# Market Responses to Firms' Voluntary Carbon Disclosure: Empirical Evidence from the United Kingdom

**Amount of words 9716**


## Abstract

In corporate boardrooms around the world, climate change has quickly risen to become a major issue, matching public concern. Recently, corporate management has encountered stakeholder pressure to disclose more information about their carbon profile and their plans to improve it. They have also been challenged to find the appropriate strategy for carbon disclosures, requiring an understanding of the costs and benefits of both carbon improvement initiatives and the reporting of them.

Using a unique data set that contains firms listed on the FTSE 350 index on the London Stock Exchange market from 2009 to 2015, we apply the event study method to examine market reaction to carbon disclosures. The results show that investors respond significantly negatively to carbon disclosure announcements via Carbon Disclosure Project (CDP) of FTSE 350 firms. Moreover, for firms working in carbon-intensive industries, investors react to carbon disclosure announcements in a more significantly negative way compared with the main sample. We also find that the study's main findings are driven by the smaller FTSE 350 firms. Furthermore, a subsample of observations for the financial crisis period of 2007-2008 was analyzed to explore the examined relationship during the crisis. In contrast, a significant positive market reaction to carbon disclosure was found for the 2007-2008 crisis period. Our study's findings offer fresh insight and updated policy implications for investors, management and sustainability institutions. We recommend management accompanies their carbon disclosures with more explicit statements of reasons for carbon initiatives and the benefits arising from them.

**Keywords:** Greenhouse gas emissions; Carbon Disclosure Project; Carbon Disclosure; Market Response; Abnormal Return; Cumulative Abnormal Return

## Highlights

- Voluntary carbon disclosures are deemed by investors to have a negative value.
- Firms operating in carbon-intensive industries experience a more pronounced negative reaction on voluntary carbon disclosure.
- Analysis indicates that the main findings are driven by smaller FTSE 350 firms.
- The negative effect of voluntary carbon disclosure was reversed for the 2007/8 period of the global financial crisis.

## 1. Introduction

Climate change has emerged as a significant business consideration over the last two decades (Mardani et al., 2019). Firms have increasingly included consideration of global warming in their strategic management decision making (e.g. Alsaifi et al., 2019; Matsumura et al., 2014) and have adopted a range of environmental strategies (Radu et al, 2020). 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. Globally, stakeholders and public interest groups have called for greater disclosure, increased transparency, and a consistent approach to GHG emissions (e.g. Flammer, 2013; Qian and Schaltegger, 2017). Meanwhile, firms and their insurers have expressed concerns over the cost of these disclosures from the viewpoint of liability exposure and competitive disadvantage (Weigand, 2010). Additionally, there are individuals who urge balancing the approach by considering both costs and benefits (e.g. Li et al., 1997). Therefore, today's firms face the challenging task of determining the appropriate level of disclosure of the risks and costs associated with GHG emissions. It is no surprise that the question of whether or not to be green recieves consistently close scrutiny by both the media and scholarly journals (Hart, 1995; Lam et al., 2016). Event study methodology is widely adopted to address this question. It does so by quantitatively examining stock market reactions to company announcements related to environmental initiatives (e.g. Jacobs et al., 2010; Klassen and McLaughlin, 1996). First introduced by Fama et al. (1969), it has been described as "the standard method of measuring security price reaction to some announcement or event" (Binder, 1998, p. 111) indicating that it is highly appropriate for the present study.

One initiative to meet the need for consistency and transparency is the Carbon Disclosure Project (CDP).[1] The CDP is a charitable organisation concerned with environmental impact and pursues the goal of spreading environmental risk management and reporting throughout the business community. Its strategy aims to facilitate investors to move away from shareholdings bearing risk arising from climate change impacts. The CDP sends companies listed on major stock indices such as the FTSE350 and S&P500 an annual survey. The survey gathers information under the following three headings: (a) climate change management: strategy, initiatives, target, communications, and governance; (b) climate change-related risks and opportunities; and (c) climate change emissions methodology, emissions performance, emissions data, and energy and emissions trading. The collected information is made available to the public via the CDP website. By agreeing to participate in the CDP, firms are committing to disclosing their existing GHG emission levels, reduction targets, initiatives to achieve these targets, and associated risks and opportunities arising from global warming (Lee et al., 2015). The CDP aims to promote investor engagement with companies on environmental issues and to use their published information to identify opportunities and reduce risks (CDP, 2020).

The objective of this study is to examine market reaction to CDP survey announcements. This objective will be achieved by applying the event study method to extend the extant literature on whether investors see voluntary disclosure of carbon emissions information as being relevant to stock valuation. The sample comprises 1,564 firm-year observations of firms listed on the FTSE350 index for the period 2009–2015. This period witnessed heightened public engagement in climate change issues and the associated policy debate. The

[1] Currently the world's largest register of corporate carbon disclosures, the CDP was established in 2000 in the UK. Its central activity is administrating an annual survey on behalf of investor signatories. The CDP survey collects information from public companies on climate change-related issues. Its breadth of coverage has also led it to become an important data source for academic research. The CDP has highlighted the fact that its data was used in 70 peer-reviewed studies published between 2005 and 2015.

89 firms listed on the FTSE350 are the UK's largest public companies by market capitalisation,
90 and hence they offer a core representation of the UK's economic performance and its carbon
91 strategy.
92 Earlier studies of market reactions to carbon disclosure have been conducted in the US
93 context (e.g. Fisher-Vanden and Thorburn, 2011; Hsu and Wang, 2013; Jacobs et al., 2010;
94 Kim and Lyon, 2011). A smaller number of studies have examined carbon disclosures in
95 developing countries, typically Asian contexts (e.g. Lam et al., 2016; Lee et al., 2015).
96 European contexts have received very limited attention regarding market reaction to carbon
97 disclosures, including the UK. Indeed, to the best of our knowledge, this is the first study
98 examining the market responses of the London Stock Exchange to announcements related to
99 carbon disclosure by applying the event study approach.
100 The UK, as a G7 (Group of Seven) member, is one of the world's biggest emitters of GHG
101 (Haque, 2017) making it a pertinent setting for studies of this kind. Moreover, the UK is
102 currently at the forefront of the development of mechanisms to proactively mitigate the
103 negative consequences of climate change. Notably, the UK has the greatest proportion of
104 firms making Scope 1 and 2 emissions disclosures (>97%) and the greatest proportion of
105 board-level oversight of climate change risk (96%) (CDP, 2018).[2] In 2008, The UK's
106 Committee on Climate Change gave the government a recommendation to put in place a
107 GHG reduction target that would see emissions fall to a minimum of 80% of the 1990 levels
108 by 2050. The following year, the government published voluntary guidelines for measuring
109 and reporting of GHG emissions to encourage firms in the UK to reduce their climate change
110 impact. Furthermore, the Companies Act 2006 (Strategic Report and Directors' Report)
111 Regulations 2013 (SI 2013/1970) brought in statutory requirements for listed companies

[2]Scope 1 emissions are those directly emitted by sources owned or controlled by the reporting firm. Scope 2 emissions are indirect and represent emissions arising from the generation of energy purchased.

