Climate-related Corporate Reporting and Cost of Equity Capital

Abstract

Purpose

This study aims to examine the reaction of stakeholders (i.e., capital providers) to climate-related corporate reporting. Climate-related corporate reporting is captured by the level of voluntary carbon disclosure, while the recognition and appreciation of capital providers are captured through the cost of equity capital.

Design/methodology/approach

This study uses a sample including the 350 largest companies by market capitalization on the London Stock Exchange, UK (FTSE350) from 2015 to 2019. We use fixed-effects regression models to examine the effect of climate-related corporate reporting on the cost of equity capital.

Findings

This study finds that voluntary carbon disclosure proxied by carbon disclosure score is negatively associated with cost of equity capital. This suggests that firms' superior quality disclosure of carbon information could contribute to a lower cost of equity capital. This implies that the market and stakeholders positively appreciate the involvement in climate-related reporting by businesses.

Originality/value

Our finding provides insights to regulators, investors and other stakeholders in terms of the positive economic implication of actively engaging in reducing climate change impact through voluntary carbon disclosure. These findings also motivate corporates to be proactively involved in climate-related reporting by extending the quality of carbon information disclosure.

Keywords: Climate change, climate-related reporting, carbon information disclosure, cost of equity capital

1. Introduction

Climate change is among the world's biggest challenges due to its considerable damage to ecological systems and potential threats to human health and global economies (Fonseca et al., 2011). The United Nations Sustainable Development Goals (SDGs) suggest that climate change is one of the top 17 priorities to be achieved by 2030. In the business sector, it has become a prominent business consideration in the past two decades (Mardani et al., 2019). Corporations have increasingly taken environmental issues into consideration when making business decisions, such as adopting strategies related to climate change or carbon mitigation (Phung et al., 2023; Radu et al., 2020).

Moreover, alongside government initiatives, the business sector has experienced increasing pressure to disclose and report more information related to carbon issues. For example, companies are increasingly expected by stakeholders and the public to disclose their climate change strategies, greenhouse gas (GHG) emissions, and carbon mitigation practices. From a global perspective, stakeholders increasingly demand more disclosure of carbon information with higher transparency and quality. The growing significance and impacts of environmental threats on businesses give rise to increasing demands for corporates' credible disclosure of carbon information, which helps outsiders identify the environmental profile and evaluate related opportunities and risks.

The UK is a significant country regarding GHG emissions and carbon disclosure. As a member of G7 (Group of Seven), it is among the biggest GHG emitters in the world. It is also on the cutting edge for developing mechanisms that proactively alleviate climate change's negative impacts (Haque, 2017). Moreover, the UK holds the greatest proportion of companies disclosing scope 1 and scope 2 emissions of GHG protocol (>97%) and has the greatest percentage of board-level oversight towards climate change risk (96%) (Alsaifi et al., 2020).

However, it is not clear how the stakeholders evaluate and react to this disclosed information. There have been inconclusive findings from prior studies regarding carbon disclosure and market reaction. For example, on one side, some studies suggest a negative association between the level of a firm's GHG emissions and its market valuation (Clarkson et al., 2015). On the other side, Gerged et al. (2020) found a U-shape relationship between the level of GHG disclosure and the cost of equity capital. Prior studies also question the quality of information disclosure (Andrew & Cortese, 2011), even when GHG emission disclosure become mandatory, businesses have raised concerns over the cost of GHG emissions disclosure from the perspective of competitive disadvantage and liability exposure (Gerged et al., 2020).

Consequently, the business should be able to determine the appropriate level of disclosure of the costs and benefits linked to GHG emissions (Bui et al., 2020; Gerged et al., 2021).

Several prior studies have investigated the determinants of voluntary carbon disclosure adopting content analysis and empirical analysis based on different settings, such as developing countries, developed countries, and multi-country (Kalu et al., 2016; Okudo, 2021). The drivers of corporate voluntary carbon disclosure mainly incorporate social factors, economic factors, corporate ownership structure, and financial market factors. In terms of the consequences of voluntary carbon disclosure, prior studies demonstrate the economic implications and non-financial implications. Especially, regarding the economic implication, recent literature in the academic fields of accounting and finance has increasingly focused on the cost of capital, an area of active research interest as it directly relates to business practice (Benson et al., 2015). Consequently, more studies are questioning the usefulness of voluntary carbon information disclosure (CID) and examining the impacts of voluntary carbon disclosure on business sectors in terms of cost of capital (Gerged et al., 2021; Matsumura et al. 2014). However, findings from those studies are contradicting and inconclusive (Gerged et al., 2020).

