

Carbon disclosure and carbon performance: Evidence from the UK's listed companies

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ABSTRACT

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The rise in carbon disclosure has yet to be matched by evidence and understanding of how carbon disclosure affects a firm's actual carbon performance? Therefore, this study examines the relationship between voluntary carbon disclosure and the carbon performance of the UK's listed firms by applying the 'outside-in' management perspective. Panel data analysis of UK FTSE350 firms and their carbon disclosures for the period 2007–2015, made on the Carbon Disclosure Project (CDP) platform, indicates that enhanced carbon disclosure was associated with improved carbon performance in terms of greenhouse gas emissions. Additional analysis found that the carbon disclosure-carbon performance relationship is more pronounced in carbon-intensive industries. Moreover, during the financial crisis period, the relationship of interest is insignificant, however, during the recovery years, improved carbon reporting was associated with lower emissions. This study confirms that carbon disclosure motivates companies and creates a momentum effect for the subsequent reduction in their emissions. Our findings are useful for corporate stakeholders and governmental policymakers who are concerned about the quality and consequences of carbon disclosure.

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1. Introduction

In recent years, businesses have experienced increasing pressure to disclose more information about their plans to lower their greenhouse gas (GHG) emissions and their overall climate change strategy (Alsaifi et al., 2020b). The raised profile of environmental threats has led to demands on businesses to disclose reliable information so that their related risks and opportunities can be thoroughly evaluated. The question of the environmental disclosure has now become a strategic one for firms and organisations (Lewandowski, 2017). Despite that, the association between carbon disclosure and carbon performance in terms of greenhouse gas emissions (GHG) is not yet fully understood. Some studies have examined the possibility that disclosure substitutes for emissions performance improvement (Freedman and Jaggi, 2009). Other studies have focussed on whether different categories of performers disclose different environmental information (Freedman and Jaggi, 2005, Hughes et al., 2001). However, until now, no studies have addressed whether enhanced disclosure is linked to improved carbon performance by decrease the emissions level. This is an important unanswered question that the present study aims to investigate. This study aims to provide explanation and evidence on carbon performance progresses associated with disclosure improvements. Stakeholders' need for a deeper understanding of the risks and opportunities arising from climate change was a significant factor in the establishment of the environmental impact charity the Carbon Disclosure Project (CDP).¹ The CDP offers a platform for firms to make disclosures of environmental information including carbon emissions with the aim of promoting transparency which may discourage investment in firms at risk of negative climate change impacts. If successful,

¹ The CDP's disclosure scheme was initially launched in 2000 and covered the UK only. However, since then it has gone on to become the biggest register of corporate emissions in the world. Every year, it administers a survey on climate change-related issues to public companies on behalf of its data users (e.g. investors, banks, pension funds, wealth advisors). The results are published in an annual report.

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this type of project would contribute to a move toward a low-carbon more sustainable economy. The sample consists of 2,089 firm-year observations for firms listed on the FTSE350 index for the period 2007–2015. This period represents a time of heightened awareness of climate related issues including emissions as well as of intense regulatory policy debate on national and international levels. Firms listed on the FTSE350 are the largest public companies on the London Stock Exchange measured by market capitalisation meaning they are representative of the UK's carbon profile and its overall economic situation. The UK is a suitable context for research in this field. The European Union (EU) is identified as globally one of the three biggest GHG-emitting economies (behind the United States and China). The UK, a member of the EU throughout the sample period, is also a member of the G7 (Group of Seven) advanced industrialised economies and ranks among the highest emitting nations in the world. In terms of carbon dioxide emissions, the UK is listed among the twenty largest emitters (UCS, 2018). Also understood is that climate change has negatively impacted the weather in the UK.² The UK government has launched several initiatives to address these emissions and also to meet its obligations under the Paris Agreement. The Climate Change Act 2008 established the Committee on Climate Change to advise the government on climate related policy and in December 2008 the committee's recommendation was for the government to 2050 target of an 80% reduction against 1990 emission levels (Committee on Climate Change, 2018). The following September, the Department for Environment, Food and Rural Affairs published voluntary guidelines on measuring and dissemination of emissions information.³ A further important step was taken in the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 (SI 2013/1970) (Secretary of State, 2013) by introducing requirements for publicly-listed companies concerning the disclosure of GHG emission information. Under the legislation, the annual directors' report published by these firms now needed, as a minimum, to include disclosures on annual carbon dioxide emissions and the methodology used for their calculation. In 2019, the UK Government legislated the level of the GHG emissions 2050 target of reducing emissions by at least 100% compared to 1990 levels, more ambitious than the earlier commitment to an 80% reduction (Committee on Climate Change, 2018). In sum, this study offers a significant contribution to an increasingly important field of research, that of climate-related corporate transparency. First, it provides updated empirical evidence on the relationship between carbon disclosure and carbon performance that has hitherto been in short supply particularly in the European and specifically UK context. The second and third contributions provided evidence concerning industry type, specifically carbon-intensive vs non-carbon-intensive industries and the effect of the financial crisis on the relationships of interest. The next section reviews the literature and develops hypotheses aimed at answering the research question: *How does carbon disclosure affect a firm's actual carbon performance?* Then section three presents research design and data. Section four reviews the empirical results and presents additional analyses. Finally, section five draws the conclusions of the study. (Freedman & Patten, 2004)