112 regarding GHG emission disclosure. Since 1st October 2013, the firms have been obligated to
113 publish a directors' report of GHG emissions and the methodology applied in calculating
114 them. The UK is, therefore, a highly significant country in terms of both emissions and
115 emissions disclosure terms. Hence, it is important to remediate the paucity of attention to the
116 effects of carbon disclosure noticed in the case of this country, which is addressed in the
117 present study.
118 Furthermore, we contribute to the continuing literature by constructing the cost-benefit
119 approach as a conceptual model, to understand market reaction to voluntarily corporate
120 engagement in climate change initiatives. One proposes that voluntary moves aimed at
121 improving corporate environmental strategy decrease profits and, therefore, runs counter to
122 the maximization of shareholder value, a "win-lose" perspective (e.g. Friedman, 1970). On
123 the other hand, there is another perspective which emphasises that shareholder value and
124 corporate environmental strategy are not mutually exclusive. Instead, under this view it is
125 proposed that tackling emissions and achieving profitability can be pursued together, in a
126 "win-win" approach (e.g. Porter and Van der Linde, 1995).
127 In the next section, we review existing literature and explain the hypothesis development.
128 The research design and methodology are explained in the Section 3. The Section 4 presents
129 the empirical results. Concluding remarks are made in the Section 5.
130

131 ## 2. Literature Review and Hypothesis Development

132 ### *2.1 Background*

133 Researchers have shown considerable interest in the economic consequences of a firm's
134 social responsibility (e.g. Clarkson, et al., 2004; Gallego-Álvarez et al., 2015; Hart and
135 Ahuja, 1996; Hahn and Kühnen, 2013; Hillman and Keim, 2001; Peloza, 2009). Some of the
136 early literature followed the approach of Friedman's proposition that the "social

responsibility of business is to increase its profits" (Friedman, 1970, p. 122) and firmly positioned corporate social responsibility (CSR) in the cost column. As a cost of doing business, CSR would inevitably mean lower profits and directly conflict with management's obligation to shareholders. For example, a firm contemplating installing new cleaner production machinery and training staff to use it, both of which would come at a significant cost requiring new capital. Conversely, another stream of literature challenges Friedman's approach by arguing that the twin pursuits of pollution control and profitability are not necessarily mutually exclusive (Porter and Van der Linde, 1995). This approach sees pollution as a wasteful use of energy and material resources; furthermore, efforts to control pollution, for example, through improved processes or products, can bring the double benefit of reducing the firm's carbon footprint while strengthening its competitiveness. Empirical studies have produced mixed results when examining carbon performance and disclosure and firm financial performance although recent meta-analysis found a broadly positive relationship (Velte et al., 2020). Studies can be put into one of the following three groups based on their analytical approach: (a) portfolio analysis, (b) regression analysis, and (c) event studies.

Studies using the portfolio analysis method aim to examine whether returns for a portfolio comprising firms with a positive environmental responsibility outperform the market as a whole. The results have been negative especially for older studies, finding that mutual funds made up of environmentally or socially responsible firms perform less well in terms of risk-adjusted returns (Geczy et al., 2005; White, 1996). Similarly, Ziegler et al. (2009) reported a negative abnormal return for investment strategies that involve buying stocks of companies that are proactively aiming to reduce GHG emissions and divesting stocks where the firms make no significant investment in environmental efforts. However, a more recent study finds that investors could gain abnormal risk-adjusted revenues of around 13% annually when

investing in portfolios entirely comprised of firms which disclose their carbon profile (Liesen et al., 2017).

Studies using regression analysis focus mainly on the relationship between environmental responsibility and financial performance over the long term. Several studies have found a positive relationship. Others, however, reported either mixed findings or a negative relationship (e.g. Clarkson, et al., 2004; Jaggi and Freedman, 1992; Molloy et al., 2002). Generally, it appears that a positive relationship is found when the environmental measures involve compliance, regulatory risk, and liability (Fisher-Vanden and Thorburn, 2011). Furthermore, Matsumura et al. (2014) reported a significantly negative relationship between GHG emissions and the value of equity. Their suggestion is attributed to the "uncertainty surrounding physical climate parameters" as well as to the costs associated with "measuring, monitoring, and reducing carbon emissions" (Matsumura et al., 2014, p. 701). The implication of the empirical evidence from these regression studies is that a negative impact on financial performance should be anticipated from environmental investments (Fisher-Vanden and Thorburn, 2011). It should be noted, however, that the long-term nature of these studies exposes firm performance to an array of explanatory factors that are beyond environmental responsibility.

Event study methodology contrasts with regression analysis in ways that suggest it is highly suitable for capturing market reaction.[3] As they focus on market returns, event studies present a reaction which is based on a forward-looking evaluation of environmental practices and their financial consequences. Furthermore, event study methodology avoids the endogeneity issue and offers greater unambiguity regardng the causal direction of the relationship (Endrikat, 2016).

[3] In statistical modeling, regression analysis refers to a quantitative tool used to estimate the relationships between a dependent variable and one or more independent variables (see Freedman, 2009).

Event studies investigate how markets react to environmental initiatives/disclosures/activities. Although event study methodology has proved to be a productive approach, the findings have not been consistent, with some results indicating a positive reaction to environment-related announcements, others a negative reaction, and some even reporting the absence of any effect. In one of the earlier studies, Shane and Spicer (1983) reported that the stock market reaction to announcements of improved pollution performance is more positive than it is for announcements of poor performance. Likewise, Klassen and McLaughlin (1996) found that positive abnormal stock returns are normally triggered by positive firm events such as the winning of an environmental award. Additionally, Griffin and Sun (2013) found that capital markets give a positive response when firms voluntarily disclose GHG emissions. Contrary to this evidence, other studies found a different negative reaction to events. For example, when Finnish forestry firms announce environmental investments, the stock market's reaction is found to be negative (Halme and Niskanan, 2001). In the same vein, when studying investor perceptions, Molloy et al. (2002) found that the perception of environmental investment is that it increases costs, not reduces them. Moreover, Beatty and Shimshack (2010) reported that stock markets react to negative environmental disclosures but not to positive ones. Basing his study on the Toxic Release Inventory's data releases, Hamilton (1995) found that the public disclosure of these data and the press coverage thereof leads to significantly negative abnormal returns in cases where the toxic release was high. Furthermore, Stevens (1984) found that companies whose pollution control costs are low are more likely to experience positive abnormal stock market returns when compared to firms incurring high costs. The interpretation of investors is that the new information increases firm liability or compliance risk, thereby leading to higher costs. Another event study on ISO 14001 certification announcements reported that the shares of firms that are relatively less polluting drop post-announcement (Cañón-de-Francia and

210 Garcés-Ayerbe, 2009). The interpretation of the authors is that investors see no significant
211 benefit with such certification, but associate it with high costs. Investors may view firms
212 asked to make disclosures to the CDP as having potentially high GHG emissions and with
213 them high mitigation costs. Furthermore, where carbon information is disclosed, there may be
214 no benefit to investors (Kolk et al., 2008). Mitigation initiatives tend to be related to costs. To
215 exemplify, the decision to deploy green technologies is associated with an investment that
216 would be unnecessary if the firm decides not to act as a green firm (Wegener, 2010). Jacobs
217 et al. (2010) suggested that markets react negatively to voluntary initiatives to reduce
218 emissions because the associated costs are evident, while the revenue benefits are hard to
219 define. Consistent with this and other studies, Fisher-Vanden and Thorburn (2011) found that
220 participation in the Environmental Protection Agency Climate Leaders programme, as a
221 resource for reducing GHG emissions voluntarily, is linked to a negative market reaction.[4]
222 Palmer et al. (1995) argued that shareholders' wealth is reduced by efforts to mitigate climate
223 change because such efforts can mean diverting the investment from more productive
224 activities, and can hence mean that the full potential earnings of its assets are not realised. As
225 a result, the firm finds itself disadvantaged economically. Alignedwith this argument, Hsu
226 and Wang (2013) reported that positive wealth effects are associated with firms receiving
227 negative news coverage regarding climate change. In recent studies, both Chapple et al.
228 (2013) and Griffin et al. (2017) found that there is a negative relationship between GHG
229 emissions disclosures to the CDP and shareholder value. They concluded that shareholders
230 treat carbon emissions as a hidden off-balance sheet liability. In a study closely related to the
231 present one, Lee et al. (2015) proposed that the stock market would react negatively to a
232 company's CDP carbon disclosure based on the fact that such announcements are viewed as

[4] The Environmental Protection Agency Climate Leaders programme is an American governmental initiative aimed at tackling climate change threats and mitigating GHG emissions.

bad news that potentially involves costly mitigation measures. Finally, as mentioned, there are studies reporting no effect. An examination of environmental conscientiousness scores covered in the press revealed no significant abnormal stock market returns in response (Yamashita et al., 1999). Similarly, Gilley et al. (2000) reported that the stock market did not react in any significant way to company announcements on environmental initiatives. This aligns with Jacobs et al. (2010) who found, among their other findings, that environmental initiative announcements fail to provoke significant stock market reactions. Kim and Lyon (2011) also showed a lack of evidence for increases in company value arising from carbon disclosure.