By shedding light on the prominent economical factor for corporates, the cost of equity capital, this study aims to explore whether businesses involved in climate-related reporting will get a better deal from fund providers. The involvement in climate-related reporting is captured by the level of voluntary carbon disclosure, while the recognition and appreciation of fund providers are captured by the level of cost of equity capital. Specifically, this study examines the effects of corporate voluntary carbon disclosure on the assessment of firms' riskiness for shareholders' investment decisions, which is proxied by the firms' cost of equity capital.

This study adopts different regression models (such as fixed-effects regression) to examine the association between voluntary carbon disclosure and the cost of equity capital using a sample of FTSE350 companies from 2015 to 2019. By focusing on companies with available carbon disclosure scores on the CDP website, we estimate a regression model with other relevant variables controlled. The results of different regression models provide evidence that better quality of corporate voluntary carbon disclosure contributes to a lower cost of equity capital.

Findings from this study have a significant contribution to literature and practice. First, by substantiating the negative association between voluntary carbon disclosure and firms' cost of equity capital in the UK setting. This study suggests a positive reaction from the market and

an appreciation from investors for the voluntary disclosure of carbon information. When businesses disclose more climate-related information, they will get lower cost of equity capital from fund providers. Second, this finding has a practical contribution as the UK government commits to achieving the net zero carbon emission target by 2050, and this study suggests that the stakeholders (i.e., investors) are serious about their actions by encouraging corporates to devote themselves to this target by lowering the capital cost to firms with more CID. Finally, the findings are also important to policymakers in fostering more guidance and best practices in relation to voluntary carbon disclosure.

The rest of this paper is structured as follows: Section 2 reviews prior studies; Section 3 presents relevant theories and development of the hypothesis; Section 4 introduces the research methodology including data, sample, and variables; Section 5 covers data analysis and result discussion; Section 6 concludes the paper.

2. Literature review

2.1 Voluntary Carbon Disclosure

Voluntary carbon disclosure reports a firm's initiatives, strategies, practices, and performance in the field of carbon issues. Specifically, it includes information on the firm's carbon emission levels, the establishment of low-carbon strategies, environmental projects, and the performance evaluation system for motivating carbon mitigation. On one hand, carbon information voluntarily disclosed by corporates acts as a company's credible commitment to environmental protection under the current state of ecological environment and government advocacy. Hence, it has a profound impact on a firm's sustainable development. Additionally, from an outsider's perspective, including stakeholders and other participants in the capital market, carbon disclosure meets their demands for environmental accountability (He et al., 2013). Consequently, for the corporate sector, the decision of integrating CID into business strategies is of vital significance (Giannarakis et al., 2018). Corporate carbon disclosure considerably affects stakeholders' environmental perceptions and confidence levels toward organizations (Gerged et al., 2021).

2.1.1 Determinants of voluntary carbon disclosure

Researchers have identified diverse determinants of corporate carbon disclosure by focusing on different industries and countries. Liu and Anbumozhi (2009) state that external factors have greater impacts on carbon disclosure relative to internal factors. They find that environmental disclosure is positively associated with government pressures, marketization

levels, and environmental sensitivity in terms of industry competition. Based on that, by examining the property industry in Malaysia, Kalu et al. (2016) find potential driving factors of carbon disclosure relating to four perspectives, namely social community, financial market, ownership structure within an organization, and economic elements. The results reveal that social factors and financial market factors significantly affect CID. More specifically, it is implied that a higher degree of public awareness of the huge threat of carbon emissions could trigger more consideration of firms' contribution to carbon mitigation, resulting in more social pressure. Therefore, given the increasing social pressures, companies are motivated to participate in carbon emission mitigation and enhance carbon disclosure voluntarily (Kalu et al., 2016).