2. Literature review and hypotheses development

For more than a decade, researchers have examined the relationship between environmental disclosure and firm GHG emissions. Initially, this research tended to focus on investigating whether a firm's disclosure strategy is influenced by its environmental emissions and used cross-sectional comparisons to this end. One example is Hughes et al., (2001) and their investigation of the disclosures of 51 American manufacturing firms. The disclosures were made in the early 1990s and reveal that differently rated companies follow different disclosure strategies and that those firms with the worst environmental performance disclose the most. Similarly, Freedman and Jaggi (2004, 2005, 2009) undertook a series of studies which confirmed a paucity of disclosure in the 1990s. They also reported in the last of the three studies that at that time firms in the EU were lagging behind those in Japan and Canada in terms of disclosure. Sutantoputra et al., (2012) investigate the link between environmental disclosure and performance, collecting data on 53 Australian firms. Their finding that no significant relationship existed between the amount of disclosure and environmental performance was in contrast to most other studies. Different again was the finding of Luo and Tang (2014) that better environmental performers were associated with higher levels of carbon disclosures although they took only a single year of observations. Unlike these previous studies, the present study is not concerned with examining whether high or low polluters are more or less likely to make carbon disclosures or indeed whether these disclosures reflect real environmental profile. Instead we investigate whether firms' carbon performance is enhanced following improvements to disclosure strategy - an area of inquiry that has received less attention. It has been asserted that research into environmental disclosure is incomplete with important gaps including the understanding of the real changes and effects of environmental and social situations (Gray and Milne, 2015). More also needs to be understood about whether individual firms alter their disclosure strategy over time and, if so, what the consequences are their carbon performance. Such questions seem to have a greater practical relevance for regulators setting policy and business managers as they make decisions on their disclosure strategy.

Having said this, previous studies, with contradictory findings on the relationship between environmental disclosure and en-

² For example, according to the Met Office (2019), on 25th August 2019, the UK recorded its highest ever temperature at 38.7°C (101.66°F). On 26th February 2019 the warmest day for a winter month in the UK was recorded at 21.2 °C (70.16°F). In the same year unusual storms have brought exceptionally wet and windy weather bringing transport disruptions and power cuts.

³ Taurigana and Chithambo (2015) present evidence that these GHG guidelines have a significantly positive influence on the level of GHG disclosures among FTSE350 companies.

environmental performance do offer some preliminary insights for the present study. We can consider the ‘outside-in’ management approach, disclosure may become a device to generate incentives or pressure within the organisation. The outside-purposed disclosure is implemented internally and can assist managers in decision-making and in undertaking measures to improve performance (Schaltegger and Burritt, 2010).

The ‘outside-in’ approach offer contrasting arguments on the question of whether disclosure is leads to improvement in carbon performance or not is now considered in more detail.

2.1 ‘Outside-in’ management approach: disclose to perform

The management-orientated perspective on environmental disclosures, sees reporting and engaging with stakeholders by responding to public expectations as being of potential utility by assisting firms to devise better measurement practices and improve management activities in this area. This could lead to real improvements in in sustainability performance (Burritt & Schaltegger, 2010). This approach to firm sustainability has been termed an ‘outside-in’ one (Schaltegger & Wagner, 2006). From this perspective, Schaltegger and Wagner (2006) argue that engaging in a dialogue with stakeholders ensures firms are continually scanning expectations which in turn will help in developing accounting practices and performance measures. Similarly, Schaltegger and Wagner (2006) view environmental and social disclosures as tools with which managers can internally promote the benefit of improving corporate performance. This view also supports the notion that environmental disclosure and the processes associated with it permits stakeholders expectations to infiltrate the organization driving forward performance improvements (Boons & Strannegård, 2000). Salo’s (2008) empirical study finds that disclosing social and environmental performance information means greater management attention is paid to the performance in these areas.