**[Figure 1 about here]**

### *2.2 Hypothesis Development*

Stakeholder theory is a popular approach among CSR researchers (Lee et al., 2015). It emphasises the influence of various stakeholder groups, including investors, employees, customers, government, and the community, on firm decision making (Freeman, 1984). Since market reaction is a consequence of investor reaction, our hypothesis is formulated based on how investors will react to voluntary carbon disclosure announcements initiated by the CDP. Two main mechanisms have been proposed to examine how CSR either increases revenues or costs (Friedman, 1970; Porter, and Van der Linde, 1995). A review of these mechanisms reveals the way voluntary carbon disclosure may impact market reaction.

The framework shown in Figure 1 was used to develop the hypothesised impact of carbon disclosure announcements on markets. Figure 1 indicates that it is possible that investors' perception of the voluntary efforts for carbon disclosure will match Friedman's perception. Friedman (1970) proposed that if a firm incurs environmental expenses beyond those

258 required for regulatory compliance, then they would be acting against the interests of
259 shareholders and would see a negative effect on firm value and performance.
260 Alternatively, as shown in Figure 1, it is also possible for investors to view carbon
261 disclosures through Porter's lens. This sees pollution as wasted resources and, therefore,
262 views mitigation measures and the enhancement of carbon profile as strengthening firm
263 competitiveness in a win-win situation (Porter and Van der Linde, 1995). Furthermore, a
264 participation in voluntary carbon disclosure will enable a firm to attract and retain high
265 quality staff (Turban and Greening, 1997), encourage innovation (Surroca et al., 2010), and
266 improve decision making as well as overall organisational culture (Hillman and Keim, 2001).
267 In line with stakeholder theory (Freeman, 1984), it has been argued that companies engaged
268 in enhancing their environmental responsibility are acquiring both stakeholder support and
269 necessary resources, which mitigates against legislative, regulatory, or fiscal actions
270 (Flammer, 2013). In turn, such activities can enhance firm reputation (Hart, 1995), may
271 manage firm legitimacy (Porter and Kramer, 2006), and reduce financial risks (Peloza, 2009).
272 It may also attract investment from the growing number of environmentally conscious
273 investors (Dowell and Hart, 2011). The increased demand from environmentally conscious
274 consumers can lead to a growth in share prices. Klassen and McLaughlin (1996) suggested
275 that important reputational benefits emerging from positive environmental actions can be
276 associated with revenue growth, therefore maximising shareholder wealth by creating
277 reputational capital. Turning to costs, participation in CDP as an environmental initiative may
278 help companies achieve cost reductions by reducing pollution and other forms of waste
279 (Porter and Van der Linde, 1995). Costs may also be lowered by improving energy efficiency
280 and operational processes (Hart and Ahuja, 1996). This might lead to better employment of
281 inputs, causing a reduction in raw materials and/or waste disposal expenses. In the long term,
282 costs related to future environmental crises, regulatory compliance, and liabilities may be

avoided (Reinhardt, 1999). Furthermore, Albarrak et al. (2019) associate carbon reporting with a reduced cost of equity. Additionally, when comparing accounting measures with market measures, Alsaifi et al. (2019) found strong evidence that voluntary carbon disclosure is more positively associated with the firm's accounting measures.

It is clear from this discussion that the views of Friedman (1970) and Porter and Van der Linde (1995) represent two expected outcomes from voluntary carbon disclosure, in terms of stock market reaction. The former is a negative reaction, and the latter is a positive one. Therefore, we formulate the following reference hypothesis:

**$H_1$**: There is a significant market reaction following the announcement of a CDP survey.

## 3. Research Design and Data

### *3.1 Sample*

Since the FTSE350 is the largest index in the UK that is annually assessed by the CDP, all firms continually listed on the FTSE350 between 2009 and 2015 were included in the sample. It is noteworthy that FTSE350 firms were originally asked in 2006 to engage with and report their carbon footprint voluntarily via the CDP online survey.[5] This first year, however, was not used for our analysis because (1) there was only a low level of participation in the CDP, and (2) the qualitative analysis only extended to assigning responses to one of the following four categories: Answered Questionnaire (AQ), Provided Information (IN), Declined to Participate (DP), and No Response (NR). From the following year, a 0 to 100 scoring scale was introduced. Notwithstanding this change, we also decided to exclude the period 2007-2008 to isolate our analysis from the effects of the global financial crisis (GFC). However, we will consider this

[5] The CDP reporting year is set to match the fiscal year of each participating firm. Subsequently, the summary of survey data is generally published in September or October of the reporting year.

impact in the additional analysis section. 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).

Following standard practice for research of this kind, financial institutions were also excluded because of their unique accounting principles and the different social and environmental guidelines they apply, such as the 'Equator Principles' (e.g Alsaifi et al., 2019; Haque, 2017).[6] Ultimately, the sample comprised of 1,564 firm-year observations crossing nine industries. The Global Industry Classification Standard (GICS) used for the CDP sector categories is also applied to this study. A summary of the final sample distribution by industry and year is given in Table 1 Panel A which indicates 2014 as the highest year for response rate (79%) and 2009 as the lowest (57%) in the sampled period. Despite the surprising drop in 2015, it is clear that the annual increase in the response rate is consistent with public concern related to climate change. Panel B shows that the utilities industry has the highest overall response rate (93%), while the technology industry has the lowest (52%). Based on the FTSE All-Share Index classification, this study indicates that the response rate for firms operating in carbon-intensive industries (72%) is almost equal to the response rate for firms in non-intensive industries (71.25%).[7] It had been posited that firms in polluting sectors were more likely to make voluntary environmental disclosures (Brammer and Pavelin, 2006). However, in the present study, and in line with Stanny and Ely (2008), we

[6] The *Equator Principles* offer financial institutions a risk management framework aimed at providing a minimum standard for determining, assessing, and managing environmental and social risks in projects. See: http://www.equator-principles.com.

[7] FTSE All-Share Index standards are applied to identify carbon-intensive industries based on the level and nature of GHG emissions. These were industrials, basic materials, utilities, consumer services, and oil and gas.

find no evidence of this, suggesting that carbon-intensive industries have decreased or failed to increase their disclosures while non-intensive industries have become increasingly transparent.

**[Table 1 about here]**

### *3.2 Event Study*

The market reaction following announcements in the CDP report is estimated by using the event study method, thereby testing the hypothesis. This method provides the means (when applying T-test) or medians (when applying Wilcoxon signed-rank test) to estimate event-related market returns and, at the same time, control for more general market influences on stock prices (Bash and Alsaifi, 2019; MacKinlay, 1997). The underlying assumption is that, in conditions of market efficiency, an event's effect is reflected immediately in the stock price of the concerned firm. Consequently, by observing the stock price for a short time span, event effects on a firm's value can be recorded (Fisher-Vanden and Thorburn, 2011).

The initial task when implementing the event study is to determine the event period, this being the period for estimating abnormal returns. To encompass the possibility of pre-announcement information leakage, the day prior to the announcement is included in addition to the announcement day itself (Lam et al., 2016). For this reason, and to align with previous event studies (Ba et al., 2013; Lam et al., 2016; Wassmer et al., 2014), we selected three days around the event dates as our main event window (i.e. days -1 to +1). This procedure would help us to account for the possibility of pre-event information leakages and the possibility of announcements being made after stock market closures. Further extension of the window would open up the possibility of market movements not being attributable to the particular

event (Fisher-Vanden and Thorburn, 2011). Calendar days are converted to event days by designating the announcement day as Day 0. If the announcement is made on a non-trading day or later than 4.30 pm London time of a trading day, then Day 0 would become the following day. All other trading days are recorded as relative to Day 0; hence, the trading day prior to Day 0 (announcement day) is recorded as Day -1. Likewise, the trading day immediately after the announcement day is designated Day +1. Additionally, aligning with previous studies, the estimation of abnormal returns is conducted using the market model (e.g. Fisher-Vanden and Thorburn, 2011; Jacobs et al., 2010; Wassmer et al., 2014). Under this model, a linear relationship is posited between a given stock's return and the market return (the return on the market portfolio) over a specified period of time:

$$ER_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

whereby $ER_{it}$ represents the expected return of stock *i* on Day *t*, $R_{mt}$ represents the market return on Day *t*, $a_i$ is the intercept of the relationship for stock *i*, and $\beta_i$ is the slope of the relationship for stock *i* regarding the market return, with $\varepsilon_{it}$ being the error term for stock *i* on Day *t*. The term $\beta_i R_{mt}$ represents the sensitivity of stock *i*'s returns to market return. This portion of the return for which market movements provide no explanation is represented by the error term $\varepsilon_{it}$, which captures the effects of the firm-specific information released. The computation of expected return for each firm in the sample is estimated in accordance with Equation (1), where $a_i$ and $\beta_i$ are estimated by applying the ordinary least squares regression across the 200-trading-day estimation period. The commencement of the estimation period was designated, with Day -200 being the first trading day of the year, and terminated on Day -21. The reason for terminating the estimation period 21 days before the event day is to protect the estimates from contamination due to the impacts of the announcement and to

render any stationarity inconsequential. In cases where a firm does not have data available for the entire estimation period, a qualifying minimum of 40 stock returns during the 200-day period was applied to the estimates in Equation (1).

