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ORIGINAL RESEARCH

Corporate carbon footprint and market valuation of restructuring announcements

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Abstract
The call for greener and more sustainable corporate practices triggered a surge in corporate restructuring. In this study, we investigate the impact of carbon emissions on the market reaction to announcements of corporate restructuring activities. Using a sample of US firms, we find that investors discount the value of corporate restructuring announcements when firms have higher levels of carbon emissions. Our results indicate that emissions are negatively associated with cumulative abnormal returns (CAR), cumulative total returns (CTR), and buy and hold abnormal returns (BHAR) around announcements. This effect is more pronounced for firms with a lower risk of bankruptcy, those financially constrained, and those with lower growth opportunities. We also find that high emissions at announcements are negatively associated with post-restructuring financial and market performance. Overall, our results highlight the growing implications of firm-level carbon emissions for corporate market valuations, especially amongst firms undertaking restructuring.

Keywords Carbon emissions · Corporate carbon footprint · Corporate reorganization · Corporate restructuring · Market reaction · ESG

JEL Classification G30 · G34 · Q51

1 Introduction

The profound implications of climate change spurred a wave of corporate and industrial restructuring (Reuters, 2007). In the last decade, companies like Alphabet, Siemens, Cisco Systems, Toyota Motors, HP, Unilever, Patagonia, Nestle, Ericsson, and Ikea have been reorganising their operations to ensure they are more sustainable. (CNN, 2018; CNBC, 2019). Although corporate restructuring announcements are price sensitive, the environmental practice of such firms may abate the market valuation of such moves. In general,

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firms engage in corporate restructuring to enhance productivity, reduce cost and enhance performance (Singh 1993). Strategies that may be employed include downsizing, upsizing, or alternating the complementary features of assets, employees and technology (Cascio 2021). It may also take the form of portfolio reconfiguration, through the sale of some business lines, or changes in organizational structure through the disposal or acquisition of assets (Bowman and Singh 1993). Similar to acquisitions and divestment, corporate restructuring may occur as a result of corporate performance, economic cycles, civil unrest, managerial optimism, and disruptive technology in an industry (Cascio 2021). Firms may also restructure to realign strategically with changing times (Eckbo and Thorburn 2008). Ultimately, the goal of restructuring is to increase the likelihood of future profitability (Singh 1993; Eckbo and Thorburn 2008; Cascio 2021).

Despite the potential operational, financial and economic benefits that it brings, corporate restructuring may also have unintended consequences (Brockner et al. 1993; Reilly et al. 1993). One area of concern relates to the potential implications it may have for firms' sustainability. All over the world, governments, institutional investors and other stakeholders are beginning to require more action from companies in terms of their contributory efforts to reducing climate change. In the United States, for example, the Wall Street Journal has recently reported that the US Government, through the Securities and Exchange Commission (SEC), is proposing more stringent requirements for publicly traded companies to report on greenhouse emissions and potential risks to climate (WSJ, 2022).

In this study, we examine the relationship between firms' carbon emissions and the market reactions to the announcement of corporate restructuring activities. Theoretically, we anchor our proposition on the theory of signalling. Firms have more and better information than investors, leading to a problem of information asymmetry, which creates transaction costs of identifying desirable companies (Akerlof 1970). Through restructuring activities, companies can reduce information costs by signalling future potential improvements in efficiency and profitability (Krishnaswami and Subramaniam 1999). However, studies such as Rugman and Verbeke (2000) show that firms' decarbonization drive is increasingly becoming a strong force in corporate strategy and could easily be considered as a sixth force to the five competitive forces first proposed by Porter (1979). Building green momentum and advantage could strategically position a firm, such that in the long run it dominates the market and controls a substantial portion of the market share (Caballero-Morales 2021; Osório 2023; Adamolekun et al. 2024). Nevertheless, it can sometimes be difficult for investors to fully assess firms' environmental commitments, particularly regarding key aspects of their strategy.

We argue that investors consider a firm's environmental commitment when assessing the potential value of its announced restructuring activities. Our empirical analysis is based on testing two competing views. On the one hand, firms that emit more greenhouse gases are likely to have their stock returns discounted by the market during announcements of corporate restructuring activities, leading to a negative effect of emissions on returns around corporate restructuring announcements. On the other hand, corporate restructuring activities may be the outcome of pressure from investors, with the view to increasing productivity and value-creation (Morin 2000; Desender et al. 2016). Hence, firm emissions are likely not to impact stock returns during corporate restructuring announcements. Moreover, corporate reorganization could be deployed specifically as a market signalling tool. To this end, companies that make such announcements may be signalling to the market a transition to more sustainable operations.

Thus, whether or not firms' levels of emissions affect the wealth effects of corporate restructuring announcements remains an open empirical question. We address this question by using a sample of US firms to investigate how emissions affect returns during

corporate restructuring announcements. We focus on short-term returns using Cumulative Abnormal Returns (CAR) and Cumulative Total Returns (CTR) during an 11-day window around announcements of corporate restructuring activities. We find that firms with higher amounts of emissions experience a decrease in both CAR and CTR. This supports the view that markets discount the value of corporate restructuring announcements in firms with higher levels of carbon emissions. In subsample analysis, we find this effect to be prominent for firms with a low risk of bankruptcy, financially constrained firms, and companies with low growth opportunities. In further analysis, we also demonstrate that the information content inferred from firm carbon emissions is distinct from firms' environmental scores. To address the question of why markets discount the value of corporate restructuring announcements by high-emitting firms, we document that high emissions at announcements are negatively related to future firm financial and market performance, with this effect persisting for up to five years after the restructuring announcements.

Our paper contributes to the literature on how carbon emissions affect firm value by focusing on corporate restructuring, a specific approach by which firms may aim to increase their value, especially amidst the call for more sustainable corporate practices. To the best of our knowledge, we are the first study to document how a firm's carbon footprint affects the valuation of its restructuring announcements. Corporate restructuring announcements offer a unique opportunity to understand the implications of corporate environmental practices since it is one of the key strategies deployed by firms to combat their climate risk exposures. Prior studies show that carbon emissions have an effect on firm value (Chapple et al. 2013; Matsumura et al. 2014; Clarkson et al. 2015; Kim et al. 2015; Griffin et al. 2017; Bolton and Kacperczyk 2021; Adamolekun et al. 2022; Perdichizzi et al. 2024; Mariani et al. 2024). We extend this literature by showing that carbon emissions also negatively affect the market reaction to firms' intention to restructure and reorganize. Our findings also complement the literature on firm corporate performance and firm carbon performance (Lewandowski 2017; Busch and Lewandowski 2018; Busch et al. 2022). We demonstrate that it pays to be green when announcing a corporate restructuring activity. We also complement the embryonic argument on carbon premium (Oestreich and Tsiakas 2015; Azar et al. 2021; Benlemlih et al. 2022; Zhang and Zhao 2022; Alam et al. 2022), which argues that corporate carbon emissions have wide-ranging implications on corporate outcomes. Our findings also have important implications for firms as we show that signalling a transition to better environmental practices does not absolve firms of past environmental misbehaviour.