The contrast with the legitimacy approach is clear as are the differences in implications between the two. The ‘outside-in’ management view posits that while firms’ initial motivation to disclose may be to respond to public expectations and pressures this does not preclude such disclosures from being an incentive to improve real performance (Burritt & Schaltegger, 2010). Clarkson et al., (2008) find that firms performing well are in a position to report more positive news and can secure competitive advantage as their less well performing counterparts struggle to replicate their performance. Similar findings have emerged from other studies (Bewley & Li, 2000, Li et al., 1997). Based on this evidence it would seem that disclosure may be a way for firms to generate momentum towards improving and signally the improvement of their environmental and social performance (Branco & Rodrigues, 2006). Value could be created and benefits accrued which would include an enhanced reputation and corporate image (Hooghiemstra, 2000). It could distinguish firms from their competitors in competitive global markets (Hasseldine et al., 2005) and even positively influence company valuation (Clarkson et al., 2015, Matsumura et al., 2014). The pressure to enhance disclosure in both quality and scope may encourage real commitment to sustainability (Al-Tuwaijri et al., 2004, Schaltegger and Csutora, 2012). It should be stated, however, that up to now there has been a paucity of empirical evidence offered to link enhanced carbon disclosure at individual firms to performance improvements over time at the same firms. Carbon emissions have become one of the most high-profile environmental issues not least because it is more visible and measurable than other issues and can be related to direct social costs (Linnenluecke et al., 2018). As a result, GHG strategy has become embedded within management both conceptually and practically. Some countries have introduced a market-based approach to carbon emissions by monetizing them through carbon trading schemes (Vesty et al., 2015). Topping (2012) asserts that with an increasing demand for carbon information both internal and external to the organization, there should be a link between the disclosure process and actual carbon performance. The logic is that if it is measured it will be managed; hence, what starts as data ends with action.

This leads us to the following hypothesis based on the ‘outside-in’ approach:

H1: An improved carbon disclosure leads to better carbon performance.

3. Research design and data

3.1 Sample

With the FTSE 350 index being the largest UK index to be included annually in the CDP, the sample includes all companies with a continuous listing during the period 2007-2015. The chosen period featured a higher level of policy debate and public awareness of the climate change and emissions issues, which included new legal requirements (i.e. The Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013, Part 7) and additional international agreements and provisions, including the Paris Agreement adopted in December 2015. Furthermore, our period starts in 2007 despite invitations to voluntarily disclose being issued by the CDP in 2006. This initial year is excluded for two reasons. Firstly, there were only modest levels of participation that year. Second, this exclusion brings greater consistency in the firms’ responses to the questionnaire the analysis of CDP data over time. This is because the 2006 data were placed into four qualitative categories for analysis: answered questionnaire (AQ), provided information (IN), declined to participate (DP), and no response (NR). Contrastingly, for all subsequent years a quantitative analysis was applied with responses being attributed a score between 0 and 100. Furthermore, and in line with much of the research in this field, financial companies were excluded from the final

sample due to their operating within their own environmental and social regulations including the ‘Equator Principles’ they apply (Alsaifi et al., 2020a).⁴ We had intended to continue the sample period beyond 2015. However, the CDP report for 2016 announced a substantial revision to the methods used to calculate firms’ CDS. By including further years consistency of data would have been lost. The report advises, “It is important to note that the 2016 scoring approach is fundamentally different from 2015, and different information is requested, so 2015 and 2016 scores are not directly comparable” (CDP, 2016, p.11). The final sample comprises 2,089 firm-year observations. In Table 1 the distribution of the final sample by Global Industry Classification Standard (GICS) classification is summarised, this matches the classification used by the CDP.

Table 1

Sample distribution

Industry/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Per cent
Basic Materials	18	21	21	26	32	31	25	22	18	214	10.24
Consumer Goods	25	25	28	25	24	25	29	29	29	239	11.44
Consumer Services	63	66	66	60	57	57	61	67	67	564	27.00
Health Care	5	9	9	8	8	10	12	14	13	88	4.21
Industrials	65	65	66	59	62	60	64	64	58	563	26.95
Oil and Gas	18	21	20	21	21	19	17	15	11	163	7.80
Technology	13	13	17	17	15	14	13	10	8	120	5.74
Telecommunications	5	6	5	7	9	8	8	7	6	61	2.92
Utilities	11	11	10	9	8	7	7	7	7	77	3.69
N	223	237	242	232	236	231	236	235	217	2089	100

3.2 Measures

3.2.1 Carbon performance

The measure used for carbon performance (CP) is actual carbon emission intensity. The CDP reported emission data is used and scaled up according to each company’s sales turnover. Taking this particular performance measure is justified because emissions are recognised as a key component of corporate carbon responsibility (Luo & Tang, 2014). The carbon emissions intensity is scaled by £’000 of sales revenue at year end. This aligns with previous studies (e.g. Clarkson et al., 2011). Unlike absolute emissions, this intensity measure takes into account variations in the output of products and services which makes it easier to compare firms across different reporting periods (Hoffmann & Busch, 2008).

