are defined in Appendix A. Robust *t*-statistics are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, based on two-tailed tests.

7. Conclusions

There has been growing demand from society and stakeholders for the disclosure of carbon emissions and reduction in carbon emissions due to environmental concerns.

This has garnered the attention of many researchers and has generated several studies that investigate the impact of such carbon emissions (disclosures) on firms' financial performance (e.g., Alvarez 2012; Gallego-Álvarez et al. 2014; Ganda and Milondzo 2018; Lee et al. 2015; Matsumura et al. 2014; Nguyen 2018; Nishitani and Kokubu 2012, etc.). Carbon emissions and reductions in such emissions can influence firms' performance. For instance, the value of firms can decline with carbon emissions, and the market may penalize firms that do not disclose carbon emissions (Bose et al. 2021; Ganda and Milondzo 2018; Matsumura et al. 2014; Nguyen 2018). The carbon reduction initiatives and expenditures may have a negative impact on profitability (Alvarez 2012). But the reduction of carbon emissions may also increase profitability due to support of customers and stakeholders (Ganda and Milondzo 2018; Lee et al. 2015). Similarly, the market may discipline the firms, and firms that reduce carbon emissions are likely to have enhanced value (Nishitani and Kokubu 2012). Another factor that could impact carbon emissions as well as firm performance is the agency costs. (e.g., Ching et al. 2006; Khan et al. 2020; Khidmat and Rehman 2014; Lang et al. 1995). Carbon emissions and agency costs are related since actions/decisions taken by mangers can also influence carbon emissions. If agency costs are higher, they may amplify the impact of carbon emissions and as a result, may have a higher impact on firm value. Therefore, we explore the combined effects of both carbon emissions and agency costs on firm performance. In addition, we study such effects over time. For this purpose, we utilize data from US firms that disclosed their environmental information to CDP from 2007 to 2016.

The results reveal that firms with higher carbon emissions report lower firm financial performance. This suggests that carbon emissions have an impact on firm performance, which is significantly negative: a win-lose effect, similar to that found in Alvarez (2012), Lee et al. (2015) and Lioui and Sharma (2012). Further, agency costs also have a negative impact on firm performance. Lastly, carbon emissions and agency costs in combination are found to have an impact on firm performance that is significantly negative. The results for the year-on-year change in firm performance show that the relationship between carbon emissions and firm performance weakens over time. This suggests that change in carbon emissions is not significantly associated with change in firms' financial performance. The negative and significant association between the interaction term (i.e., change in carbon emissions and agency costs) and firm performance confirms our expectations that higher agency costs exacerbate the negative impact of carbon emissions on firm performance. Overall, the paper suggests that the market responds negatively to firms' environmental decisions, particularly where firms have high agency costs.

This study has few limitations, as follows. First, this study draws on data from the CDP database which is not the only channel for disclosing carbon emissions data. Firms may disclose carbon related information through other sources such as annual reports and sustainability reports. Future research may utilize information from other sources in addition to the CDP data. Second, this study investigates only US firms and further studies may conduct comparative analyses between US firms and European and/or Asia-Pacific firms. Thirdly, this study focusses only on the impacts of carbon emissions and agency costs on firm performance. Innovation is another factor that could impact both carbon emissions and firm's performance. Future research might explore the relationship among carbon emissions, innovation and firm performance.

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Appendix A

Variable Descriptions

Variable	Label	Definition
Dependent variables		
TOBQ	Tobin's Q	Market value of equity plus the book value of liabilities divided by the book value of assets.
ΔTOBQ	Change in Tobin's Q	The difference in Tobin's Q for current year and previous year.
MTB	Market-to-book	Market value of equity divided by book value of equity.
ΔMTB	Change in Market-to-book	The difference in market-to-book value for current year and previous year.
ROA	Return on assets	Net income before extraordinary items divided by previous year total assets.
ΔROA	Change in Return on assets	The difference in return on assets for current year and previous year.
Independent variables		
CE	Carbon emission	Logarithm transformation of absolute emissions which is the aggregate of Scope 1 and Scope 2 carbon emissions.
ΔCE	Change in carbon emissions	The difference in carbon emissions for current year and previous year.
AC	Agency cost	Ratio of sales revenue to total assets.
CE*AC	Interaction of CE*AC	Interaction term between carbon emissions and agency cost.
ΔCE*AC	Interaction of ΔCE*AC	Interaction term between change in carbon emissions and agency cost.
POLL	Polluter	A dummy variable which takes the value of 1 if a firm emits more than 25,000 metric tons of carbon in a year, and 0 otherwise.
POST	Post regulations	A dummy variable which takes the value of 1 for periods after 2009, and 0 otherwise.
POLL*POST	Interaction of POLL*POST	Interaction term between polluter dummy and post dummy.
Control variables		
SIZE	Firm size	Logarithm transformation of total assets.
LEV	Firm leverage	Ratio of firm's total debts to total assets.
GWTH	Sales growth	Change in sales divided by the beginning of period sales.
MC	Market capitalisation	Number of outstanding shares multiplied by share price.
CAPX	Capital intensity	Capital expenditure divided by total assets.
TANG	Tangibility	Ratio of gross property, plant, and equipment and total assets.
BIG4	Big four audit firms	A dummy variable which takes the value of 1 if a firm is audited by top four audit firms, and 0 otherwise.
LIT	Litigious industries	A dummy variable which takes the value of 1 if a firm is operating in a high-litigation industry, and 0 otherwise.
IEI	Environmentally sensitive industries	A dummy variable which takes the value of 1 if a firm is from an emission-intensive industry, and 0 otherwise.

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