The rest of the paper is organized as follows. We review prior literature and develop our hypotheses in Sect. 2. In Sect. 3, we discuss our research design. We present our main results in Sect. 4 and conduct additional analyses and robustness checks in Sect. 5. Section 6 concludes.

2 Literature and hypotheses development

2.1 Literature review

Theoretically, market reactions to corporate restructuring activities can be viewed from a signaling perspective due to the information effect that they hold (Poon et al. 2001). However, it is well-established that information asymmetry exists between firms and investors, with the former always having more and better information than the latter (Myers and Majluf 1984). This makes it difficult for investors to identify firms with

desirable qualities due to the high transaction costs of doing so (Akerlof 1970). It is thus imperative for firms to reduce information asymmetry by sending credible signals in their corporate decisions. Indeed, Krishnaswami and Subramaniam (1999) argue that restructuring activities help mitigate information asymmetry problems within firms, especially regarding profitability and operational efficiency.

The relationship between firms' carbon emissions and the market reactions to restructuring announcements can therefore be viewed in this context because environmental decarbonization externalities are increasingly seen as an important force in firms' competitive strategy (Rugman and Verbeke 2000). Indeed, pursuing green capabilities could offer firms benefits, both in terms of performance and enhanced reputation (Chen et al. 2023; Rugman and Verbeke 2000), leading to long-run competitive advantage (Osório 2023). Thus, from a strategic viewpoint, while restructuring decisions may be announced to convey signals about corporate competitiveness (Cascio 2021; Eckbo and Thorburn 2008), the potential value of these activities can be assessed by taking into account firms' environmental commitments. Moreover, amidst green transition, firms may elect to restructure as a means of easing excessive exposure to downside transition risks within their competitive environment. Market reaction to corporate restructuring announcements confirms the consensus view of whether such decisions enhance competitiveness. In contrast, if corporate carbon emissions are viewed through the lens of a competitive force, then poor green credentials may be considered inefficiencies in green capabilities and discounted in corporate valuation.

Empirically, several prior studies document a positive market reaction to corporate restructuring announcements (Brickley and Van Drunen 1990; Francis et al. 1996; Bunsis 1997). A few studies, however, also find a negative reaction to restructuring announcements Poon et al. (2001). Thus, investors react to corporate restructuring announcements based on their expectations of how such restructuring activity might lead to improvements in firms' future performance (Jaggi et al. 2009).

Concerning carbon emissions, interest in climate change risk has led to a growing body of research that investigates its relationship with various firm-level outcomes. These studies have focused on the impact of firms' exposure to climate change risk (using a variety of measures) on capital structure (Nguyen and Phan 2020; Adasi Manu et al. 2022), dividend policy (Balachandran and Nguyen 2018), bond returns (Huynh and Xia 2021) and cost of debt (Javadi and Masum 2021). The group of studies most relevant to ours focuses on the implications of carbon risk on firm returns and market value (Chapple et al. 2013; Matsumura et al. 2014; Garcia-Blandon et al. 2020; Choi and Luo 2021; Basse Mama and Mandaroux 2022). For example, Matsumura et al. (2014) use a sample of S&P 500 firms that voluntarily disclosed carbon emissions data between 2006 and 2008 and find that an additional thousand tons of carbon emissions are associated with a decrease in market value by about $212,000. Basse Mama and Mandaroux (2022) examine a sample of US firms and find a concave relationship between firms' emissions and market valuations. At lower levels, emissions appear to have a positive impact on market valuations since they may be considered essential for the production process. Above a threshold, emissions hurt valuations, especially in light of both regulatory and transition risks. Taken together, while carbon emissions may affect some aspects of firm value, little is known about whether and how they affect shareholder wealth around the announcement of restructuring activities.

2.2 Hypotheses development

2.2.1 Carbon emissions and market reactions to restructuring announcements

We rely on the literature articulated above to infer that the relationship between firms' carbon emissions and the market valuation of their restructuring may be unclear (Basse Mama and Mandaroux 2022; Choi and Luo 2021; Garcia-Blandon et al. 2020). On the one hand, given the regulatory, climate, and transition risk associated with increased carbon issues and the growing call to action by policymakers and some institutional investors, corporate restructuring, however well-intended, may be associated with lower returns at announcement if the carbon emissions of the firms involved are high (Adamolekun et al. 2022). On the other hand, as mentioned earlier, corporate structuring is intended to achieve cost reductions, revenue enhancements, and improved efficiency (Eckbo and Thorburn 2008; Cascio 2021). As such, when restructuring announcements are made in line with market expectations, carbon emissions may have no impact on excess firm returns around such announcements, especially as it is considered a non-financial metric. We state our first hypothesis in alternative form as we expect that markets will discount the value of corporate restructuring announcements when firms have higher levels of carbon emissions.

Hypothesis 1 Higher firm carbon emissions are associated with negative returns around corporate restructuring announcements.

2.2.2 Carbon emissions, bankruptcy risk and market reactions to restructuring announcements

The market valuation of restructuring activities may be influenced by a firm's risk of bankruptcy, as bankruptcy serves as a primary mechanism for reorganizing failing companies (Dellisanti and Wagner 2018). Recent studies in the bankruptcy literature show a link between bankruptcy risk and various corporate environmental outcomes. (Feng et al. 2022; Palea and Drogo 2020; Adamolekun 2023). We, therefore, rely on these two strands of literature to infer that the implications of firm carbon emissions on market valuation of restructuring announcements may be moderated by the risk of bankruptcy. On the one hand, firms facing the threat of bankruptcy may deprioritize environmentally responsible policies, given that they may not be held accountable for poor environmental practices (Boomhower 2019). Consequently, they may emit higher levels of carbon than their comparable peers. Moreover, the scarcity of resources and the imperative to focus on survival may lead such firms to neglect their environmental responsibilities (Kabir et al. 2021). On the other hand, firms with lower risk of bankruptcy are expected to invest more to reduce the adverse environmental impact of their operations. Thus, in the presence of high carbon emissions, the market reactions to restructuring announcements may be less favourable for firms with limited risk of bankruptcy. Taken together, firms' carbon emissions should vary in their impact on returns around corporate restructuring announcements based on the level of bankruptcy risk associated with the firm. Accordingly, we hypothesize that:

Hypothesis 2 The impact of carbon emissions on returns around corporate restructuring announcements is more pronounced for firms with a lower risk of bankruptcy.