Next, the computation of the abnormal return for firm *i* on Day *t*, which is the difference between the actual and the expected return, goes as follows:

$$AR_{it} = R_{it} - ER_{it} \quad (2)$$

whereby $AR_{it}$ is equal to the abnormal return on security *i* on date *t*, $R_{it}$ represents the actual return of stock *i* on Day *t*, and $ER_{it}$ represents the expected return of stock *i* on Day *t*.

After this, aligning with previous event studies (e.g. Gilley et al., 2000; Jacobs et al., 2010; Lam et al., 2016), the data is both parametrically and non-parametrically tested. First, for testing the data parametrically, we use the t-test to determine the statistical significance of the mean of cumulative abnormal returns (CARs). Second, for testing the data non-parametrically, we control for the effect of outliers using the Wilcoxon signed-rank test, which determines the statistical significance of the median of CARs.[8] Finally, the CARs are computed by cumulating ARs over the announcement period.

$$CAR\ [t_1, t_2] = \sum_{t=t_1}^{t_2} AR_{it} \quad (3)$$

[8] Since the study's observations are not normally distributed on the basis of a Sapiro-Francia normality test, the Wilcoxon signed-rank non-parametric statistical test is prioritized for explaining the results (McDonald, 2009). Therefore, if the results of these two tests (t-test and Wilcoxon signed-rank test) are inconsistent, we consider the Wilcoxon signed-rank results.

whereby $CAR$ is the cumulative abnormal return, *t* is the selected day related to the announcement event and $AR_{it}$ is the abnormal return on security *i* on date *t*.

## 4. Results and Analysis

### *4.1 Descriptive Statistics*

Descriptive statistics of the sample use data from the fiscal year immediately prior to the most recent announcement, and are shown in Table 2. The averages of firms' market value and total assets are £9.7 and £8.8 billion, respectively, which suggests that our sample comprises large firms. While there is broad variation in firm characteristics found in the sample, there is an overall weighting towards the London Stock Exchange's largest firms by market capitalisation.

**[Table 2 about here]**

### *4.2 Market Reaction to CDP Announcements*

Table 3 (Panel A) shows how markets reacted to announcements from companies participating in the CDP report; additionally, the t-test and Wilcoxon signed-rank test results of ARs and CARs are presented. The ARs on Day -1 are not statistically significant for both the t-test and Wilcoxon signed-rank test, indicating an absence of evidence of information leakage prior to CDP announcements. Furthermore, the median of ARs on day 0 is significantly negative on the Wilcoxon signed-rank test. A subsequent checking of CARs periods reveals evidence that responses from capital markets had a significantly negative relationship with the voluntary carbon information disclosure for various lengths of the event window. Notably, the mean (median) of CARs over the two-day window (0 to +1) and for the key three-day event window (-1 to +1) are statistically negatively significant at the 5% and

10% levels, respectively, for the Wilcoxon signed-rank test, which indicates that investors respond negatively to the CDP announcements of FTSE350 firms. This could be ascribed to the fact that investors interpret climate-related environmental initiatives as an investment/cost to the company without an offsetting benefit, that reduces competitive advantage, which aligns with the conclusions of Cañón-de-Francia and Garcés-Ayerbe (2009). It would also align with Hsu and Wang's (2013) findings that, generally, investors hold the belief that when firms tackle climate change, it can increase costs and place firms at an economic disadvantage. In other words, voluntary carbon disclosure requires additional costs that reduce the attractiveness of investment in the firm, which may lead investors to abandon the firm's stock even at low prices. Therefore, **H**1 is supported, and London Stock Exchange investors' reaction is consistent with Friedman's (1970) view that expenses incurred for environmental purposes, which fall outside of regulatory compliance, run counter to the best interests of shareholders and degrade firm value. Conversely, market reactions to CDP's non-participants, shown in Panel B of Table 3, were not significant, particularly for the key event window (-1 to +1), with the exception of Day 0 that is negatively significant in the Wilcoxon signed-rank test.

**[Table 3 about here]**

The explanation of our findings is that participation in the CDP survey is perceived as leading to extra costs from the investors' perspective. The robustness of the main results presented in Table 3 are inducted on firms participating in the CDP and working in carbon-intensive industries. For such firms, there is a greater likelihood of significant costs being incurred in relation to environmental protection, including risk management, clean-up costs, and reporting and compliance costs (Nguyen, 2018). For this, we divide the firms participating in

the CDP survey into ten industries (nine after excluding the financial industry) based on GICS classification.

We then apply FTSE All-Share Index standards to identify carbon-intensive industries within the subsample of firms that participated in the CDP survey (1,100 observations). These were found to be consumer services, basic materials, industrials, utilities, and oil and gas. Panel A in Table 4 indicates that investors react to CDP announcements for firms working in carbon-intensive industries in a significantly negative way at the 5% level. This response occurs in almost all window periods, particularly in the key event window (-1 to +1) and on the announcement day itself (Day 0). The mean and median results of ARs and CARs for these and other periods support the notion that investors' impressions of participation in measures to tackle climate change and voluntary carbon disclosure initiatives are a cost on firms. This finding is aligned with Chapple et al. (2013) who also found that the market evaluates the most carbon-intensive firms in the sample more negatively than other firms. These investors' reactions reflect the expectation that environment-related costs will increase, creating negative financial consequences; an expectation that is even more pronounced for firms in carbon-intensive industries (Ramiah et al., 2013). These cost consequences may be carbon-related management and accounting costs, clean-up costs, litigation and compliance costs or reputational damage costs. For firms working in non-intensive industries (Panel B), although there are significant positive reactions through t-test on the announcement day (day 0) and for the event window of (-1 to 0), we were unable to confirm these results since the test of Wilcoxon signed-rank has insignificant signs.

**[Table 4 about here]**

### *4.3 Additional Analyses*

While the FTSE 350 comprises the UK's largest publicly listed firms there is considerable range of firm size among them. Therefore, to examine the effect of firm size on market reaction we grouped participating firms into one of two groups based on whether their market capitalization was higher or lower than the mean market capitalization (£12.55 billion for participated firms). In Table 5 the higher market capitalization group (Panel A) shows no significant market reaction. In contrast, the group of smaller market capitalization firms (Panel B) indicates significant negative market reaction on day 0 and in the key period which is confirmed by Wilcoxon signed-rank test or T-test. This further finding suggests that the earlier main findings are driven by the smaller firms listed on the FTSE 350. The firm size effect may be explained by investors perceiving that for smaller firms' investment in environmental initiatives is not a priority. Moreover, investors may also perceive that larger firms are in a better position to absorb environmental costs than their smaller counterparts (Jaggi et al., 2018; Stanny and Ely, 2008).[9]

**[Table 5 about here]**

To examine the impact of the GFC period, we apply the same criteria as for the main sample, but change the period from 2009-2015 to 2007-2008, and the total observations for the new sample becomes 455.[10] Table 6 (Panel A) shows the market responses for companies participating in CDP announcements during the crisis period. The results through the two tests (i.e. t-test and Wilcoxon signed-rank test) over several event window periods, including

