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1 **Market Responses to Firms' Voluntary Carbon Disclosure: Empirical Evidence from**
2 **the United Kingdom**

3 **Amount of words 9716**

4 **Abstract**

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

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

24

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

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33 **Highlights**

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

46 Climate change has emerged as a significant business consideration over the last two decades
47 (Mardani et al., 2019). Firms have increasingly included consideration of global warming in
48 their strategic management decision making (e.g. Alsaifi et al., 2019; Matsumura et al., 2014)
49 and have adopted a range of environmental strategies (Radu et al, 2020). In recent years,
50 businesses have experienced increasing pressure to disclose more information about their
51 plans to lower their greenhouse gas (GHG) emissions and their overall climate change
52 strategy. Globally, stakeholders and public interest groups have called for greater disclosure,
53 increased transparency, and a consistent approach to GHG emissions (e.g. Flammer, 2013;
54 Qian and Schaltegger, 2017). Meanwhile, firms and their insurers have expressed concerns
55 over the cost of these disclosures from the viewpoint of liability exposure and competitive
56 disadvantage (Weigand, 2010). Additionally, there are individuals who urge balancing the
57 approach by considering both costs and benefits (e.g. Li et al., 1997). Therefore, today’s
58 firms face the challenging task of determining the appropriate level of disclosure of the risks
59 and costs associated with GHG emissions. It is no surprise that the question of whether or not
60 to be green receives consistently close scrutiny by both the media and scholarly journals
61 (Hart, 1995; Lam et al., 2016). Event study methodology is widely adopted to address this
62 question. It does so by quantitatively examining stock market reactions to company
63 announcements related to environmental initiatives (e.g. Jacobs et al., 2010; Klassen and
64 McLaughlin, 1996). First introduced by Fama et al. (1969), it has been described as “the
65 standard method of measuring security price reaction to some announcement or event”
66 (Binder, 1998, p. 111) indicating that it is highly appropriate for the present study.

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

83 The objective of this study is to examine market reaction to CDP survey announcements.
84 This objective will be achieved by applying the event study method to extend the extant
85 literature on whether investors see voluntary disclosure of carbon emissions information as
86 being relevant to stock valuation. The sample comprises 1,564 firm-year observations of
87 firms listed on the FTSE350 index for the period 2009–2015. This period witnessed
88 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 administering 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

²Scope 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; Pelozo, 2009). Some of the
136 early literature followed the approach of Friedman's proposition that the "social

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

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

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

164 Studies using regression analysis focus mainly on the relationship between environmental
165 responsibility and financial performance over the long term. Several studies have found a
166 positive relationship. Others, however, reported either mixed findings or a negative
167 relationship (e.g. Clarkson, et al., 2004; Jaggi and Freedman, 1992; Molloy et al., 2002).

168 Generally, it appears that a positive relationship is found when the environmental measures
169 involve compliance, regulatory risk, and liability (Fisher-Vanden and Thorburn, 2011).

170 Furthermore, Matsumura et al. (2014) reported a significantly negative relationship between
171 GHG emissions and the value of equity. Their suggestion is attributed to the “uncertainty
172 surrounding physical climate parameters” as well as to the costs associated with “measuring,
173 monitoring, and reducing carbon emissions” (Matsumura et al., 2014, p. 701). The
174 implication of the empirical evidence from these regression studies is that a negative impact
175 on financial performance should be anticipated from environmental investments (Fisher-
176 Vanden and Thorburn, 2011). It should be noted, however, that the long-term nature of these
177 studies exposes firm performance to an array of explanatory factors that are beyond
178 environmental responsibility.

179 Event study methodology contrasts with regression analysis in ways that suggest it is highly
180 suitable for capturing market reaction.³ As they focus on market returns, event studies present
181 a reaction which is based on a forward-looking evaluation of environmental practices and
182 their financial consequences. Furthermore, event study methodology avoids the endogeneity
183 issue and offers greater unambiguity regarding the causal direction of the relationship
184 (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).