2.2.3 Carbon emissions, growth opportunities and market reactions to restructuring announcements

Firm growth opportunities constitute a portion of firm value that reflects the valuation of future projects (Miller and Modigliani 1961). Several prior studies find that firm growth opportunities affect corporate decisions (Gaver and Gaver 1993; Goyal et al. 2002; Johnson 2003; Billett et al. 2007). More importantly, some other studies document an impact of growth opportunities on the market reaction to corporate financing and investment decisions (Goergen and Renneboog 2004; Burton et al. 2000). Since restructuring also allows firms to maximize their full growth potential, it can be expected that the cost–benefit pendulum may tilt in favour of the pursuit of growth (Eckbo and Thorburn 2008; Cascio 2021). This would imply an insignificant impact of carbon emissions on the market reaction to corporate restructuring announcements for firms with higher growth opportunities. However, abnormal returns to corporate events are negative for firms with low growth opportunities, especially in the presence of financial constraints (Che et al. 2018). We rely on this evidence to conjecture that during restructuring announcements, firms with higher carbon emissions but lower growth opportunities will experience significantly more negative abnormal returns compared to their high-growth counterparts. This is because firms with exercisable growth opportunities could modify their operations such that they cater for their carbon risk. However, their counterparts with low growth opportunities may find it difficult to alter their operations as doing this may further exacerbate future cash flow risk. This leads us to our third hypothesis, which we state as follows:

Hypothesis 3 The negative impact of carbon emissions on returns around corporate restructuring announcements is more pronounced for firms with low growth opportunities.

2.2.4 Carbon emissions, financial constraints and market reactions to restructuring announcements

Reducing carbon emissions can increase costs to firms due to the investments required to adopt more climate-friendly technologies. Nguyen and Phan (2020) argue that reducing carbon emissions can be particularly challenging for some firms, especially in periods of economic downturns. They find that following the adoption of the Kyoto Protocol, which increased climate risk for firms in Australia, firms' use of leverage falls. Their findings are consistent with the view that increases in carbon emissions may reduce firms' access to capital markets as a result of an increase in the cost of debt (Javadi and Masum 2021; Lemma et al. 2021). To that extent, we expect no significant effect of carbon emissions on returns around corporate restructuring announcements for financially unconstrained firms. This is because, due to their higher contribution and exposure to carbon risk, financially constrained firms are unable to access funds to make the needed corrective investments. Therefore, the carbon premium for financially constrained firms will be typically higher (Zhang and Zhao 2022). However, for firms that are financially unconstrained and with better access to capital markets, we expect that the carbon premium for such firms will be lesser than that of their counterparts, who are otherwise constrained.

Hypothesis 4 The negative impact of carbon emissions on returns around corporate restructuring announcements is more pronounced for firms that are financially constrained.

3 Research design

3.1 Data and sample

We collect data on corporate restructuring announcements for US firms from Capital IQ in the Wharton Research Data Service (WRDS) database between 2010 and 2020. In Appendix 1, we show examples of these corporate restructuring announcements. We collect firm-level financial data from Compustat. We obtain data on firms' carbon emissions from Refinitiv Eikon. Our measure of carbon emissions considers both scope 1 (direct) and scope 2 (indirect) emissions. Merging all three datasets yields 489 corporate restructuring announcements by 207 firms.

3.2 Variables

3.2.1 Market valuation of corporate restructuring announcements measures

We estimate the market valuation of corporate restructuring announcements using cumulative abnormal returns (CAR) and cumulative total returns (CTR). We employ an event study methodology to compute both CAR and CTR. For CAR, we adopt the market model to first determine the abnormal return for each day of an 11-day window $(-5,+5)$ around the announcement. The abnormal returns are defined in the following equation:

$$AR_{it} = R_{it} - \left(\alpha_i + \beta_i RM_t\right) \tag{1}$$

where AR_{it} refers to the abnormal returns of firm i on a day t. R_{it} is defined as the actual return of firm i on day t. RM_t is the return on the S&P 500 index on day t. β_i is the estimated coefficient of the relationship between a firm's returns and the returns on the S&P 500 index during a 100-trading day period prior to the start of the event window. We then calculate the CAR for each firm for the period $[-5,+5]$ around the announcement as follows:

$$CAR = \sum_{t-5}^{t+5} AR_{it} \tag{2}$$

We compute the CTR by summing up the returns for each firm during the event window $[-5,+5]$:

$$CTR = \sum_{t-5}^{t+5} R_{it} \tag{3}$$

In robustness tests, we also employ an alternative method of measuring the market valuation of corporate restructuring announcements using Buy-Hold-Abnormal Returns (BHAR). The BHAR approach evaluates the difference between firms with corporate restructuring announcements and matched portfolios based on similar characteristics (Kothari and Warner 2007). We compute BHAR as:

$$BHAR = \prod_{t=1}^{T}(1 + R_{it}) - \prod_{t=1}^{T}(1 + E(R_{it}) \tag{4}$$

3.2.2 Carbon emissions

We measure carbon emissions using our variable *Emissions Level*, which we compute as the ratio of firms' carbon emissions, in tonnes, to total assets (Safiullah et al. 2021; Garel and Petit-Romec 2022). We scale total emissions by total assets to reflect the carbon emissions of firms relative to their size, which, Aswani et al. (2024) argue, is a better way to determine a firm's carbon footprint and risk.

3.2.3 Control variables

We control for several firm-level variables. Firstly, we control for leverage (Leverage) as corporate restructuring activities could have the consequence of altering firm leverage, target leverage ratios or changes in leverage ratios (Cook et al. 2016). We measure leverage as the ratio of total debt to total assets. Secondly, we control for firm size (Size) given that the value of corporate restructuring differs according to the size of the firms being restructured (Poon et al. 2001). Size is measured as the natural logarithm of total assets. Next, we control for firms' cash (Cash Holdings) which we compute as the ratio of cash to total assets. Firms' level of cash holdings affects the likelihood of and market reactions to their restructuring activities such as acquisitions (Erel et al. 2021) as well as investment announcement announcements (Jones et al. 2022). We also control for profitability (ROA). Khurana and Lippincott (2000) find that returns of firms during periods of restructuring vary according to their level of profitability. We compute ROA as Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Finally, we control for Tobins Q (Q), as studies such as Kogan and Papanikolaou (2013) argue that it is an important firm characteristic in predicting stock returns. We measure Q as the market value of equity plus debt, divided by total assets.

3.2.4 Moderating variables

In our main analysis, we examine whether the relationship between carbon emissions and the market valuation of corporate restructuring announcements is moderated by three main variables which include bankruptcy risk and financial constraints. To measure bankruptcy risk, we calculate the Z Score for each firm following Altman (1968):

$$Z = 0.012\beta_1 + 0.014\beta_2 + 0.033\beta_3 + 0.006\beta_4 + 0.999\beta_5 \tag{5}$$

where β_1 is working capital divided by total assets. β_2 is retained earnings deflated by total assets.β_3 is earnings before interest and taxes deflated by total assets. β_4 refers to the market value of equity deflated by total assets. β_5 is annual sales scaled by total assets.

To measure financial constraints, we calculate the modified KZ index as specified by Baker et al. (2003).

$$KZ\,Index = -1.002 * CashFlow - 39.368 * Dividends - 1.315 * Cash + 3.139 * Leverage \tag{6}$$

where Cash Flow refers to earnings before interest, tax, depreciation and amortization (EBITDA). Dividend is the cash equivalent of profit distributed to shareholders. Cash is a firm's cash holdings in a year. Leverage refers to total liabilities. All variables are scaled by total assets.