3.2.2 Carbon disclosure

It has been suggested that future research which aims to use survey methods to measure firms’ social environmental practices is a valuable direction to take (Koh et al., 2014). Our study uses the Carbon Disclosure Score (CDS), from the CDP database, as a proxy for a firm’s carbon disclosure. This CDS is acquired from a survey based on a firm’s responses to items on the annual CDP questionnaire administered through the CDP’s Online Response System. Scores of between 0 and 100 are attributed based on a qualitative assessment of the responses. The CDP “is working to reduce the risks associated with transparency by facilitating dialogue and information-sharing between companies” (Wilhelm, 2013, p. 159). To achieve this the CDP collaborates with corporations and institutional shareholders to maintain their environmental disclosure system which gathers and publishes the GHG emissions of thousands of the world’s largest firms including those listed on leading exchanges including the FTSE350 and the S&P500. The proven strategic competence and broadly accepted legitimacy of its carbon disclosure standards has made it appealing to multiple stakeholders (Knox-Hayes and Levy, 2011). The disclosures companies make through the questionnaire can be grouped under three main headings (1) climate change management (including governance, strategy, targets, initiatives and communications); (2) climate change-related risks and opportunities; (3) emissions methodology, data, energy, emissions performance, and emissions trading. Of note is that in this third group of items, comprising 48% of the total CDS, emissions performance (change in volume of carbon emissions) is one of five items. Moreover, one of these five is emissions volumes which is crucial. As with financial disclosures, companies must be aware of the possibility of disclosing not just positive information but negative as well, regarding their emissions volumes. Significantly, the measure used for this item in the third category relates to reliability, honesty and fairness irrespective of the volumes emitted. In other words, the standard is not an increase or decrease in carbon emissions volume, but the quality of information disclosed. A summary of the CDS questionnaire items and structure is appended as Appendix 1.

3.2.3 Controls

There has been widespread use of firm size as a control variable in existing environmental disclosure literature (Clarkson et al., 2011, Deegan and Gordon, 1996). An argument has been raised that larger more prominent firms are subjected to stronger

⁴ Widely adopted by financial institutions, the *Equator Principles* is a risk management framework, used to determine, assess and manage social and environmental risk in projects. See <http://www.equator-principles.com>.

regulatory and political pressures with resultant higher political costs. Therefore, in the present study, firm size (SIZE) is controlled for using the natural log of total assets. Moreover, firms with good cashflows are in a better position to invest in substantial environment projects, allocate funds for compliance costs and improve environmental situation (De Villiers et al., 2011). Hence, we use the current ratio (total current assets/total current liabilities) to control for liquidity (LIQ). Furthermore, there is evidence that financial risk is an important influencing factor on corporate decision-making regarding changes to environmental strategy and environmental investments (Clarkson et al., 2011). To measure financial risk, we calculate the leverage ratio (LEV) by divide the total debt to total assets. Furthermore, prior studies found a significant relationship between financial performance and corporate sustainability (Spicer, 1978). We control for the financial performance (FP) effect by applying the return on assets. A firm's willingness and ability to invest in environmental issues is influenced by its management efficiency and capability. Having a superior management capability makes it more likely the firm will proactively adopt longer term environmental investment strategies (Sharma and Vredenburg, 1998). Growth in sales has been applied to measure management capability to generate financial value and enhance environmental situation (De Villiers et al., 2011). In the present study, sales growth (S.GROW) is measured by dividing changes in sales by beginning period sales. There is evidence of a significant correlation between board structure and carbon disclosure (Elsayih et al., 2018). Therefore, in line with Galbreath's (2010) proposition that board structure and the application of organisational resources for managing the opportunity and risk arising from climate change affect climate change governance practices, the influence of corporate board composition is controlled for by computing a composite index with the components of board composition as dummy industry-adjusted variables. Following Zaman et al., (2011), we use six variables, as presented in Appendix 2, to develop the index for board composition (BC). Prior literature indicates that growth companies are likely to have raised levels of information asymmetry potentially prompting managers to make further disclosures aimed at attracting new investors (Dhaliwal et al., 2011). In controlling for growth (GROW) we apply the market-to-book ratio. The sampled firms have, since 1st October 2013, been obliged to comply with the UK's GHG reporting regulation which includes a requirement to report their GHG emissions in the annual Director's Report⁵. Therefore, a dummy variable (REG) is included and is set to one for 2014-2015 and zero otherwise. Finally, we control for the possible influence of fluctuating business trends which could affect the examined relationship, by including yearly dummy variables (Alsaifi, 2019).