9 We would like to acknowledge the anonymous reviewer who attracts our attention to this additional analysis

10 Consistent with Erkens et al., 2012, we specify the years of 2007-2008 as the GFC period.

497 the key period (i.e. -1, +1), show a significant positive market reaction. This finding can be
498 explained as an investor perception of the CDP announcement as a signal of the financial
499 strength of the participating firms. This perception is based on the view that firms that
500 participated in CDP during the GFC are confident of their financial situation. This is
501 demonstrated by their allocation of financial resources to non-profit social initiatives, such as
502 voluntarily disclosure of their carbon profile through the CDP report. This finding is
503 supportive of Mohr et al., (2001) who argue that investment in CSR should be maintained
504 during economic crises as it exerts a positive influence on stakeholder behavior. Similarly,
505 Gallego-Álvarez et al., (2014) state that CSR is required in times of financial crises to induce
506 greater trust in the business. The results of non-CDP participants for the 2007-2008 period, as
507 presented in Panel B of Table 6, shows that while market responses are inconsistent through
508 ARs and CARs periods, for the key period (i.e. -1, +1) reactions are insignificant. Having
509 said that, the market would not react positively or negatively for firms that do not disclose
510 their carbon profile during the GFC period but will reward firms that disclose their carbon
511 profile during the GFC period.
512
513 **[Table 6 about here]**
514
515 **5. Conclusion**
516 Climate change has become a major issue in corporate decision making and poses a challenge
517 to corporate leadership. There is increasing pressure for businesses to operate in a climate-
518 friendly way, but a potential conflict may arise when such a strategy contradicts the pursuit of
519 shareholder value. Empirical studies have produced mixed results when examining the issue
520 of CSR and firm's financial consequences. Our study set out to understand the market
521 reaction to carbon disclosures for the UK context. To this end, a conceptual model was

applied which explains the market reactions, negative or positive (i.e. Friedman, 1970; Porter and Van der Linde, 1995). In line with this model, we hypothesize that there would be a significant market reaction, either positive or negative, following the announcement of voluntary carbon disclosure via the CDP survey. The study uses an event study approach and a data set of 1,564 firm-year observations of large firms listed on the FTSE350 index for the period 2009-2015. In addition, two subsamples were analyzed, one based on industry status (carbon-intensive/non-carbon-intensive) for CDP participating firms, and another that included a sample for the GFC period 2007-2008.

For the main sample, our analysis showed a statistically significant negative market reaction to carbon disclosure announcements of FTSE350 firms. This suggests that investors perceive such disclosures to be associated with climate-related environmental investments, representing costs that are not perceived to be offset by tangible benefits and that weaken competitive advantage. This result supports the win-lose view that any costs incurred beyond regulatory compliance is against the interests of shareholders and would have a negative effect on firm value (Friedman, 1970). For the industry status subsample, our results also show that investors in firms operated in carbon-intensive industries react to carbon disclosure announcements in a significantly negative way. This result also supports the expectation that firms operating in carbon-intensive industries experience a more pronounced negative reaction on voluntary carbon disclosure. Dividing the sample into two groups based on market capitalization indicates that the significant negative market reaction result was driven by the smaller firm group. For the temporal subsample (2007-2008), carbon disclosure announcements are associated with a significantly positive market reaction. We conjecture that this may be explained as an investor perception of the carbon disclosure announcement in the crisis period as a signal of the financial robustness of participating firms, though this

546 explanation does not necessarily align with Porter and Van der Linde (1995) and their win-
547 win approach.
548 Hence, overall, we can conclude that, in the case of the London Stock Exchange's investors,
549 voluntary carbon disclosures are deemed to have a negative value as they signal directly
550 assignable associated costs that are not matched by tangible financial benefits. The exception
551 to this was the 2007-2008 crisis period.

552 **5.1 Implications for theory and practice**

553 This study considered two contrasting theoretical approaches to firm sustainability and
554 broader CSR, those of Friedman and Porter. While there is some evidence that carbon
555 disclosure may be positively related to financial performance (Matsumura et al., 2013; Saka
556 and Oshika, 2014) our study suggests that at the level of perception the market reaction is
557 negative. This result could be associated theoretically with Friedman's (1970) assertion that
558 incurring non-mandatory environmental expenses is against shareholders' interests. The
559 study adds to the literature which suggests a mismatch between the immediate market
560 reaction and accounting-based measures of the effect of carbon reporting (Alsaifi et al., 2019;
561 Hart and Ahuja, 1996; Peloza, 2009).
562 In practical terms, our study's finding leads to the implication that more emphasis needs to be
563 placed by management on identifying and justifying firms' environmental strategies and the
564 resultant initiatives including investments in cleaner production. Carbon disclosures should
565 be accompanied by these clarifications, and expressions of the resultant value should be as
566 tangible as possible. The potential for waste reduction and lower costs through energy
567 efficient cleaner production are tangible benefits from environmental initiatives and while not
568 all sustainability investments are so direct in their cost-benefit impact improved messaging
569 could alter investors' perceptions. Future research may consider the scores of voluntary
570 carbon disclosure for the firms included in the CDP report as a possible factor in the market

reaction toward climate change initiatives. This could be achieved by controlling the disclosure score as a piece of good news for firms with a high disclosure score and bad news for firms with a low disclosure score. Moreover, using carbon disclosures data from a different source to the CDP would add to the present study and the empirical robustness of its findings. Finally, market reaction to mandatory carbon disclosure announcements could be considered in future research.

596

597

598

599

600 **References**

601 Alsaifi, K., Elnahass, M., & Salama, A. (2019). Carbon disclosure and financial performance:
602 UK environmental policy. Bus. Strategy Environ. *27*(4), 437-455
603 https://doi.org/10.1002/bse.1985
604 Albarrak, M. S., Elnahass, M., & Salama, A. (2019). The effect of carbon dissemination on
605 cost of equity. Bus. Strategy Environ. https://doi.org/10.1002/bse.2310 *28*(6), 1179-1198
606 Ba, S., Lisic, L. L., Liu, Q., & Stallaert, J. (2013). Stock market reaction to green vehicle
607 innovation. Prod. Oper. Manag., *22*(4), 976-990. https://doi.org/10.1111/j.1937-
608 5956.2012.01387.x
609 Bash, A., & Alsaifi, K. (2019). Fear from uncertainty: An event study of Khashoggi and stock
610 market returns. J. Behav. Exp. Econ. , *23*, 54-58. DOI: 10.1016/j.jbef.2019.05.004
611 Beatty, T., & Shimshack, J. P. (2010). The impact of climate change information: new
612 evidence from the stock market. B. E. J. Econ. Anal. Pol. , *10*(1). DOI:
613 https://doi.org/10.2202/1935-1682.2374.
614 Cañón-de-Francia, J., & Garcés-Ayerbe, C. (2009). ISO 14001 environmental certification: a
615 sign valued by the market? Environ. Resour. Econ. , *44*(2), 245-262.
616 https://doi.org/10.1007/s10640-009-9282-8
617 Carbon Disclosure Project (CDP) (2020) CDP Investor Initiatives [online] Available at:
618 https://www.cdp.net/en/investor (accessed 29th January 2020).
619 Carbon Disclosure Project (CDP) (2016) CDP Climate Change Report 2016 CEE edition
620 Available at: https://b8f65cb373b1b7b15feb-

c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/001/233/original/CEE-edition-climate-change-report-2016.PDF?1478599986 (accessed 24th January 2020).