In the context of European companies, Giannarakis et al. (2018) identify the potential factors determining a company's climate change disclosure in three aspects: the organization's ownership structure, environmental performance, and substantiation of environmental information. They focus on the voluntarily disclosed sustainability reports of 500 European companies that were the most liquid capitalized in 2014. Importantly, the level of voluntary disclosure relating to climate change is firstly measured by the Climate Performance Leadership Index (CPLI), which indicates firms' transparency, adaptation to, and mitigation of climate change. The results indicate that these three factors significantly impact climate change disclosure. Specifically, better environmental performance means that firms have positive impacts on their voluntary climate change disclosure. Besides, it is revealed that an objective and independent assessment of firms' environmental initiatives is positively correlated with climate change disclosure as it provides a credible evaluation of climate change risks that is less likely to be manipulated by firms.

Moreover, corporate governance is another factor that has been found to have a significant impact on carbon information disclosure. Okudo (2021) suggests that ownership concentration, board gender diversity, and the establishment of a sustainability committee have a significant and positive association with carbon disclosure.

2.1.2 Consequences of voluntary carbon disclosure

Recently, the consequences of carbon disclosure on business sectors have attracted more academic attention. Several studies have documented the economic impact as a result of voluntary carbon disclosure. For instance, Griffin and Sun (2013) find that companies' voluntary disclosure of carbon information could result in positive responses in capital markets. The positive effects of voluntary carbon disclosure on firms' market-based financial

performance are also documented in other studies (Matsumura et al., 2014; Saka & Oshika, 2014). It is shown that voluntary carbon disclosure facilitates enhancing investors' benefits (Liesen et al., 2017). In particular, it reveals that the portfolios of firms with good carbon disclosure could generate an additional 13% income for their investors. Moreover, it is posited that improved carbon disclosure quality facilitates reducing the volatility of stock prices and increasing the liquidity of the stock market (Krishnamurti & Velayutham, 2018).

Even though voluntary carbon disclosure could hardly impact corporates' financial performance through free cash flows, carbon disclosure with enhanced transparency and quality contributes to lower risk and better financial consequences by reducing information asymmetry for shareholders and other stakeholders (Lueg et al., 2019). This is in line with the study of Zhou et al. (2018) showing that carbon disclosure has negative effects on firms' agency costs proxied by total asset turnover and management expense ratio. Furthermore, Velte et al. (2020) find that carbon disclosure facilitates reducing information asymmetry and improving the financial performance of companies. Specifically, companies with higher voluntary carbon disclosure are more motivated to improve their carbon strategies and enhance efficient measures toward carbon mitigation.

2.2 Voluntary carbon disclosure and the cost of capital

Several prior studies have examined the relationship between voluntary carbon disclosure and corporates' cost of capital. However, findings from those studies are inconclusive and open to further examination into this relationship. According to Richardson and Welker (2001), carbon information disclosure reflects firms' strategies in response to carbon risk exposure, which reduces the information gap between managers and stakeholders, and consequently impacts the perception of investors, which may lead to changes in equity capital cost.

On one side, some empirical studies suggest that carbon disclosure leads to a lower cost of capital due to reducing information asymmetry (Li et al., 2019; Francis et al., 2005). Stakeholders could capture more information about a firm's carbon practices based on published environmental information. Therefore, investors are more willing to trade the securities and portfolios of firms that make credible and comprehensive carbon disclosure, especially when it comes to carbon-intensive sectors.

In addition, information disclosure by businesses can facilitate the confidence of stakeholders in their operations. The stakeholders (i.e., investors and fund providers) may offer

the businesses more preferable funds at a lower rate of return. Reverte (2012) examines the effect of corporate social responsibility (CSR) disclosure ratings on cost of capital in the context of Spain's listed firms. The study finds that CSR disclosure rating is negatively associated with the cost of capital. This association is more profound among organizations in environmentally sensitive industries. He et al. (2013) suggest that voluntary carbon disclosure has a negative association with cost of capital. Similar findings of the negative association between voluntary carbon disclosure and cost of equity capital have been found with carbon-intensive companies in the Chinese context (Li et al., 2017), in the context of South Africa (Lemma et al., 2019) or internationally (Bui et al., 2020).

On the other hand, it is suggested that firms' actions of voluntarily disclosing carbon information could trigger more proprietary costs, resulting in negative economic outcomes for companies (Peters & Romi, 2014). Moreover, it is argued that carbon disclosure could generate undesirable impacts on business sectors. Particularly, public disclosure of carbon information may result in negative concerns and supervision from stakeholders, such as the social community, government departments, and environmental institutions (Peters & Romi, 2014). Subsequently, this negative attention may give rise to extra litigation costs. In a similar vein, Lee et al. (2015) state that carbon information disclosed by firms could give rise to unfavourable outcomes in capital markets. The carbon practices may be interpreted as negative news, for instance, extravagant expenditures on reducing carbon emissions.