185 Event studies investigate how markets react to environmental
186 initiatives/disclosures/activities. Although event study methodology has proved to be a
187 productive approach, the findings have not been consistent, with some results indicating a
188 positive reaction to environment-related announcements, others a negative reaction, and some
189 even reporting the absence of any effect. In one of the earlier studies, Shane and Spicer
190 (1983) reported that the stock market reaction to announcements of improved pollution
191 performance is more positive than it is for announcements of poor performance. Likewise,
192 Klassen and McLaughlin (1996) found that positive abnormal stock returns are normally
193 triggered by positive firm events such as the winning of an environmental award.
194 Additionally, Griffin and Sun (2013) found that capital markets give a positive response
195 when firms voluntarily disclose GHG emissions. Contrary to this evidence, other studies
196 found a different negative reaction to events. For example, when Finnish forestry firms
197 announce environmental investments, the stock market's reaction is found to be negative
198 (Halme and Niskanen, 2001). In the same vein, when studying investor perceptions, Molloy
199 et al. (2002) found that the perception of environmental investment is that it increases costs,
200 not reduces them. Moreover, Beatty and Shimshack (2010) reported that stock markets react
201 to negative environmental disclosures but not to positive ones. Basing his study on the Toxic
202 Release Inventory's data releases, Hamilton (1995) found that the public disclosure of these
203 data and the press coverage thereof leads to significantly negative abnormal returns in cases
204 where the toxic release was high. Furthermore, Stevens (1984) found that companies whose
205 pollution control costs are low are more likely to experience positive abnormal stock market
206 returns when compared to firms incurring high costs. The interpretation of investors is that
207 the new information increases firm liability or compliance risk, thereby leading to higher
208 costs. Another event study on ISO 14001 certification announcements reported that the shares
209 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. Aligned with 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.

233 bad news that potentially involves costly mitigation measures. Finally, as mentioned, there
234 are studies reporting no effect. An examination of environmental conscientiousness scores
235 covered in the press revealed no significant abnormal stock market returns in response
236 (Yamashita et al., 1999). Similarly, Gilley et al. (2000) reported that the stock market did not
237 react in any significant way to company announcements on environmental initiatives. This
238 aligns with Jacobs et al. (2010) who found, among their other findings, that environmental
239 initiative announcements fail to provoke significant stock market reactions. Kim and Lyon
240 (2011) also showed a lack of evidence for increases in company value arising from carbon
241 disclosure.

242

243 **[Figure 1 about here]**

244

245 ***2.2 Hypothesis Development***

246 Stakeholder theory is a popular approach among CSR researchers (Lee et al., 2015). It
247 emphasises the influence of various stakeholder groups, including investors, employees,
248 customers, government, and the community, on firm decision making (Freeman, 1984). Since
249 market reaction is a consequence of investor reaction, our hypothesis is formulated based on
250 how investors will react to voluntary carbon disclosure announcements initiated by the CDP.
251 Two main mechanisms have been proposed to examine how CSR either increases revenues or
252 costs (Friedman, 1970; Porter, and Van der Linde, 1995). A review of these mechanisms
253 reveals the way voluntary carbon disclosure may impact market reaction.
254 The framework shown in Figure 1 was used to develop the hypothesised impact of carbon
255 disclosure announcements on markets. Figure 1 indicates that it is possible that investors’
256 perception of the voluntary efforts for carbon disclosure will match Friedman’s perception.
257 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 (Pelozo, 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

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

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

291

292 **H₁:** There is a significant market reaction following the announcement of a CDP survey.

293

294 **3. Research Design and Data**

295 *3.1 Sample*

296 Since the FTSE350 is the largest index in the UK that is annually assessed by the CDP, all
297 firms continually listed on the FTSE350 between 2009 and 2015 were included in the sample.

298 It is noteworthy that FTSE350 firms were originally asked in 2006 to engage with and report
299 their carbon footprint voluntarily via the CDP online survey.⁵ This first year, however, was not

300 used for our analysis because (1) there was only a low level of participation in the CDP, and

301 (2) the qualitative analysis only extended to assigning responses to one of the following four
302 categories: Answered Questionnaire (AQ), Provided Information (IN), Declined to Participate

303 (DP), and No Response (NR). From the following year, a 0 to 100 scoring scale was introduced.