Carbon Disclosure Project (CDP). (2018). New research shows clear gap between companies' awareness of climate risks and actions for tackling them. Available at: https://www.cdp.net/en/articles/media/new-research-shows-clear-gap-between-companies-awareness-of-climate-risks-and-actions-for-tackling-them (accessed 4th July 2019)

Carbon Disclosure Project FTSE 350 Report. (2017). Carbon Disclosure Project Climate Change Report United Kingdom Edition. London: Carbon Disclosure Project

Chapple, L., Clarkson, P. M., & Gold, D. L. (2013). The cost of carbon: capital market effects of the proposed emission trading scheme (ETS). Abacus, *49*(1), 1-33. https://doi.org/10.1111/abac.12006

Clarkson, P. M., Li, Y., & Richardson, G. D. (2004). The market valuation of environmental capital expenditures by pulp and paper companies. Account. Rev., *79*(2), 329-353. https://doi.org/10.2308/accr.2004.79.2.329

Dowell, G., & Hart, S. (2011). A natural-resource-based view of the firm: fifteen years after. J. Manag. *37*(5), 1464-1479. https://doi.org/10.1177/0149206310390219

Endrikat, J. (2016). Market reactions to corporate environmental performance related events: A meta-analytic consolidation of the empirical evidence. J. Bus. Ethics, *138*(3), 535-548.https://doi.org/10.1007/s10551-015-2598-0

Erkens, D. H., Hung, M., & Matos, P. (2012). Corporate governance in the 2007–2008 financial crisis: Evidence from financial institutions worldwide. J. Appl. Corp. Finance , *18*(2), 389-411. https://doi.org/10.1016/j.jcorpfin.2012.01.005

Fisher-Vanden, K., & Thorburn, K. S. (2011). Voluntary corporate environmental initiatives and shareholder wealth. J. Environ. Econ. Manag., *62*(3), 430-445. https://doi.org/10.1016/j.jeem.2011.04.003

Flammer, C. (2013). Corporate social responsibility and shareholder reaction: the environmental awareness of investors. Acad. Manag. J., *56*(3), 758-781. https://doi.org/10.5465/amj.2011.0744

Friedman, M. (1970). The social responsibility of business into increase profit. The New York Times Magazine. September 13, 1970.

Freeman, R. E. (1984). Strategic management: A stakeholder perspective. Boston, MA: Pitman.

Freedman, D. A. (2009). *Statistical models: theory and practice*. Cambridge University Press.

Gallego-Álvarez, I., García-Sánchez, I. M., & da Silva Vieira, C. (2014). Climate change and financial performance in times of crisis. Business Strategy & the Environment, *23*(6), 361-374. https://doi.org/10.1002/bse.1786

Gallego-Álvarez, I., Segura, L., & Martínez-Ferrero, J. (2015). Carbon emission reduction: The impact on the financial and operational performance of international companies. J. Clean. Prod., *103*, 149-159. https://doi.org/10.1016/j.jclepro.2014.08.047

Geczy C. C., Stambaugh R. F. & D. Levin, 2005, Investing in Socially Responsible Mutual Funds. Working Paper, *The Wharton School.* DOI: http://dx.doi.org/10.2139/ssrn.416380

Gilley, K. M., Worrell, D. L., Davidson III, W. N., & El–Jelly, A. (2000). Corporate environmental initiatives and anticipated firm performance: the differential effects of process-driven versus product-driven greening initiatives. J. Manag., *26*(6), 1199-1216. https://doi.org/10.1016/S0149-2063(00)00079-9

Griffin, P. A., & Sun, Y. (2013). Going green: market reaction to CSRwire news releases. J. Account. Public Policy, *32*(2), 93-113. https://doi.org/10.1016/j.jaccpubpol.2013.02.002

Griffin, P. A., Lont, D. H., & Sun, E. Y. (2017). The relevance to investors of greenhouse gas emission disclosures. Contemp. Account. Res., *34*(2), 1265-1297. https://doi.org/10.1111/1911-3846.12298

Hahn, R., & Kühnen, M. (2013). Determinants of sustainability reporting: a review of results, trends, theory, and opportunities in an expanding field of research. J. Clean. Prod., *59*, 5-21. https://doi.org/10.1016/j.jclepro.2013.07.005

Halme, M., & Niskanen, J. (2001). Does corporate environmental protection increase or decrease shareholder value? The case of environmental investments. Business Strategy & the Environment, *10*(4), 200-214. DOI: 10.1002/bse.290

Hamilton, J. T. (1995). Pollution as news: media and stock market reactions to the Toxics Release Inventory data. J. Environ. Econ. Manag., *28*(1), 98-113. https://doi.org/10.1006/jeem.1995.1007

Haque, F. (2017). The effects of board characteristics and sustainable compensation policy on carbon performance of UK firms. Br. Account. Rev., *49*(3), 347-364. https://doi.org/10.1016/j.bar.2017.01.001

Hart, S. L. (1995). A natural-resource-based view of the firm. Acad. Manag. Rev., *20*(4), 986-1014. https://doi.org/10.2307/258963

Hart, S. L., & Ahuja, G. (1996). Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Business Strategy & the Environment, *5*(1), 30-37. https://doi.org/10.1002/(SICI)1099-0836(199603)5:1<30::AID-BSE38>3.0.CO2-Q

694 Hillman, A. J., & Keim, G. D. (2001). Shareholder value, stakeholder management, and
695 social issues: what's the bottom line? Strategic Manage. J., *22*(2), 125-139.
696 https://doi.org/10.1002/1097-0266(200101)22:2<125::AID-SMJ150>3.0.CO2-H
697 Hsu, A. W., & Wang, T. (2013). Does the market value corporate response to climate
698 change? Omega, *41*(2), 195-206. https://doi.org/10.1016/j.omega.2011.07.009
699 Jacobs, B. W., Singhal, V. R., & Subramanian, R. (2010). An empirical investigation of
700 environmental performance and the market value of the firm. J. Oper. Manag. , *28*(5),
701 430–441. https://doi.org/10.1016/j.jom.2010.01.001
702 Jaggi, B., & Freedman, M. (1992). An examination of the impact of pollution performance on
703 economic and market performance: pulp and paper firms. J. Bus. Finance Account. ,
704 *19*(5), 697-713. https://doi.org/10.1111/j.1468-5957.1992.tb00652.x
705 Jaggi, B., Allini, A., Macchioni, R. and Zampella, A., 2018. Do investors find carbon information
706 useful? Evidence from Italian firms. Rev. Quant. Finance. Account., *50*(4), pp.1031-1056.
707 Karpoff, J. M., Lott, Jr., J. R., & Wehrly, E. W. (2005). The reputational penalties for
708 environmental violations: empirical evidence. J. Law Econ., *48*(2), 653-675.
709 https://doi.org/10.1086/430806
710 Kim, E. H., & Lyon, T. (2011). When does institutional investor activism increase
711 shareholder value?: the carbon disclosure project. B. E. J. Econ. Anal. Pol., *11*(1).
712 https://doi.org/10.2202/1935-1682.2676.
713 Klassen, R. D., & McLaughlin, C. P. (1996). The impact of environmental management on
714 firm performance. Manag. Sci., *42*(8), 1199-1214.
715 https://doi.org/10.1287/mnsc.42.8.1199
716 Kolk, A. and Levy, D., 2001. Winds of Change: Corporate Strategy, Climate change and Oil
717 Multinationals. *European Management Journal*, *19*(5), 501-509.

718 Kolk, A., Levy, D., & Pinkse, J. (2008). Corporate responses in an emerging climate regime:
719 the institutionalization and commensuration of carbon disclosure. Eur. Account Rev.,
720 *17*(4), 719-745. https://doi.org/10.1080/09638180802489121
721 Lam, H. K. S., Yeung, A. C. L., Cheng, T. C. E., & Humphreys, P. K. (2016). Corporate
722 environmental initiatives in the Chinese context: performance implications and
723 contextual factors. Int. J. Prod. Econ. , *180*, 48-56.
724 https://doi.org/10.1016/j.ijpe.2016.06.020
725 Lee, S. Y., Park, Y. S., & Klassen, R. D. (2015). Market responses to firms' voluntary climate
726 change information disclosure and carbon communication. Corp. Soc. Responsib.
727 Environ. Manag., *22*(1), 1-12. https://doi.org/10.1002/csr.1321
728 Li, Y., Richardson, G. D., & Thornton, D. B. (1997). Corporate disclosure of environmental
729 liability information: theory and evidence. Contemp. Account. Res., *14*(3), 435–
730 474. https://doi.org/10.1111/j.1911-3846.1997.tb00535.x
731 MacKinlay, A. (1997). Event studies in economics and finance. J. Econ. Lit. *35*(1), 13–39.
732 Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N. and Khoshnoudi, M., 2019.
733 Carbon dioxide (CO2) emissions and economic growth: A systematic review of two
734 decades of research from 1995 to 2017. *Science of the total environment*, *649*, 31-49.
735 Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon
736 emissions and carbon disclosures. Account. Rev., *89*(2), 695-724.
737 https://doi.org/10.1080/0969160X.2015.1068565
738 McDonald, J. H. (2009). Handbook of biological statistics (Vol. 2, pp. 173-181). Baltimore,
739 MD: Sparky House Publishing
740 Mohr, L. A., Webb, D. J., & Harris, K. E. (2001). Do consumers expect companies to be
741 socially responsible? The impact of corporate social responsibility on buying
742 behavior. J. Consum. Aff. , *35*(1), 45-72. DOI: 10.1111/j.1745-6606.2001.tb00102.x