3.2.4 Model tested

Our principal empirical model, used to test the hypothesis, is as follows:

$$CP_{it} = \beta_0 + \beta_1 CDS_{it} + \beta_2 SIZE_{it} + \beta_3 LIQ_{it} + \beta_4 LEV_{it} + \beta_5 FP_{it} + \beta_6 S.GROW_{it} + \beta_7 BC_{it} + \beta_8 GROW_{it} + \beta_9 REG_{it} + \beta_{10} YEAR_{it} + \epsilon_{it}$$

where CP is the proxy for carbon performance; CDS is the carbon disclosure score; SIZE is the natural log of total assets; LIQ is the current ratio; LEV is the total debt to total capital ratio; FP is the return on assets; S.GROW is the sales growth; BC is the board composition index; GROW is the market-to-book ratio; REG is a dummy variable set to "1" for 2014-2015 and "0" otherwise; and YEAR are dummy variables.⁶ Panel data regression controls for individual heterogeneity, reduces multicollinearity and estimation bias, and identifies the time-varying relationship between dependent and independent variables (Al-Awadhi et al., 2020).

4. Results and analysis

4.1 Descriptive statistics

The descriptive statistics are shown in Tables 2 and 3. In line with Alsaifi et al. (2020), table 2 that reports the key descriptive statistics presents the averages for companies' total assets and market value at £8.117 and £9.360 billion respectively. This suggests our sample is composed of major businesses. Within the sample there is a broad range company characteristics it is clearly weighted towards the largest companies listed on the London Stock Exchange, in terms of market capitalisation.

Table 2

Descriptive statistics of sample observations

	Market Value (£M)	Total Assets (£M)	Sales (£M)	Net Income (£M)	Employees
Mean	9,360.90	8,117.62	7,576.11	594.92	26,819,31
Median	1,939.54	1,633.53	1,425.12	105,71	8,830
SD	22,875.03	24,478.27	28,464.29	1,871,63	60,770,59
Max	143,762.50	226,632.40	314,186.60	20,902,44	648,254
Min	243.62	22.05	0.29	-274.56	8

In Table 3 the mean and distributional characteristics for each variable are shown. Approximately 64% (1330 of 2089) of our sample responded to the CDP survey and the mean CDS score for these responders is 69.11. This result is rather higher than those reported in previous studies using CDS as an independent variable. Luo and Tang (2014) reported a CDS of 65 in their

⁵ Based on the Companies Act 2006 'Amendment of Part 7' Regulations 2013 (Secretary of State, 2013)

⁶ For the treatment of the outliers, our data are winsorised at the 2.5th and 97.5th percentiles.

study based on 2010 CDP data. Prado-Lorenzo and Garcia-Sanchez (2010) used data from the CDP 2007 survey and their sample averaged a CDS score of 60. The difference between our average CDS score and those of previous studies could be explained by the single year period used, or indeed by the rising level of public pressure for carbon disclosures in more recent years. As reported in Table 3, the average total emission intensity as a measure for CP is 4.839 meaning that the sample firms emit 4.839 tonnes of total emissions per thousand pounds of sales revenue. The mean of emission is considerably larger than the median; $4.839 > 0.733$ suggesting the sample includes some of the larger emitters. The logarithm of total assets was used to measure SIZE, and the mean and median result were 21. This is similar to that resulting from the Clarkson et al., (2008) sample.