3.2.5 Model specification

To test the impact of carbon emissions on the market valuation of corporate restructuring announcements, we estimate the following multivariate regression model by Ordinary Least Squares (OLS):

$$Y_{i,t} = \alpha + \beta\, Emissions\, Level_{it} + \gamma' X_{it} + \delta'\, Year\, Dummy_t + \upsilon'\, Industry\, Dummy_j + \varepsilon \quad (7)$$

where emissions level is a firm's carbon emission at announcement scaled by total assets. X_{it} is a vector of firm-level characteristics that affect the market valuation of announcements. These include Leverage, Size, Cash Holdings, ROA, and Q ratio. δ and υ represent year and industry dummies respectively. The year dummies capture regulatory interventions such as the Paris Agreement which were introduced, amongst other things, to shape corporate environmental practices.

4 Empirical results

4.1 Summary statistics

Table 1 reports the summary statistics of the variables used in this study. On average, firms generate CARs of 0.5% during corporate restructuring announcements. The average CTR generated over the period [−5 to+5] is 1%. This implies that there are positive wealth effects attributable to corporate restructuring announcements.

The average CAR value reported in this study is similar to those reported in other announcement studies (Zhou et al. 2020; Dandapani et al. 2020; Tunyi 2021). The average firm in our sample emits 6 million tonnes of carbon. However, Fig. 1 indicates that average corporate carbon emission has been on a decline since 2005. This suggests that corporate behaviour towards the environment may be improving. This could be a motivation to discount the value of firms with higher-than-average levels of carbon emissions.

Table 1 Summary statistics

	N	Mean	SD	Min	P25	P75	Max
Cumulative Abnormal Return	489	0.005	0.069	−0.623	−0.026	0.033	0.317
Cumulative Total Return	489	0.010	0.071	−0.578	−0.026	0.045	0.353
Emissions Level	489	3.273	2.051	−3.668	2.420	4.423	8.013
Emissions in Tonnes	489	6 m	16 m	1 k	313 k	3 m	13 m
Log Emissions	489	13.896	1.950	7.222	12.654	15.184	18.750
Environmental Score	90	51.116	21.685	8.065	37.698	67.104	87.088
Leverage	436	0.242	0.144	0.000	0.139	0.346	0.694
Size	489	10.623	1.761	6.235	9.189	11.803	14.780
Cash Holdings	477	0.078	0.065	0.000	0.029	0.104	0.362
ROA	472	0.122	0.091	−1.163	0.080	0.163	0.342
Q	421	1.391	0.851	0.046	0.861	1.686	6.971

This table presents summary statistics of the variables used in the study. All variables are defined in Appendix 2

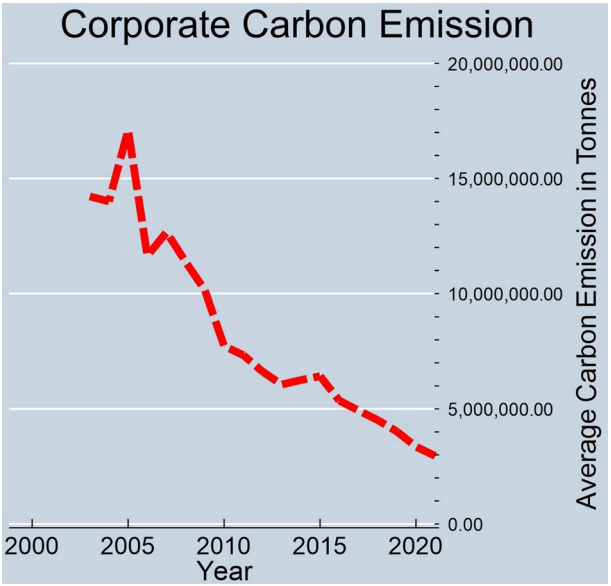

Fig. 1 The figure reports the average carbon emission by firms in the S&P 1500 from the period 2000 to 2021

4.2 Carbon emissions and market valuation of corporate restructuring announcements

Table 2 reports the results of the regression analysis that evaluates the relationship between carbon emissions and the market valuation of corporate restructuring announcements. In all columns, we include both industry and year dummies. Columns 1 & 3 report the results for CAR and CTR, respectively, where we use a parsimonious model, without the control variables. We observe negative and statistically significant coefficients of our predictor variable. Columns 2 & 4 report the result with the introduction of relevant control variables. Coefficient estimates of our predictor variable continue to remain negative and statistically significant. The introduction of the control variables also appears to magnify the impact of carbon emissions on the market valuation of corporate restructuring announcements. Consistent with previous studies (Griffin et al. 2017; Choi and Luo 2021; Adamolekun et al. 2022), the results across all four columns confirm the view that carbon emissions negatively affect firm value. Thus, corporations with higher carbon emissions at announcements of restructuring activities see their market value discounted.

We interpret this finding to mean that the market discounts a firm's future cash flows based on the level of its carbon emission. The discount in share prices may be due to the inherent risk of firms' environmental practices. Our results also show that the risks associated with high emissions are priced negatively. Some of the risks inherent in high emissions levels include reputational damage, litigation, asset fire sales, and regulatory compliance risk (Matsumura et al. 2014; Nikolaou et al. 2015; Jung et al. 2018; Herbohn et al. 2019). Overall, our results from the baseline model show that while restructuring activities may be a way to send positive signals about a firm's future potential enhancement in profitability and operational efficiency, the valuations of these activities, when announced, are discounted in the presence of high carbon emissions.

Table 2 Emissions and market valuation of restructuring announcements

Variables	CAR		CTR	
	(1)	(2)	(3)	(4)
Emissions Level	−0.010**	−0.016**	−0.013***	−0.018***
	(−2.06)	(−1.99)	(−2.65)	(−3.14)
Leverage		−0.001		0.017
		(−0.03)		(0.44)
Size		−0.012*		−0.010*
		(−1.75)		(−1.82)
Cash Holdings		0.001		0.091
		(0.01)		(1.03)
ROA		0.021		0.060
		(0.72)		(1.25)
Q		−0.002		0.007
		(−0.20)		(0.87)
Constant	0.087	0.245**	0.088	0.202*
	(1.37)	(2.52)	(1.30)	(1.95)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	489	410	489	410
Adjusted R^2	0.330	0.340	0.273	0.252

This table presents the regression results of the relationship between carbon emissions and market valuation of corporate restructuring announcements. The dependent variables are CAR, the 11-day $(-5,+5)$ market model Cumulative Abnormal Return and CTR the 11-day $(-5,+5)$ Cumulative Total Return around the restructuring announcement. Emissions Level is the value of a firm's carbon emissions in tonnes divided by total assets. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels respectively