Interestingly, Kim et al. (2015) find that investors' estimations of a firm are not affected by their voluntary carbon reporting since carbon disclosure may reflect the firm's carbon risk and level of carbon risk control. However, Li et al. (2017) find that voluntary carbon disclosure has a negative impact on the cost of equity capital with carbon-intensive companies in China.

3. Theories and hypothesis development

According to Al Amosh, Khatib and Ananzeh (2022), theoretical frameworks provide a specific lens for interpreting empirical evidence in scientific research. Many prior studies relied on multiple theories to support the interpretation of results (Al Amosh and Khatib, 2023; Al Amosh et al., 2022). In this study, in order to explain a possible association between a firm's voluntary carbon disclosure and the cost of equity capital, we use a combination of agency theory, signalling theory and legitimacy theory.

First, the agency theory suggests that there are conflicts of interest between principals and agents (Jensen & Meckling, 1976). Furthermore, the information asymmetry between

principals and agents increases risk perceived by principals in the capital market (Easley & O'Hara, 2004), which results in investors' higher required rate of return (premium). Specifically, the information asymmetry theory posits that the agents (managers) hold more private information regarding the organization's operating conditions relative to the principals.

Subsequently, those information-disadvantaged investors will get undesirable outcomes resulting from wrong investment decisions based on insufficient and inaccurate information. Consequently, the information gap could result in increasing perceived risks of owners (Moses et al., 2018), which induces additional risk premium demand and hence a higher cost of equity financing. Given that a lower level of information asymmetry contributes to reducing perceived risk by the investors and lowering the cost of capital, companies exert great efforts attempting to reduce information asymmetry to achieve lower cost of capital (Easley & O'Hara, 2004; Francis et al., 2005).

With respect to investors' perceived and estimated risk, a firm's carbon emissions and other carbon information, such as carbon strategies and mitigation practices, is crucial to those investors since it is closely related to the company's climate risk and thus impacts their investment decisions. As carbon risk becomes a crucial factor for investors considering their investment decisions, carbon reporting could facilitate a reduction in information asymmetry between agents and principals. It is argued that companies provide extensive carbon information to stakeholders to mitigate information asymmetry. Therefore, the reduced perceived risk resulting from higher carbon disclosure and a lower information gap permits firms to reap benefits from the reduced cost of capital and attract more favourable investments.

Second, signalling theory (Hughes, 1986; Morris, 1987) indicates that increased disclosure signals the quality of the firm, and thus reduces adverse selection risk (Ali et al., 2022). Connelly et al. (2011) elaborate on the signalling process between the signaller and receiver. They state that receivers make the decision based on their observation and interpretation of the signals sent by signallers. The information transmission could contribute to reducing the information gap and enhancing the confidence of investors. Moreover, it is presented that the investors generally regard the entities' information disclosure as favourable signals. It is suggested that companies with a low level of disclosure tend to be perceived as entities with higher risks. Hence, it could result in a lower level of liquidity and additional premium demanded by investors (Handa & Linn, 1993).

In this study, the signaller is the firm that conveys CID as a signal to investors and other stakeholders. Those external investors who received the signals assess the related carbon risk to finally make their investment decisions. Signalling theory also argues that the firm with a lower level of carbon risk has a higher propensity to disclose carbon information voluntarily since it could not be readily imitated by other firms with higher carbon risk (Clarkson et al., 2008).

Third, in line with the legitimacy theory, legitimacy is the appropriate and desirable perception that a company complies with social norms, values, and beliefs (Suchman, 1995). Corporations could manage their stakeholders' perceptions in terms of legitimacy with several approaches, such as performing legally, developing and reinforcing cooperative relationships with other organizations, seeking external and internal support, and attracting more resources (Alakent & Ozer, 2014). From the environmental aspect, environmental legitimacy is related to the perception that the firm's environmental performance is desirable and appropriate (Bansal & Clelland, 2004). It serves as an external and informal factor that affects the firms' actions regarding climate change issues. Specifically, it is posited that environmental legitimacy impacts corporate carbon disclosure mainly in three ways, incorporating pressures from government regulations, consumers, and competitors in the market (Caruana & Chatzidakis, 2014). It is argued that investors would prefer the securities of corporates that engage in positive expectations regarding social and environmental actions. Specifically, they generally demand a lower rate of returns toward such securities (Amel-Zadeh and Serafeim 2018; El Ghoul et al., 2011; Wang et al., 2013).