Table 3

Descriptive statistics of model variables

Variable	N	Mean	Median	SD	Min	Max
CP	1332	4.839	0.733	19.867	0.005	431.628
CDS	1330	69.116	72.000	21.016	4	100
SIZE	2076	21.365	21.214	1.534	16.909	26.147
LEV	1898	24.343	22.382	16.743	0.004	114.539
FP	2067	8.093	6.522	12.523	-68.135	235.464
LIQ	2077	1.619	1.285	1.916	0.217	61.977
S.GROW	2065	0.956	1.039	0.862	0.001	26.525
BC	1797	2.874	3.000	1.337	0	6
GROW	1982	0.503	0.363	0.619	0.001	14.141

Table 4 reports the correlation between CP and the other right-hand variables (e.g. SIZE, BC, GROW and REG) and the results are in line with earlier studies.⁷ Regarding SIZE, as Haque (2017) argues, “large firms need to maintain their economic scale in terms of products, sales and employees, and thus cause greater GHG emissions” (p. 357). Furthermore, a significant positive association between CP and GROW corroborates that continual economic growth causes aggregate carbon emissions to escalate rapidly (Holtz-Eakin and Selden, 1995). Moreover, the significant negative correlation between CP and BC is confirmation of the influence of board composition on the examined relationship, whereby superior board composition decreases GHG emissions (Galbreath, 2010). The significant negative association between CP and CDS, which aligns with theoretical expectations, offers a primary finding that carbon disclosure tends to positively affect carbon emissions amount by reduction its level.

Table 4

The correlation analysis of model variables.

Variables	CP	CDS	SIZE	LEV	FP	LIQ	S.GROW	BC	GROW	REG
CP	1									
CDS	-0.050*	1								
SIZE	0.056**	0.369***	1							
LEV	0.001	0.009	0.154***	1						
FP	-0.044	-0.093*	-0.237***	-0.132***	1					
LIQ	0.031	-0.017	-0.127***	-0.224***	0.116***	1				
S.GROW	0.004	-0.046*	0.016	-0.005	-0.013	0.122***	1			
BC	-0.052*	0.298***	0.411***	-0.052**	-0.027	-0.123***	-0.001	1		
GROW	0.139***	-0.085***	0.172***	0.040*	-0.240***	0.059***	0.025	0.010	1	
REG	-0.018	0.427***	0.069***	0.008	0.004	-0.012	0.028	0.122	-0.076***	1

*, ** and *** denote significance at 10%, 5% and 1%.

4.2 Empirical tests

4.2.1 Carbon disclosure and carbon performance

The empirical results of the relationship between carbon disclosure and carbon performance are presented in Table 5 (Panel 1). Two empirical assessments are used to examine the impact of carbon disclosure on carbon performance so that our hypothesis can be tested. These are, in order, the Ordinary Least Squares (OLS) regression followed by the instrumental variable-two-Stage Least Squares (IV-2SLS) model (using Firm Age and CDS “lag-1 year”), which addresses the endogeneity issue between CDS and CP (Jo and Harjoto, 2012, Schreck, 2011)⁸ From these results, we can see that our hypothesis is confirmed as improved carbon disclosure leads to decrease in the carbon emissions amount. In other words, there is a significantly negative association between carbon disclosure and carbon performance. Consistent with the ‘outside-in’ management approach, enhanced carbon disclosure encourages firms to improve their carbon strategy and therefore achieve reduction in their emissions levels. From this we can conclude that carbon disclosure may be a means for firms to generate

⁷ Unreported variance inflation factors (VIFs) are within levels of tolerance for multicollinearity.

⁸ The IV-2SLS estimate utilises a reduced sample as instruments (lagged values) were only available for 741 observations.

momentum within the organisation toward improving social and environmental situation (Branco and Rodrigues, 2006). Hence, institutional pressures on sustainability as represented by the CDP are focusing firm's priorities on GHG emissions. To check the robustness of the results, the analysis was extended by dividing the sample into two subsamples: one for firms with high carbon disclosure, the other for those with low carbon disclosure. In Table 5 (Panel 2), we found that firms achieving high carbon disclosure were associated with lower emissions levels comparing to those with modest carbon disclosure whose emissions levels was high.

4.3 Additional analysis

4.3.1 Industry effect

We examine the potential effect of industry in the relationship of interest. Media and wider public scrutiny is greater for high GHG emitting industries and regulation is stricter. Based on the GICS definitions, our sample contains both intensive and non-intensive industries, nine in all after the exclusion of financial firms. Carbon-intensive industries are identified using the FTSE All-Share Index guidelines evaluating the level and nature of emissions. Five industries were identified as carbon-intensive: oil and gas, industrials, utilities, basic materials and consumer services. To test the potential industry effect, the sample was split into two subsamples one comprising the five intensive industries and the other the four non-intensive ones. To identify the potential impact of industry on the CDS-CP relationship an OLS regression test was conducted. The results, shown in Table 5 (Panel 3), indicate a significantly negative relationship for the carbon intensive subsample. No significant relationship was found for the non-intensive subsample. These results confirm the finding that voluntary environmental disclosures are predominant among firms in environmentally sensitive industries (Hasseldine et al., 2005, Patten, 1991, Roberts, 1992). This is in line with Hart and Ahuja (1996) who posit that firms with intensive emissions can improve both competence and productivity by reducing their industrial waste. A probable outcome is improved use of inputs and a consequent cut in the amount of raw materials used and waste disposed of both of which lead to lower emissions.