4.3 Carbon emissions, bankruptcy risk and market valuation of corporate restructuring

It is possible that the market valuation of restructuring activities can be influenced by firms' risk of bankruptcy as bankruptcy is a main approach for reorganizing failing companies (Dellisanti and Wagner 2018). Corporations in danger of bankruptcy may not prioritize environmentally responsible policies since they may not bear the liability of poor environmental practices (Boomhower 2019). Additionally, due to a shortage of resources and the focus on survival, such firms may not prioritize their environmental practice. To this effect, we examine whether the market values corporate restructuring announcements differently based on firms' risk of bankruptcy. We calculate firms' Z Scores based on Altman (1968), and categorize firms with Z scores below or equal to 1.81 as having a high likelihood of bankruptcy and those with greater than 1.81 as having a low likelihood of bankruptcy. We then re-estimate our baseline regressions with control variables for each sub-sample. We present the results in Table 3. The results suggest that the negative impact of carbon emission on the market valuation of corporate restructuring is more pronounced in firms with a low risk of bankruptcy. Based on

Table 3 Bankruptcy risk, emissions and market valuation of corporate restructuring

Variables	CAR		CTR	
	Low Risk	High Risk	Low Risk	High Risk
Emissions Level	−0.239**	−0.010*	−0.273***	−0.011*
	(−2.74)	(−1.68)	(−3.05)	(−1.73)
Leverage	−0.161	−0.009	0.435	−0.002
	(−0.43)	(−0.24)	(1.13)	(−0.05)
Size	−0.014	−0.010*	0.022	−0.009
	(−0.36)	(−1.79)	(0.56)	(−1.50)
Cash Holdings	0.129	−0.004	0.243	0.098
	(0.40)	(−0.05)	(0.74)	(1.01)
ROA	2.106*	0.054	2.458**	0.088*
	(1.86)	(1.23)	(2.12)	(1.81)
Q	−0.221	−0.005	−0.122	0.005
	(−1.31)	(−0.76)	(−0.70)	(0.66)
Constant	0.760	0.189*	0.080	0.157
	(1.58)	(1.93)	(0.16)	(1.45)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	67	343	67	343
Adjusted R^2	0.507	0.388	0.362	0.278

This table presents regression results of the impact of carbon emissions level on market reaction to corporate restructuring announcements based on a firms likelihood of bankruptcy. The dependent variables are CAR, the 11-day (−5, +5) market model Cumulative Abnormal Return and CTR the 11-day (−5, +5) Cumulative Total Return around the restructuring announcement. Emissions Level is the number of firms' emissions in tonnes divided by total assets. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively

Kim et al. (2015), we interpret this result to mean that the market prices carbon emission levels negatively for firms with a lower likelihood of bankruptcy because the inherent risk associated with bad environmental practices would increase their cost of capital. Furthermore, since firms with higher bankruptcy risk lack the resources to pursue innovative environmentally friendly projects, the market is more lenient in pricing their carbon emissions level during corporate restructuring announcements.

4.4 Growth opportunities, carbon emission, and market valuation of corporate restructuring

In Table 4, we evaluate how the market's perception of carbon emissions during corporate restructuring announcements varies between firms with high and low growth opportunities. To determine a firm's future growth opportunities, we follow Lang et al. (1996) and

calculate the ratio of capital expenditures, net of depreciation, to total assets. Firms with values above the sample median are regarded as having high growth opportunities while those below the median are considered as those with low growth opportunities. We then re-estimate our baseline model for each sub-sample and present the results in Table 4.

The results indicate that the market's valuation of firms' carbon emission levels during corporate restructuring announcements is negative among firms with low growth opportunities. This implies that firms with low growth opportunities experience lower returns because they do not have as many growth options to exercise which may mitigate the environmental risk inherent in their carbon emissions level. Indeed, transitioning to greener and more sustainable processes could adversely affect corporate performance (Andreou and Kellard 2021). This effect will be severe for firms with fewer growth opportunities. The findings also demonstrate that the relationship between carbon emission and market valuation of corporate restructuring for firms with high growth opportunities is insignificant. This is worrying and indicates that there are no discounts on firm value for high-growth firms with high emission levels. Empirical evidence suggests that carbon emission reduction can improve corporate innovation (Huang and Yang 2021). Therefore, investors and market participants may be passing up an opportunity to encourage corporate innovation.

Table 4 Growth opportunities, emissions and market valuation of corporate restructuring

Variables	CAR		CTR	
	Low Growth	High Growth	Low Growth	High Growth
Emissions Level	−0.023**	0.001	−0.025**	−0.004
	(−2.16)	(0.20)	(−2.05)	(−0.60)
Leverage	0.051	−0.051	0.051	−0.025
	(0.60)	(−1.03)	(0.53)	(−0.47)
Size	−0.025**	−0.000	−0.023**	−0.001
	(−2.49)	(−0.04)	(−2.00)	(−0.18)
Cash Holdings	−0.078	0.083	−0.049	0.089
	(−0.52)	(0.70)	(−0.29)	(0.71)
ROA	0.120	0.016	0.309	0.056
	(0.47)	(0.37)	(1.07)	(1.30)
Q	0.008	−0.014	0.003	−0.002
	(0.35)	(−1.22)	(0.13)	(−0.19)
Constant	0.477***	0.023	0.416***	0.026
	(3.41)	(0.20)	(2.67)	(0.22)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	197	213	197	213
Adjusted R^2	0.436	0.219	0.350	−0.043

This table reports the results of the relationship between carbon emissions and market valuation of corporate restructuring announcements based on the degree of a firms growth opportunities. The dependent variables are CAR, the 11-day (−5, +5) market model Cumulative Abnormal Return and CTR the 11-day (−5, +5) Cumulative Total Return around the restructuring announcement. Emissions Level is the amount of firms' emissions in tonnes divided by total assets. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively

4.5 Financial constraints, carbon emission, and market valuation of corporate restructuring

Next, we examine the effect of carbon emissions on the market valuation of restructuring announcements based on firms' level of financial constraints. Financially constrained firms may struggle to generate finance to drive investment in carbon–neutral infrastructures and services (Lemma et al. 2021). We split firms into financially constrained and financially unconstrained subsamples based on whether their KZ index lies above or below the sample median. We re-estimate our baseline regressions for each sub-sample and present the results in Table 5. The results suggest that the market negatively perceives carbon emissions for the set of financially constrained firms when valuing corporate restructuring announcements. This is because financially constrained firms cannot easily access capital for investment in green technology (Zhang and Zhao 2022). Such firms are penalised for not adopting technologies that reduce their carbon footprint given their financing limitations. For financially unconstrained firms, the impact of carbon emissions on the market valuation of corporate restructuring announcements is insignificant. The market recognises that this category of firms has access to finances that will drive investment in green technologies. In general, these findings complement the view that financial constraints limit the extent to which firms can engage with their environmental performance (Guérin and Suntheim 2021). Although not reported, we also employ an alternative measure of financial constraints based on Almeida and Campello (2007). We find consistent results with those reported in Table 5.

4.6 Additional analyses and robustness checks

In this section, we conduct additional analyses and also carry out some robustness checks.