Based on the combination of the three theoretical perspectives and findings from prior studies, we hypothesize that:

H1: The voluntary carbon disclosure of a business is negatively associated with the cost of equity capital.

4. Methodology

4.1 Data and samples

This study uses a sample comprising all FTSE350 companies, which are the largest companies listed on the LSE according to market capitalization level (Gerged et al., 2021). The initial samples cover the full list of FTSE350 companies, which are assessed by the Carbon Disclosure Project (CDP) annually. FTSE350 companies were initially asked to engage in the Carbon Disclosure Project and voluntarily reported their carbon information through the format

of an online CDP questionnaire in 2006. Specifically, the CDP launched an annual survey in the format of a questionnaire. Then the executives of firms voluntarily participated in the survey, reporting information related to carbon issues. The questionnaire includes diverse aspects of climate change, such as carbon emission levels, carbon strategies, carbon risk, and management of carbon risk (Luo & Tang, 2014). Subsequently, based on the responses received, the CDP assesses and grades those companies based on the carbon-related information's quality and comprehensiveness. In the academic field, the carbon disclosure scores evaluated by the CDP are extensively adopted as the proxy for corporate voluntary carbon disclosure. Therefore, we adopt the carbon disclosure scores provided by CDP as the proxy of our main variable in this empirical study. Besides, this study intends to encompass the companies continually listed on the FTSE350 from 2015 to 2019. Most of the relevant data were retrieved from the Bloomberg database, incorporating the Carbon Disclosure Score, cost of equity capital, and some common financial data. Meanwhile, data of other firm-level variables were gathered from the FAME database.

Our sample incorporates all sampled firms with available data. However, we exclude financial companies as they have different regulatory requirements that may differ from the rest of the sectors. We also exclude firms with missing data in terms of the main variables, which are the cost of equity capital (dependent variable) and voluntary carbon disclosure (independent variable). This procedure leads to data elimination, with 873 firm-year observations left as preliminary samples. The most noticeable data elimination is observed on the independent variable (carbon disclosure scores) where some companies failed to provide sufficient carbon information or failed to participate in the annual survey launched by the Carbon Disclosure Project (CDP). We further drop the missing data of control variables, resulting in a final sample of 543 firm-year observations. Among the data of control variables, the most prominent data missing is observed on board gender diversity. Finally, we use an unbalanced panel dataset covering 543 observations from all FTSE350 companies between 2015 and 2019.

4.2 Models and variables

The following model is employed in the hypothesis test in terms of the correlation between voluntary carbon disclosure (*VCDi,t*) and the cost of equity capital (*COE,t*).

$$COE_{i,t}\ (Cost\ of\ Equity\ Capital) = a_0 + a_1*CDS_{i,t} + a_2*SIZE_{i,t} + a_3*PRFT_{i,t} + a_4*LEV_{i,t} + a_5*BGD_{i,t} + a_6*ESGScr_{i,t} + a_7*TobinQ_{i,t} + a_8*BETA_{i,t} + a_9*ICOV_{i,t} + a_{10}*GRW_{i,t} + a_{11}*ABAS_{i,t} + \varepsilon \quad (1)$$