304 Notwithstanding this change, we also decided to exclude the period 2007-2008 to isolate our
305 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.

306 impact in the additional analysis section. We had intended to continue the sample period
307 beyond 2015. However, the CDP report for 2016 announced a substantial revision to the
308 methods used to calculate firms' CDS. By including further years consistency of data would
309 have been lost. The report advises, "It is important to note that the 2016 scoring approach is
310 fundamentally different from 2015, and different information is requested, so 2015 and 2016
311 scores are not directly comparable" (CDP, 2016, p.11).

312 Following standard practice for research of this kind, financial institutions were also excluded
313 because of their unique accounting principles and the different social and environmental
314 guidelines they apply, such as the 'Equator Principles' (e.g. Alsaifi et al., 2019; Haque,
315 2017).⁶ Ultimately, the sample comprised of 1,564 firm-year observations crossing nine
316 industries. The Global Industry Classification Standard (GICS) used for the CDP sector
317 categories is also applied to this study. A summary of the final sample distribution by
318 industry and year is given in Table 1 Panel A which indicates 2014 as the highest year for
319 response rate (79%) and 2009 as the lowest (57%) in the sampled period. Despite the
320 surprising drop in 2015, it is clear that the annual increase in the response rate is consistent
321 with public concern related to climate change. Panel B shows that the utilities industry has
322 the highest overall response rate (93%), while the technology industry has the lowest (52%).
323 Based on the FTSE All-Share Index classification, this study indicates that the response rate
324 for firms operating in carbon-intensive industries (72%) is almost equal to the response rate
325 for firms in non-intensive industries (71.25%).⁷ It had been posited that firms in polluting
326 sectors were more likely to make voluntary environmental disclosures (Brammer and
327 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.

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

331

332

333

334 **[Table 1 about here]**

335 ***3.2 Event Study***

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

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

353 event (Fisher-Vanden and Thorburn, 2011). Calendar days are converted to event days by
354 designating the announcement day as Day 0. If the announcement is made on a non-trading
355 day or later than 4.30 pm London time of a trading day, then Day 0 would become the
356 following day. All other trading days are recorded as relative to Day 0; hence, the trading day
357 prior to Day 0 (announcement day) is recorded as Day -1. Likewise, the trading day
358 immediately after the announcement day is designated Day +1. Additionally, aligning with
359 previous studies, the estimation of abnormal returns is conducted using the market model
360 (e.g. Fisher-Vanden and Thorburn, 2011; Jacobs et al., 2010; Wassmer et al., 2014).

361 Under this model, a linear relationship is posited between a given stock's return and the
362 market return (the return on the market portfolio) over a specified period of time:

363

$$364 \quad ER_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

365

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

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

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

383

$$384 \quad AR_{it} = R_{it} - ER_{it} \quad (2)$$

385

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

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

395

$$396 \quad CAR [t_1, t_2] = \sum_{t=t_1}^{t_2} AR_{it} \quad (3)$$

397

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.

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

400

401 **4. Results and Analysis**

402 *4.1 Descriptive Statistics*

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

409

410 **[Table 2 about here]**

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412

413 *4.2 Market Reaction to CDP Announcements*

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

424 10% levels, respectively, for the Wilcoxon signed-rank test, which indicates that investors
425 respond negatively to the CDP announcements of FTSE350 firms. This could be ascribed to
426 the fact that investors interpret climate-related environmental initiatives as an investment/cost
427 to the company without an offsetting benefit, that reduces competitive advantage, which
428 aligns with the conclusions of Cañón-de-Francia and Garcés-Ayerbe (2009). It would also
429 align with Hsu and Wang's (2013) findings that, generally, investors hold the belief that
430 when firms tackle climate change, it can increase costs and place firms at an economic
431 disadvantage. In other words, voluntary carbon disclosure requires additional costs that
432 reduce the attractiveness of investment in the firm, which may lead investors to abandon the
433 firm's stock even at low prices. Therefore, **H1** is supported, and London Stock Exchange
434 investors' reaction is consistent with Friedman's (1970) view that expenses incurred for
435 environmental purposes, which fall outside of regulatory compliance, run counter to the best
436 interests of shareholders and degrade firm value. Conversely, market reactions to CDP's non-
437 participants, shown in Panel B of Table 3, were not significant, particularly for the key event
438 window (-1 to +1), with the exception of Day 0 that is negatively significant in the Wilcoxon
439 signed-rank test.