4.7 Green restructuring announcements

Since some corporate restructuring announcements are simply motivated by environmental concerns, we examine whether the market perception of carbon emissions varies for this group of announcements. To identify this set of announcements, we review all our announcements and categorize an announcement as green if the company explicitly states that the reason for the announcement is to combat or improve its environmental practice. We then create a dummy variable, Green Restructuring Announcements, which we set to 1 for firms with announcements categorised as green and 0 otherwise. We then interact this with our Emissions Level variable to examine whether the effect of firms' carbon emissions on the market valuation of restructuring announcements varies according to whether the announcement can be described as green. We present the results from this analysis in Table 6. As can be seen from the table, the stand-alone Emissions Level variable continues to be negative and statistically significant. However, the interaction term is statistically insignificant. This demonstrates that the impact of carbon emissions on the market valuation of general restructuring announcements is not distinguishable from green corporate restructuring announcements. Thus, in the presence of high levels of carbon emissions by firms, markets do not place much value on restructuring announcements by firms to be greener.

Table 5 Financial constraints, emissions and market valuation of corporate restructuring

Variables	CAR		CTR	
	Unconstrained	Constrained	Unconstrained	Constrained
Emissions Level	−0.000	−0.030***	−0.001	−0.022*
	(−0.04)	(−2.78)	(−0.14)	(−1.96)
Leverage	0.011	−0.036	−0.011	0.016
	(0.22)	(−0.54)	(−0.20)	(0.23)
Size	−0.021**	−0.011	−0.032***	−0.006
	(−2.37)	(−1.13)	(−3.23)	(−0.63)
Cash Holdings	0.190**	−0.345*	0.148	−0.065
	(2.25)	(−1.79)	(1.58)	(−0.32)
ROA	0.024	0.024	0.083*	−0.069
	(0.63)	(0.13)	(1.95)	(−0.35)
Q	−0.010	−0.001	−0.004	0.008
	(−1.19)	(−0.03)	(−0.45)	(0.47)
Constant	0.209*	0.363**	0.335**	0.194
	(1.80)	(2.22)	(2.60)	(1.13)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	210	200	210	200
Adjusted R^2	0.086	0.426	0.166	0.308

The Table reports the results of the relationship between carbon emissions and market valuation of corporate restructuring announcements based on the severity of a firm's financial constraint. The dependent variables are CAR, the 11-day (−5, +5) market model Cumulative Abnormal Return and CTR the 11-day (−5, +5) Cumulative Total Return around the restructuring announcement. Emissions Level is the value of a firm's emissions in tonnes divided by total assets. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively

4.8 Environmental score and market valuation of corporate re-structuring

Similar to previous studies that evaluate corporate environmental practice through the lenses of Rifinitiv scores (Albuquerque et al. 2020; Gangi et al. 2022), we examine whether the signals inferred from firms' carbon emission levels are distinct from third-party corporate environmental scores like the Rifinitiv environmental score. We present these results in Table 7. The results indicate that the information deduced from a firm's carbon emission level is unique and cannot be inferred from the Rifinitiv corporate environmental score. This is particularly insightful because several investment managers rely on these third-party ratings for information on a firm's environmental practices. The results suggest that such measures may not be all-encompassing.

4.9 Post announcement performance

We explore the mechanisms by which carbon emissions affect abnormal returns to restructuring announcements. We do so by establishing a relationship between the carbon

Table 6 Green corporate restructuring announcements

	(1) CAR	(2) CAR
Emissions Level	−0.010**	−0.016***
	(−2.07)	(−2.89)
Emissions Level # Green Restructuring Announcements	−0.024	−0.033
	(−1.54)	(−1.57)
Green Restructuring Announcements	0.104	0.145
	(1.37)	(1.48)
Leverage		−0.002
		(−0.04)
Size		−0.012**
		(−2.22)
Cash Holdings		0.000
		(0.00)
ROA		0.021
		(0.47)
Q		−0.002
		(−0.26)
Constant	0.086	0.242**
	(1.35)	(2.49)
Industry	Yes	Yes
Year	Yes	Yes
N	489	410
Adjusted R^2	0.331	0.341

This table reports the results of interacting green restructuring announcements with corporate carbon emissions. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%,5% and 10% levels respectively

emissions of firms at the announcement of the restructuring activity, and financial performance gains post-restructuring. Intuitively, if high carbon emissions are negatively correlated with future performance gains post-restructuring, we should expect this effect to translate to a negative relationship between firms' carbon emissions and the contemporaneous market reaction to the restructuring announcements. This is because the market will be pricing in the future potential reduction in firm performance based on the firm's environmental practices. We measure firm financial and market performance using profitability and Tobin's Q, respectively. Our modelling approach is motivated by the work of Fresard (2010). We then regress each variable on the level of carbon emissions at announcement and report the results in Table 8. The results indicate that a high carbon footprint at announcement is negatively associated with future profitability and future value. For profitability, for instance, the negative impact of high emissions manifests even up to 5 years after the announcement. In the case of Tobin's Q, the findings suggest that heavy reliance on hydrocarbons is negatively associated with future value. The results documented for Tobin's Q hold at both the short term and medium term. The finding implies that the discount in valuation at announcement accounts for future losses as a result of a firm's heavy reliance on fossil fuels. Our findings from this analysis align with the prior strand of

Table 7 Environmental score and market valuation of corporate restructuring

Variables	CAR		CTR		BHAR	
	(1)	(2)	(3)	(4)	(5)	(6)
Environmental Score	−0.001	−0.001	−0.000	0.000	−0.001	−0.001
	(−1.21)	(−0.45)	(−0.25)	(0.20)	(−1.20)	(−0.45)
Leverage		−0.137		−0.248		−0.120
		(−0.48)		(−0.86)		(−0.41)
Size		−0.002		0.014		−0.013
		(−0.03)		(0.16)		(−0.15)
Cash Holdings		−0.480		−0.157		−0.503
		(−0.97)		(−0.31)		(−1.00)
ROA		0.071		−0.491		0.056
		(0.10)		(−0.67)		(0.08)
Q		−0.128		−0.070		−0.139
		(−1.16)		(−0.62)		(−1.24)
Constant	0.146	0.283	0.057	0.032	0.145	0.385
	(1.33)	(0.36)	(0.49)	(0.04)	(1.28)	(0.48)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	90	84	90	84	90	84
Adjusted R^2	0.464	0.524	0.347	0.445	0.360	0.435

This table reports the results of the relationship between Refinitiv Environmental Score and market valuation of corporate restructuring announcements. The dependent variables are CAR, the 11−day (−5,+5) market model Cumulative Abnormal Return and CTR the 11-day (−5,+5) Cumulative Total Return around the restructuring announcement. Environmental Score is the environmental score of each firm obtained from Refinitiv. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%,5% and 10% levels respectively

environmental economics literature that argues that carbon efficiency could enhance firm value and corporate earnings (Trinks et al. 2020; Matsumura et al. 2014).

4.10 Using buy-hold abnormal returns (BHAR)

We employ an alternative dependent variable using BHAR. This allows us to capture the magnitude of the returns through the lenses of an investment strategy. We then re-estimate our baseline model and present the results in Table 9. Similar to the results in Table 2, we find that the coefficient estimates of our predictor variable are negative and statistically significant. Thus, our findings are not necessarily driven by the choice of our measure of the market reaction.