4.2.1 Voluntary carbon disclosure

Voluntary carbon disclosure is measured by Carbon Disclosure Score (CDS) which is assessed by CDP, an independent global system through which companies report their carbon information such as carbon risks, GHG emissions, and climate change strategies in an annual questionnaire (Depoers et al., 2016). CDP evaluates the quality and depth of the companies' response to the survey by employing the Carbon Disclosure Leadership Index (CDLI). The scores range from A to F with higher scores indicating higher quality and more extensive carbon disclosure. Unlike several prior studies that employed dummy variables based on whether a firm has made responses to the CDP questionnaire for public disclosure of carbon information (Ben-Amar et al., 2017) or self-constructed indices (Plumlee et al., 2015), this study adopts Carbon Disclosure Score (CDS) as the proxy of corporate voluntary carbon disclosure. CDS performs better in two aspects. Firstly, CDS is provided by CDP, which publicly issues the annual CDP reports. It is recognised as the leading source of assessment of corporate CID (Griffin et al., 2017). Thus, compared with self-constructed indices, CDS could provide the evaluation with greater objectivity and fairness. Secondly, CDS serves as the metric of the transparency, quality, and comprehensiveness of the carbon information provided in the corporates' responses to the CDP annual survey (Luo & Tang, 2014). Therefore, it measures a corporation's activities related to climate change in a multidimensional way, which is more comprehensive and accurate compared with the dummy variable that barely reflects corporates' decisions on carbon disclosure.

In this study, the CDS data collected from the Bloomberg database in which the Carbon Disclosure Score (CDS) is assessed by Carbon Disclosure Project (CDP) based on corporates' responses to the questionnaire are converted to numerical values. It represents the level of quality, transparency and comprehensiveness of an entity's carbon disclosure, reflecting its practices and performance regarding carbon commitment. Given that the quality of corporate voluntary carbon disclosure is scored by CDP based on different levels (from level A to level F), the Bloomberg database converted those different levels to numerical values. The specific conversion method is that A to F is represented by numerical values 0 to 8 (8 replaces score A; 7 replaces score A-; 6 replaces score B; 5 replaces score B-; 4 replaces score C; 3 replaces score C-; 2 replaces score D; 1 replaces score D-; 0 replaces score F). Companies failing to

disclose or report sufficient carbon information will be scored F. However, F does not indicate a company's failure in terms of carbon practices and management (corporates participate in the survey voluntarily).

4.2.2 Cost of equity capital

The dependent variable of this study is cost of equity capital (COE). It serves as a crucial determinant of a corporate's valuation since it indicates the estimated rate of return demanded by investors and thus the expected discounted future cash flows (Kim et al., 2015; Persakis & Iatridis, 2017). The cost of equity capital of a firm is significantly related to the riskiness of the company relative to its peers. Specifically, with other factors being constant, the corporate with a higher level of risk is generally required more by its investors regarding the rate of return, thus resulting in a higher cost of capital for the company. Because of the absence of directly observable and accurate measures for a company's cost of equity, it is normally based on analysts' estimation, represented as implied cost of equity capital (Botosan, 2006), which provides an excellent alternative to measuring the cost of equity since it is superior in capturing variation of expected returns (Pástor et al., 2008).

Prior studies have documented several approaches for estimating implied cost of equity capital, and consistent with Gerged et al. (2021), we adopt Easton's (2004) price-earnings growth (PEG) model in this study, which was extensively employed in previous empirical studies due to its simple application. To enhance the reliability of results, we will employ an alternative measure as the proxy of the cost of equity capital, aiming to check the robustness. The specific formula of the PEG model is as follows:

$$\text{PEG} = \sqrt{[(\text{EPS2} - \text{EPS1}) \div \text{P0}]}$$

Within this estimation, PEG means the implied cost of equity capital, EPS1, refers to the 1-year forward EPS (Earning per Share) of analysts' consensus, EPS2 refers to the 2-year forward EPS of analysts' consensus, and P0 represents the firms' stock price at the end of the financial year.

4.2.3 Control variables

Based on prior empirical studies (Lemma et al., 2019), the cost of equity capital in this study identifies and incorporates the following control variables. Firstly, we adopt firm size (SIZEi,t), which represents a range of firm-level factors such as financial resources and level of market capitalization. It also serves as a proxy of collateral and inverse information asymmetry that motivates firms' CID (Shan & Taylor, 2014). It is extensively verified that the