440

441

[Table 3 about here]

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443

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

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

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

471

472

[Table 4 about here]

473

474 **4.3 Additional Analyses**

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

488

489

490 **[Table 5 about here]**

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492 To examine the impact of the GFC period, we apply the same criteria as for the main sample,
493 but change the period from 2009-2015 to 2007-2008, and the total observations for the new
494 sample becomes 455.¹⁰ Table 6 (Panel A) shows the market responses for companies
495 participating in CDP announcements during the crisis period. The results through the two
496 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

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

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

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

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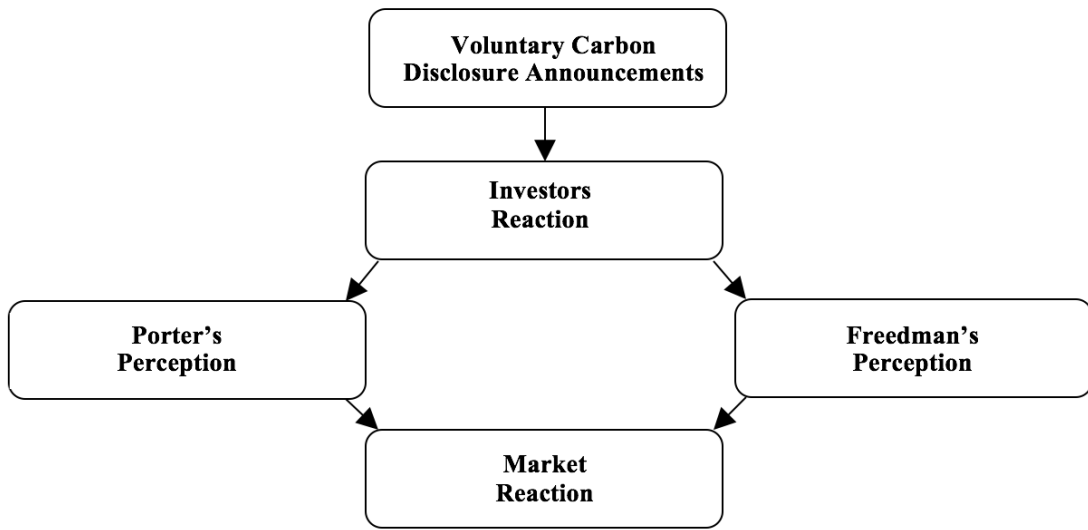
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843 **Figure 1**

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

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857 **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	

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

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865 **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

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

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885 **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

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This table reports the market reaction for participated and non-participated firms in CDP, based on our

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*sample for the period 2009 to 2015, comprising 1,564 firm-year observations. * $p < 10\%$ (one-tailed tests),*

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*** $p < 5\%$ (one-tailed tests), and *** $p < 1\%$ (one-tailed tests).*

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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

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*This table reports the market reaction for participated firms in CDP for intensive and non-intensive industries, based on firms participated in CDP from our sample 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).*

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903 **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

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This table reports the market reaction for participated firms in CDP based on their market capitalization mean

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*(£12.55 billion), for the period of 2009 to 2015, comprising 1,100 firm-year observations. * $p < 10%$ (one-tailed*

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*tests), ** $p < 5%$ (one-tailed tests), and *** $p < 1%$ (one-tailed tests).*

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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

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This table reports market reaction for participated and non-participated firms in CDP for crisis period,

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*based on our sample for the crisis period of 2007-2008, comprising 455 firm-year observations. * $p < 10\%$*

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*(one-tailed tests), ** $p < 5\%$ (one-tailed tests), and *** $p < 1\%$ (one-tailed tests).*

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