743 Molloy, L., Erekson, H., & Gorman, R. (2002), Exploring the relationship between
744 environmental & financial performance. Miami, FL: Miami University.
745 Nguyen, J. H. (2018). Carbon risk and firm performance: evidence from a quasi-natural
746 experiment. Aust. J. Manag., *43*(1), 65-90.
747 https://doi.org/10.1177/0312896217709328
748 Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening environmental standards: the
749 benefit-cost or the no-cost paradigm? J. Econ. Perspect., *9*(4), 119-132.
750 https://doi.org/10.1257/jep.9.4.119
751 Peloza, J. (2009). The challenge of measuring financial impacts from investments in
752 corporate social performance. J. Manag., *35*(6), 1518-1541.
753 https://doi.org/10.1177/0149206309335188
754 Porter, M. E., & Kramer, M. R. (2006). Strategy and society: The link between competitive
755 advantage and corporate social responsibility. Harvard Business Review, *84*(12), 78
756 92.
757 Porter, M. E., & Van der Linde, C.V.D. (1995). Toward a new conception of the
758 environment-competitiveness relationship. J. Econ. Perspect., *9*(4), 97-118.
759 https://doi.org/10.1257/jep.9.4.97
760 Qian, W., & Schaltegger, S. (2017). Revisiting carbon disclosure and performance:
761 legitimacy and management views. Br. Account. Rev., *49*(4), 365-379.
762 https://doi.org/0.1016/j.bar.2017.05.005
763 Radu, C., Caron, M.-A. & Arroyo, P., 2020. Integration of carbon and environmental
764 strategies within corporate disclosures. J. Clean. Prod., *244*. 118681
765 https://doi.org/10.1016/j.jclepro.2019.118681

766 Ramiah, V., Martin, B., & Moosa, I. (2013). How does the stock market react to the
767 announcement of green policies? J. Bank. Finance, *37*(5), 1747-1758.
768 https://doi.org/10.1016/j.jbankfin.2013.01.012
769 Reinhardt, F. (1999). Market failure and the environmental policies of firms: economic
770 rationales for "beyond compliance" behavior. J. Ind. Ecol., *3*(1), 9-21.
771 https://doi.org/10.1162/108819899569368
772 Saka, C., Oshika, T., 2014. Disclosure effects, carbon emissions and corporate value.
773 Sustain. Account. Manag. Policy J. 5, 22-45. DOI: 10.1108/SAMPJ-09-2012-0030
774 Secretary of State. (2013). Companies Act 2006 (Strategic Report and Director's Report)
775 Regulations 2013. UK.
776 Shane, P. B., & Spicer, B. H. (1983). Market response to environmental information
777 produced outside the firm. Account. Rev., *58*(3), 521-538.
778 Stanny, E. and Ely, K., 2008. Corporate environmental disclosures about the effects of
779 climate change. Corp. Soc. Responsib. Environ. Manag., *15*(6), pp.338-348.
780 Stevens, W. P. (1984). Market reaction to corporate environmental performance. Advances in
781 Accounting, *1*, 41-61.
782 Surroca, J., Tribó, J. A., & Waddock, S. (2010). Corporate responsibility and financial
783 performance: the role of intangible resources. Strategic Manage. J., *31*(5), 463-490.
784 https://doi.org/10.1002/smj.820
785 Turban, D. B., & Greening, D. W. (1997). Corporate social performance and organizational
786 attractiveness to prospective employees. Acad. Manag. Rev., *40*(3), 658-672.
787 https://doi.org/10.2307/257057
788 Velte P, Stawinoga M, Lueg R, 2020. Carbon performance and disclosure: A systematic
789 review of governance-related determinants and financial consequences, J. Clean.
790 Prod. 120063 https://doi.org/10.1016/j.jclepro.2020.120063.

Wassmer, U., Cueto, D. C., & Switzer, L. N. (2014). The effect of corporate environmental initiatives on firm value: evidence from Fortune 500 firms. *M@n@gement*, *17*(1), 1-19. https://doi.org/10.3917/mana.171.0001

Wegener, M. (2010). The Carbon Disclosure Project, an evolution in international environmental corporate governance: motivations and determinants of market response to voluntary disclosures. Master of Science in Management (Accounting) thesis. Brock University, St. Catherines, Ontario.

Weigand, K. 2010. Climate change disclosure: Ensuring the viability of the insurance industry while protecting the investor. Wm. & Mary Envtl. L. & Pol'y Rev. *34* (1): 281–314.

White, M. (1996). Corporate environmental performance and shareholder value. University of Virginia Online Scholarship Initiative.

Yamashita, M., Sen, S., & Roberts, M. C. (1999). The rewards for environmental conscientiousness in the US capital markets. J. Financ. Strat. Decis., *12*(1), 73-82.

Ziegler, A., Busch, T., & Hoffmann, V. H. (2009). Corporate responses to climate change and financial performance: the impact of climate policy. SSRN Electronic Journal. Available at: https://EconPapers.repec.org/RePEc:eth:wpswif:09-105 (accessed 5th July 2019).

816

817

818

819

820

821

822

823

824

825

826

827

828

829

830

831

832

833

834

835

836

837

838

839

840

**Figure 1**

This figure illustrates the conceptual model linking voluntary carbon disclosure to market reaction

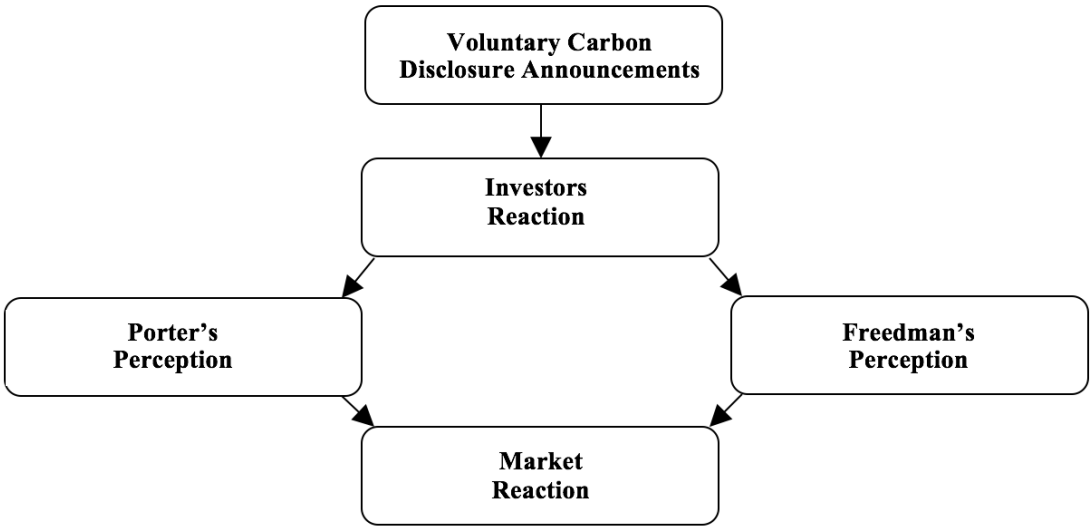

**Table 1**

| | Participated Firms | Non-Participated Firms | Total | Response Rate % |
|---|---|---|---|---|
| **Panel A: Sample Structure and Response Rates by Year** | | | | |
| **2009** | 130 | 100 | 230 | 57% |
| **2010** | 137 | 87 | 224 | 61% |
| **2011** | 156 | 74 | 230 | 68% |
| **2012** | 163 | 47 | 210 | 78% |
| **2013** | 176 | 53 | 229 | 77% |
| **2014** | 171 | 45 | 216 | 79% |
| **2015** | 167 | 58 | 225 | 74% |
| **N** | 1,100 | 464 | 1,564 | |
| **Panel B: Sample Structure and Response Rates by Industry** | | | | |
| **Basic Materials** | 102 | 61 | 163 | 63% |
| **Consumer Goods** | 155 | 33 | 188 | 82% |
| **Consumer Services** | 266 | 145 | 411 | 65% |
| **Health Care** | 54 | 20 | 74 | 73% |
| **Industrials** | 311 | 107 | 418 | 74% |
| **Oil and Gas** | 79 | 43 | 122 | 65% |
| **Technology** | 45 | 41 | 86 | 52% |
| **Telecommunications** | 36 | 10 | 46 | 78% |
| **Utilities** | 52 | 4 | 56 | 93% |
| **N** | 1,100 | 464 | 1,564 | |