4.3.2 Financial crisis effect

Considering the sample period of this study that includes the years of 2007-2008 (financial crisis period) and 2009-2015 (recovery period). A test was then undertaken to isolate any possible effect of the financial crisis on the relationship of interest.⁹

Table 5

The relationship between carbon disclosure and carbon performance. Heteroscedasticity-robust standard errors are in parentheses

CP Model	Panel 1		Panel 2		Panel 3		Panel 4	
	OLS	IV-2SLS	High-CDS	Low-CDS	Intensive	Non-Intensive	Crisis	Recovery
CDS	-9.853** (4.041)	-17.416** (7.55)	-45.078** (17.289)	0.292 (0.257)	-12.436** (4.827)	1.053 (1.051)	-4.214 (7.411)	-9.109** (4.355)
SIZE	103.645*** (35.130)	91.234* (48.592)	-245.908 (280.438)	14.956*** (3.883)	113.137** (54.121)	-9.033 (8.502)	-80.079 (159.787)	107.669** (36.093)
LEV	1.428 (4.589)	5.198 (7.209)	38.063 (33.757)	0.808*** (0.272)	-2.173 (4.808)	0.056 (0.976)	4.440 (5.441)	-0.434 (4.996)
FP	-13.195 (18.335)	-20.787 (19.970)	-1.096 (48.575)	-1.845** (0.810)	-15.449 (21.835)	-5.026** (2.424)	32.111 (28.097)	-24.589 (22.084)
LIQ	191.247* (113.923)	159.612 (111.529)	364.670 (365.619)	-6.582 (4.694)	355.026* (196.44)	-30.216*** (6.715)	-103.880 (204.673)	204.484* (123.145)
S.GROW	-24.512 (117.401)	-1015.962 (1088.953)	-94.489 (97.014)	-18.263 (20.087)	-21.468 (105.020)	-68.629* (40.539)	-413.068 (567.765)	-22.013 (113.458)
BC	-39.046 (48.871)	-29.942 (49.468)	290.232 (314.942)	-15.401*** (3.607)	-33.696 (57.258)	8.726 (8.854)	202.755 (216.218)	-54.769 (48.270)
GROW	618.14 (484.840)	1093.080 (827.649)	4244.824 (2915.947)	0.770 (11.276)	890.576 (683.742)	23.513 (17.649)	-158.322 (227.228)	618.862 (510.900)
REG	258.364 (187.484)	1577.450 (1060.784)	810.006 (1280.203)	10.287 (34.287)	280.891 (241.420)	66.098 (85.577)		317.559 (214.412)
YEAR Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Constant	-1612.827** (631.120)	-1187.281* (714.191)	5791.276 (4302.430)	-193.007** (84.948)	-1835.863** (888.771)	302.342** (138.903)	1540.317 (3307.45)	-1544.586** (611.340)
R ²	0.05	0.08	0.19	0.10	0.07	0.10	0.06	0.06
N	957	741	179	778	734	223	115	842

*, ** and *** denote significance at 10%, 5% and 1%, respectively. (two-tailed test).

As indicated in Table 5 (Panel 4) the CDS-CP relationship is not significant in the financial crisis period but becomes highly negatively significant for the subsequent recovery period. This result indicates that companies may need to adjust to crises conditions by temporarily downgrading their emissions mitigation investments (Njoroge, 2009). Post crisis, corporate social and environmental responsibility appears to rise up the public agenda. KPMG's assessment states: "Before the financial crisis,

⁹ Consistent with Erkens et al., 2012, we specify the years of 2007-2008 as the financial crisis period.

investors typically saw environmental due diligence as a risk management tick-box exercise to secure financial institution funding. However, post-this exogenous shock, there appears to be a greater focus on responsible investment. We are seeing an increased appetite for the potential upsides (e.g. cost savings, additional revenue streams) of the sustainability agenda, in a transactional context. Strategies to manage energy (buy better, use less and self-generate) and waste (convert waste to an asset) are transforming the environmental due diligence process” (KPMG, 2017). This suggests that during the financial crisis period a company’s value was less dependent on intangible assets and that, today, companies strive for investor confidence in the financial market for reputational gains in competitive markets (Abimbola et al., 2010).