4.11 Using log of emissions

Finally, because our measure of carbon emissions may be subject to measurement error, we specify our model using the natural log of a firm's carbon emissions level. Despite the additional

Table 8 Carbon emissions and post restructuring performance

Variable	Profitability			Tobins Q		
	t+1	t+3	t+5	t+1	t+3	t+5
Emissions at Announcement	−0.012*	−0.012	−0.019**	−0.160***	−0.244***	−0.314***
	(−1.84)	(−1.63)	(−2.16)	(−2.81)	(−3.15)	(−2.93)
Size	−0.022**	−0.018**	−0.009	0.034	0.045	0.192
	(−4.88)	(−3.21)	(−1.26)	(0.67)	(0.69)	(1.64)
Cash holdings	0.060	0.086	0.058	2.628***	2.231***	0.278
	(1.26)	(1.60)	(0.87)	(4.74)	(3.54)	(0.31)
Leverage	−0.024	−0.005	0.078	0.404	0.296	−0.700
	(−0.88)	(−0.14)	(1.27)	(1.41)	(0.77)	(−1.07)
CAPEX	0.593***	0.751***	1.435***	7.133***	5.967**	0.268
	(3.54)	(3.34)	(3.87)	(4.04)	(2.51)	(0.07)
Tobins Q	0.020***	0.023***	0.029***			
	(4.73)	(4.51)	(4.48)			
ROA				2.771***	5.499***	10.178***
				(5.95)	(7.15)	(7.53)
Sales Growth				0.000	0.000	−0.001
				(0.54)	(0.55)	(−0.80)
Dividend				8.936***	6.603**	4.268
				(3.80)	(2.14)	(1.19)
Constant	0.582***	0.000	0.454***	0.000	0.000	0.000
	(5.61)	(0.0)	(3.21)	(0.0)	(0.0)	(0.0)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	917	616	368	903	605	365
Adjusted R^2	0.437	0.459	0.485	0.367	0.398	0.396

The Table reports the results of the relationship between carbon emissions in the year of the announcement and firm post-restructuring performance. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively

approach, our results are unchanged. The market perception of carbon emission levels is negative during corporate restructuring announcements. Using the three return-generating models, we find a consistent relationship between carbon emissions and the market valuation of corporate restructuring announcements. The results of this procedure are reported in Table 10.

4.12 Alternative event windows and return generating models

To ensure our results are not sensitive to specific event windows, we estimate our baseline model using CARs, CTRs and BHARs generated from alternative event windows, specifically [0 to+1] and [−1 to+1]. We present the results in In Table 11. As can be seen from the table, our findings are not driven by our choice of estimation windows. Across our three measures, the results confirm that high carbon emissions at the announcement of corporate restructuring reduce market valuation of the announcements. We estimate our other regressions using these alternative windows and find consistent results, which we do not show for brevity. We also

Table 9 Carbon emissions and buy-hold abnormal returns (BHAR)

Variables	Dependent variable: BHAR							
	Baseline		Bankruptcy risk		Growth opportunties		Financial constraints	
	No controls	Controls	Low risk	High risk	Low growth	High growth	Unconstrained	Constrained
Emissions Level	−0.010**	−0.016***	−0.239**	−0.010*	−0.023**	0.001	−0.000	−0.030***
	(−2.08)	(−2.97)	(−2.73)	(−1.68)	(−2.06)	(0.14)	(−0.01)	(−2.77)
Leverage		−0.002	−0.170	−0.011	0.054	−0.046	0.007	−0.036
		(−0.06)	(−0.45)	(−0.27)	(0.61)	(−0.92)	(0.13)	(−0.53)
Size		−0.012**	−0.015	−0.009*	−0.025**	0.000	−0.023**	−0.011
		(−2.15)	(−0.40)	(−1.69)	(−2.42)	(0.03)	(−2.47)	(−1.14)
Cash Holdings		0.009	0.128	0.003	−0.071	0.078	0.198**	−0.336*
		(0.11)	(0.40)	(0.03)	(−0.46)	(0.65)	(2.26)	(−1.73)
ROA		0.022	2.048*	0.056	0.099	0.018	0.028	0.014
		(0.48)	(1.80)	(1.27)	(0.38)	(0.42)	(0.69)	(0.07)
Q		−0.001	−0.215	−0.005	0.008	−0.012	−0.012	0.000
		(−0.16)	(−1.27)	(−0.70)	(0.37)	(−1.03)	(−1.30)	(0.02)
Constant	0.080	0.234**	0.772	0.176*	0.469***	0.009	0.229*	0.356**
	(1.25)	(2.37)	(1.60)	(1.78)	(3.29)	(0.08)	(1.91)	(2.16)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	489	410	67	343	197	213	210	200
Adjusted R^2	0.265	0.268	0.523	0.309	0.337	0.231	0.082	0.351

This table presents the results of the relationship between carbon emissions and market valuation of corporate restructuring announcements calculated through the buy-and-hold abnormal return (BHAR) method. Emissions Level is the value of firms' emissions in tonnes divided by total assets. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels respectively

Table 10 Using log values of emissions

Variables	CAR		CTR		BHAR	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Emissions	−0.009***	−0.016***	−0.013***	−0.018	−0.009***	−0.016***
	(−2.64)	(−2.96)	(−3.46)	(−3.14)	(−2.59)	(−2.97)
Leverage		−0.001		0.017		−0.002
		(−0.04)		(0.44)		(−0.06)
Size		0.004		0.008		0.005
		(0.60)		(1.09)		(0.69)
Cash Holdings		0.001		0.091		0.009
		(0.01)		(1.03)		(0.11)
ROA		0.021		0.059		0.022
		(0.47)		(1.25)		(0.48)
Q		−0.002		0.007		−0.001
		(−0.24)		(0.87)		(−0.16)
Constant	0.183***	0.245***	0.223**	0.202**	0.174***	0.234***
	(2.27)	(2.53)	(2.59)	(1.95)	(2.13)	(2.37)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	489	410	489	410	489	410
Adjusted R^2	0.335	0.340	0.282	0.252	0.270	0.268

This table presents the regression analyses that evaluate the relationship between carbon emissions and market valuation of corporate restructuring announcements. The dependent variables are CAR, the 11-day $(-5,+5)$ market model Cumulative Abnormal Return, CTR, the 11-day $(-5,+5)$ Cumulative Total Return and BHAR, the Buy-Hold Abnormal Returns around the restructuring announcement. Log Emissions natural log of firms' emissions levels. Leverage is total debt divided by total assets. Size is the natural log of total assets. Cash Holdings is the ratio of cash to total assets. ROA is Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA) divided by total assets. Q is the market value of equity plus total debt divided by total assets. T statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively

estimate our baseline model using the Fama and French 3-factor model and find largely consistent results. Again, we do not report these to maintain brevity.

5 Conclusion

In this study, we evaluate the market's perception of firms' carbon emission levels during corporate restructuring announcements. The results suggest that the market views high carbon emission levels negatively during corporate restructuring announcements. We find that this effect is more pronounced among firms with a low likelihood of bankruptcy, those financially constrained and those with low growth opportunities.