*This table reports the distribution of our sample from 2009 to 2015 by industry and year.*

**Table 2**

| | Market Value (£M) | Total Assets (£M) | Sales (£M) | Net Income (£M) | Employees |
|---|---|---|---|---|---|
| **Mean** | 9,776.55 | 8,835.48 | 7,875.15 | 593.31 | 26,643.69 |
| **Median** | 1,961.40 | 1,660.80 | 1,425.33 | 108.58 | 8,354.50 |
| **SD** | 23,582.01 | 26,594.06 | 28,930.35 | 1,789.27 | 61,447.96 |
| **Max** | 143,951.20 | 226,632.40 | 298,487.50 | 17,374.88 | 648,254 |
| **Min** | 242.63 | 38.54 | 0.29 | -274.56 | 8 |

*This table is based on our sample for the period 2009 to 2015, comprising 1,564 firm-year observations.*

**Table 3**

| **Panel A: Participated Firms** | | | | | |
|---|---|---|---|---|---|
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 1100 | -0.018% | -0.018% | -0.378 | -0.755 |
| **0** | 1100 | -0.054% | -0.095% | -1.030 | -2.483** |
| **+1** | 1100 | -0.045% | -0.061% | -0.804 | -0.948 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 1100 | -0.072% | -0.115% | -1.103 | -2.092** |
| **0, +1** | 1100 | -0.098% | -0.144% | -1.326* | -2.156** |
| **-1, +1** | 1100 | -0.122% | -0.202% | -1.351* | -1.798* |
| **Panel B: Non-Participated Firms** | | | | | |
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 464 | 0.120% | -0.142% | 1.301 | -0.636 |
| **0** | 464 | -0.178% | 0.109% | -1.867 | -2.195** |
| **+1** | 464 | 0.096% | 0.062% | 1.060 | 1.334 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 464 | -0.072% | -0.115% | -0.453 | -0.782 |
| **0, +1** | 464 | -0.058% | -0.221% | -0.634 | -0.583 |
| **-1, +1** | 464 | -0.050% | 0.154% | -0.295 | -0.632 |

*This table reports the market reaction for participated and non-participated firms in CDP, based on our sample for the period 2009 to 2015, comprising 1,564 firm-year observations. * p<10% (one-tailed tests), ** p<5% (one-tailed tests), and *** p<1% (one-tailed tests).*

892

893

894 **Table 4**

| **Panel A: Intensive Industries** | | | | | |
|---|---|---|---|---|---|
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 810 | -0.023% | -0.036% | -0.4258 | -1.099 |
| **0** | 810 | -0.136% | -0.129% | -2.313** | -3.169*** |
| **1** | 810 | -0.041% | -0.053% | -0.581 | -0.268 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 810 | -0.159% | -0.171% | -2.116** | -2.116** |
| **0, +1** | 810 | -0.176% | -0.161% | -2.001** | -2.347** |
| **-1, +1** | 810 | -0.198% | -0.266% | -1.812** | -2.089** |
| **Panel B: Non-Intensive Industries** | | | | | |
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 290 | -0.003% | 0.022% | -0.033 | 0.384 |
| **0** | 290 | 0.175% | 0.019% | 1.575* | 0.431 |
| **1** | 290 | -0.056% | -0.118% | -0.702 | -1.458 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 290 | 0.171% | 0.082% | 1.322* | 1.065 |
| **0, +1** | 290 | 0.119% | -0.079% | 0.869 | -0.239 |
| **-1, +1** | 290 | 0.089% | -0.038% | 0.562 | 0.009 |

895 *This table reports the market reaction for participated firms in CDP for intensive and non-intensive*
896 *industries, based on firms participated in CDP from our sample for the period of 2009 to 2015,*
897 *comprising 1,100 firm-year observations. * p<10% (one-tailed tests), ** p<5% (one-tailed tests), and*
898 *** p<1% (one-tailed tests).*

899

900

## Table 5

**Panel A: Higher Market Capitalization**

| Day | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
|---|---|---|---|---|---|
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 213 | -0.017% | -0.012% | -0.178 | -0.360 |
| **0** | 213 | -0.093% | -0.060% | -0.875 | -1.400 |
| **+1** | 213 | 0.063% | -0.072% | 0.793 | -0.186 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 213 | -0.110% | -0.114% | -0.855 | -1.163 |
| **0, +1** | 213 | -0.030% | -0.206% | -0.233 | -1.376 |
| **-1, +1** | 213 | -0.051% | -0.148% | -0.340 | -1.083 |

**Panel B: Lower Market Capitalization**

| Day | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
|---|---|---|---|---|---|
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 887 | -0.018% | -0.021% | -0.335 | -0.664 |
| **0** | 887 | -0.044% | -0.115% | -0.746 | -2.050** |
| **+1** | 887 | -0.070% | -0.060% | -1.064 | -1.003 |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 887 | -0.063% | -0.115% | -0.839 | -1.764* |
| **0, +1** | 887 | -0.115% | -0.130% | -1.325* | -1.782* |
| **-1, +1** | 887 | -0.139% | -0.226% | -1.311* | -1.530 |

*This table reports the market reaction for participated firms in CDP based on their market capitalization mean (£12.55 billion), for the period of 2009 to 2015, comprising 1,100 firm-year observations. * p<10% (one-tailed tests), ** p<5% (one-tailed tests), and *** p<1% (one-tailed tests).*

910

911

912 **Table 6**

| **Panel A: Participated Firms** | | | | | |
|---|---|---|---|---|---|
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 181 | 0.128% | 0.166% | 0.528 | 0.665 |
| **0** | 181 | 0.598% | -0.327% | 1.569* | -0.098 |
| **+1** | 181 | 0.465% | 0.354% | 1.670** | 1.674* |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 181 | 0.725% | 0.036% | 1.706** | 0.849 |
| **0, +1** | 181 | 1.063% | 0.358% | 2.381*** | 1.881* |
| **-1, +1** | 181 | 1.191% | 0.183% | 2.606*** | 1.918* |
| **Panel B: Non-Participated Firms** | | | | | |
| **Day** | N | Mean | Median | t-Test | Wilcoxon signed-rank test |
| **Abnormal Return (ARs)** | | | | | |
| **-1** | 274 | -0.305% | -0.0503% | -1.823** | -1.046 |
| **0** | 274 | -0.234% | -0.446% | -0.972 | -2.480** |
| **+1** | 274 | 0.890% | 0.535% | 5.215*** | 4.998*** |
| **Cumulative Abnormal Return (CARs)** | | | | | |
| **-1, 0** | 274 | -0.540% | -0.314% | -1.746** | -1.849* |
| **0, +1** | 274 | 0.655% | 0.201% | 2.573*** | 1.851* |
| **-1, +1** | 274 | 0.350% | -0.053% | 1.1489 | 0.915 |

913 *This table reports market reaction for participated and non-participated firms in CDP for crisis period,*
914 *based on our sample for the crisis period of 2007-2008, comprising 455 firm-year observations. * p<10%*
915 *(one-tailed tests), ** p<5% (one-tailed tests), and *** p<1% (one-tailed tests).*

916

917