5. Conclusion

Motivated by the need for a fuller understanding of the relationship between carbon disclosure and carbon performance, this study is undertaken against a background of public concern over climate change and rising interest in green finance. The study applies the lens of the outside-in management approach to offer both explanations and empirical evidence while addressing the research question of how carbon disclosure affects a firm’s carbon performance. With a sample comprising 2,089 firm-year observations for firms listed on the FTSE350 index for the period 2007–2015, years notable for the heightened public concern and policy debate on climate change issues. The firms listed on the FTSE350 are the largest publicly listed businesses on the London Stock Exchange, according to their market capitalization. Hence, they are an appropriate representation of both the UK’s economy and its carbon profile. The CDS reported by the CDP were used in our analysis. The findings indicate a significant and negative relationship between voluntary carbon disclosure and carbon performance. Moreover, selecting the period we did meant we are able to capture the potential effect of the financial crisis on this relationship, with the findings indicating that carbon disclosure had no effect on performance during the crisis years. By contrast, within the recovery period after the financial crisis, a higher level of carbon reporting is associated with better carbon performance. Our analysis also extended to a comparison of carbon-intensive sectors with non-carbon-intensive ones finding that carbon disclosure and carbon performance is more markedly related in carbon-intensive sectors. Lastly, to check the results robustness, we divided the sample into high and low carbon disclosure firms with the results showing that high carbon disclosure was associated with low emissions and conversely low carbon disclosure was associated with high emissions. The empirical evidence offered by this study should add credibility to the use of CDP reporting for measuring carbon performance among firms. Moreover, the policy implication of our research is that environmental policy should shift its focus from producing more reports and guidelines to providing support to management and employees in improving their knowledge, skills and capacity to implement carbon performance measurement. Future policy needs to encourage environmental accounting methodology as well as its application, including the use of effective methods for achieving emissions reduction targets. The study is limited by sampling only the largest listed firms on the London Stock Exchange as measured by market capitalization. Therefore, when considering generalizing these findings to other types of businesses appropriate caution should be exercised. Further research avenues may be opened by the UK’s withdrawal from the EU with the potential impact this may have on UK firms’ carbon situation. The withdrawal is given added relevance due to the UK’s potential departure from the EU Emissions Trading System and its carbon policy responses to its new non-EU status.

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Appendix 1

Summary of the Carbon Disclosure and Scoring Weight

-
- 1. Climate Change Management: Governance, Strategy, Targets and Initiatives and Communications** – *Scoring weighted average* = $41.5/188 \times 100 = 22\%$
-

- 1.1 Governance Questions**
1.2 Strategy Questions
1.3 Targets and Initiatives Questions
1.4 Communications Questions
-

- 2. Climate Change Risks and Opportunities** – *Scoring weighted average* = $54/188 \times 100 = 29\%$
-

- 2.1 Regulatory, Physical and Other Climate Change Risks Questions**
2.2 Regulatory, Physical and Other Climate Change Opportunities Questions
-

- 3. Climate Change Emissions Methodology, Emissions Data, Energy, Emissions Performance and Emissions Trading** – *Scoring weighted average* = $91/188 \times 100 = 48\%$
-

- 3.1 Emissions Methodology Questions**
3.2 Emissions Data Questions
3.3 Energy Questions
3.4 Emissions Performance Questions
3.5 Emissions Trading Questions
-

Sign Off – *Scoring weighted average* = $1.5/188 \times 100 = 1\%$

- Please provide the following information for the person that has signed off (approved) the CDP climate change response:
 - i) Name
 - ii) Job title
 - iii) Corresponding job category
-

CDP climate change scoring methodology.

Appendix 2: Board Composition Index

1. **Chairman Independence** Are the chair positions separated from the CEO? 1 if yes; 0 otherwise.
 2. **Board Size** Is a firm's Board Size > the Industry Average? 1 if yes; 0 otherwise.
 3. **Board Independence** Is a firm's independent directors percentage > the Industry Average? 1 if yes; 0 otherwise.
 4. **Female on Board** Is a firm's female board director percentage > the Industry Average? 1 if yes; 0 otherwise.
 5. **Board Meeting Number** Are a firm's board meetings per year > the Industry Average? 1 if yes; 0 otherwise.
 6. **Board Meeting Attendance** Is a firm's board attendance percentage > the Industry Average? 1 if yes; 0 otherwise.
-



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