For firms with a low risk of bankruptcy, the market prices high carbon emissions levels negatively because such firms, when compared with their counterparts, can afford to invest in green technologies but choose not to (Boomhower 2019). For financially constrained firms, the market reacts negatively to their carbon emissions level because they cannot access finance for funding green investments from the capital market (Zhang and Zhao 2022). This implies that

Table 11 Alternative event windows

	CAR		CTR		BHAR	
	(1)	(2)	(3)	(4)	(5)	(6)
Emissions Level	−0.000**	−0.000**	−0.000*	−0.000**	−0.000*	−0.000**
	(−2.21)	(−2.28)	(−1.92)	(−2.13)	(−1.97)	(−2.08)
Leverage	−0.032	−0.030	−0.036	−0.040	−0.035	−0.039
	(−1.09)	(−0.95)	(−1.26)	(−1.31)	(−1.24)	(−1.30)
Size	−0.003	−0.005	−0.005	−0.008*	−0.005	−0.007
	(−0.83)	(−1.16)	(−1.28)	(−1.73)	(−1.24)	(−1.65)
Cash Holdings	0.062	0.099	0.020	0.037	0.024	0.046
	(0.97)	(1.41)	(0.31)	(0.55)	(0.38)	(0.68)
ROA	−0.002	0.016	0.002	0.005	0.003	0.006
	(−0.06)	(0.43)	(0.06)	(0.14)	(0.08)	(0.17)
Q	−0.000	0.002	−0.003	−0.000	−0.004	−0.001
	(−0.04)	(0.34)	(−0.56)	(−0.01)	(−0.69)	(−0.19)
Constant	0.070	0.039	0.100	0.086	0.097	0.081
	(1.02)	(0.53)	(1.48)	(1.20)	(1.46)	(1.13)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	316	316	316	316	316	316
Adjusted R^2	0.061	0.161	0.056	0.090	0.050	0.071

This table presents the results of our estimates using various estimation parameters. Models 1 & 2 report estimation estimates using cumulative abnormal returns (CARs) computed over the period [t0 to t+1] and [t−1 to t+1] respectively. Models 3 & 4 reports the results based on cumulative total returns (CTRs) for the period [t0 to t+1] and [t−1 to t+1] respectively. Models 5 & 6 reports the results according to buy and hold abnormal returns (BHAR) calculated over the period [t0 to t+1] and [t−1 to t+1] respectively. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels respectively

such financially constrained firms may struggle to make the transition. The results also reveal that the relationship between carbon emissions and market valuation of corporate restructuring announcements is negative for the set of firms with low growth opportunities and insignificant for firms with high growth opportunities. One explanation for the negative relationship is that firms with fewer growth opportunities have lesser chances of reducing the implied environmental risk they possess due to their carbon emissions level. In understanding why markets discount the value of restructuring announcements by carbon dependent firms, we examine how emissions at announcements affect post-announcement performance. Our results suggest that high emissions levels at announcements are negatively associated with future firm financial and market performance.

The signals inferred from a firm's carbon emissions level are different from aggregate corporate environmental measures. The results from this study join the call by governments, academics and wider society requiring firms to pay attention to their environmental practices. In particular, the findings indicate that corporate behaviour towards the environment is an important factor when valuing a firm relative to its corporate activities. In addition, the value relevance of this practice differs with firm characteristics such as bankruptcy likelihood, financial constraints, and growth opportunities. Put together, our findings imply that the market never forgets. Signalling through corporate restructuring does not absolve firms of prior poor environmental practices. Future studies in this area could evaluate to

what extent firms with high bankruptcy risk turn to green investments to mitigate their financial exposure. Finally, we leave the question of identifying the best corporate restructuring strategy for the green transition to future research.

Appendix 1: Sample Announcements

02/05/2018

"The AES Corporation announced a reorganization as part of its ongoing strategy to simplify its portfolio, optimize its cost structure and reduce its carbon intensity. Reflecting AES' simplified portfolio, the company is consolidating its five Strategic Business Unit structure and will now manage its global operations and infrastructure activities under Executive Vice President and Chief Operating Officer, Bernerd Da Santos. The company also has reorganized its growth and commercial activities into three new units. These units will be led by three existing executives and they are, Executive Vice President and Chief Financial Officer, Tom O'Flynn will continue in his current role and assume additional responsibility for leading the US Renewables growth unit; Manuel Pérez Dubuc will lead a consolidated South America growth unit that includes Argentina, Brazil, Chile and Colombia; and Juan Ignacio Rubiolo will lead the Mexico, Central America and the Caribbean growth unit. The new leaner organizational structure reflects the simplification of the company's portfolio and cumulative investments in IT, and will result in a lower headcount and overhead costs. This initiative supports the company's objectives of achieving investment grade metrics by 2019 and delivering attractive returns. The new organizational structure will also accelerate the application of new technologies in AES' existing businesses"

Source: Capital IQ

11/04/2015

"Duke Energy announced it has created a new plan for its proposed infrastructure upgrade for the Western Carolinas in response to community feedback. Under the revised plan, the company will replace its coal plant in Asheville with two smaller gas units rather than one large one. As a result, the proposed 45-mile Foothills Transmission Line and Campobello substation are no longer necessary. To successfully meet the region's growing power needs, the revamped project will require significantly more participation in energy efficiency, demand-side management, renewable energy and developing technologies from the company, communities and customers in the region. The new plan does require a stepped-up effort to work with customers and interested groups to expand participation in programs to reduce peak power demand and grow renewable energy and associated technologies. It also includes a two-phased approach to reconfigure the Asheville Power Plant site that will provide the same significant environmental benefits as the original modernization plan. As with the original plan, the newly reconfigured natural gas units are estimated to have significantly lower environmental impacts than the existing coal plant. Sulfur dioxide will be reduced by an estimated 90 to 95%. Nitrogen oxide will be reduced by an estimated 35%. Mercury will be eliminated. Water withdrawals will be reduced by an estimated 97%. Water discharges will be reduced by an estimated 50%. Carbon dioxide emissions will be reduced by about 60%, on a per-megawatt-hour basis, due to the efficiency of the new gas units and the fact that natural gas burns more cleanly than coal. The company will be working with major suppliers of key components for the plant to further refine the overall cost estimate, but it is expected to be essentially the same as the original plan of approximately $1.1 billion."

Source: Capital IQ

Appendix 2: Variable definitions

Variable	Definition
CAR	The sum of market model abnormal returns during an 11-day event $(-5,+5)$ window around a firm's restructuring announcement
CTR	The sum of actual returns during an 11-day event window $(-5,+5)$ around a firm's restructuring announcement
Emissions level	Emissions in tonnes divided by total assets
Log emissions	Natural logarithm of emissions level
Leverage	Total debt divided by total assets
Size	Natural logarithm of total assets
Cash holdings	Cash divided by Total Assets
ROA	Earnings before interest, tax, depreciation, and amortization (EBITDA) divided by Total Assets
Q	Market value of equity plus total debt divided by total assets

Declarations

Conflict of interest There are no conflicts of interest to declare.

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