leverage (LEVi,t) of a firm has a positive correlation with its default risk and thus its cost of capital (Chen & Gao, 2012). Thirdly, high-growth companies could relate to higher levels of information asymmetry, which results in a higher risk premium required by their investors and hence higher cost of capital for firms (Lemma et al., 2018). Therefore, firm growth (GRWi,t) is adopted as a control variable. Moreover, companies with higher profits (PRFTi,t) are less likely to get financially constrained and hence are related to lower default risk, leading to lower cost of capital (Lopes & Alencar, 2010). In a similar vein, companies with a higher interest coverage rate (ICOVi,t) are likely to benefit from the reduced cost of capital while high-interest coverage implies better capability for covering interests and thus lower default risk. Also, the model incorporates the BETA (BETAi,t) as a control variable, serving as the proxy of systemic risks associated with a company (Persakis & Iatridis, 2017). It is extensively documented that the disclosure score of corporate environmental, social, and governance practices is correlated with the cost of equity capital (Plumlee et al., 2015), hence, we control for the ESG disclosure score (ESGScrit). Furthermore, we also control for board gender diversity (BGDit) in this study since several prior studies substantiate the correlation between board gender diversity and cost of capital (Adams & Ferreira, 2009; Gul et al., 2011). Table 1 below presents the description, symbol, and specific measurement of all variables involved in this study.

[Table 1 is here]

5. Data and result analysis

5.1 Descriptive statistics

Table 2 below shows the number of carbon-disclosing firms among FTSE350 that made responses to the annual CDP survey from 2015 to 2019. It is represented that the number of disclosing corporates reached the highest level (256 companies out of 350) in 2019, revealing that a larger proportion (72.86%) of FTSE350 firms participated in the CDP survey compared with the previous four years.

[Table 2 is here]

Table 3 presents the descriptive statistics of the variables employed. All continuous variables employed are winsorized at 1 and 99 percentiles. The mean cost of equity capital (COE) for all samples involved is 10.2%, and the standard deviation and median are 0.023 and

10%, respectively. The figure of the mean value of cost of capital is consistent with Gerged et al. (2021), revealing a 10% mean for the cost of equity capital in the UK. Regarding the independent variable, voluntary carbon disclosure proxied by carbon disclosure score (CDS) shows a mean value of 4.94, with a median of 6 and a standard deviation of 2.37.

[Table 3 is here]

It is implied that the average quality of sampled firms' voluntary carbon disclosure from 2015 to 2019 is in the medium range. The BGD proxied by the percentages of female boards is recorded as a 26.35% mean, suggesting that the designated firms hold an average of 26.35% female directors on the boards. Regarding the environmental, social, and governance disclosure score (ESGScr), the results recorded a 42.6 mean, a 41.32 median, and a 10.32 standard deviation. In addition, the Av.Bid-Ask Spread (ABAS) reported a mean of 0.249, a 0.143 median, and a standard deviation of 0.319, in line with the results reported in prior studies investigating the UK's capital market (Gerged et al., 2021). In terms of the common firm characteristic variables, the mean value of firm size, financial leverage, and Tobin's Q (TobinQ) are 8.47, 0.555, and 1.942, respectively. The profitability (PRFT) proxied by the ratio of corporate net income on total assets has reported a 0.07 mean, a 0.059 median, and a 0.064 standard deviation. Besides, the market beta (Beta), indicating the volatility of stock price relative to the volatility of the capital market, indicated a mean of 0.403 and a median of 0.977 with a standard deviation of 3.764. The interest coverage ratio (ICOV) measured by corporate EBIT with respect to total interest recorded a mean value of 53.73, a median of 8.688, and a standard deviation of 248.4. Specifically, there is a large span of maximum and minimum value of interest coverage ratio, with a maximum value of 3,911 and a minimum value of -35.05. Additionally, the sustainable growth rate (GRW) scored a 9.255 mean, 7.008 median, and a standard deviation of 16.52.

5.2 Correlation analysis

Table 4 shows the matrix of pairwise correlation coefficients for the variables employed in the empirical test. Consistent with the expectations based on prior empirical studies, most variables are significantly correlated at the 1% or 5% significant level. Specifically, the correlation results for the cost of equity capital (COE) indicate a positive coefficient with SIZE (0.311), LEV (0.167), and Beta (0.192) all at the 1% significant level. Likewise, in line with the expectations, the correlation results for COE signify the negative coefficient with PRFT (-0.165), TobinQ (-0.068), and ICOV (-0.056). In terms of the multicollinearity issue, the

correlations between the independent variables are all under 0.60. We assess the multicollinearity of independent variables by employing VIF (Variance Inflation Factor), resulting in a mean VIF of 1.69 (less than 10). Consequently, there is no apparent multicollinearity problem that has an impact on the reliability and rigor of regression within the independent variables.

[Table 4 is here]

5.3 Result analysis and discussion

This study's main objective is to examine the association between voluntary carbon disclosure and cost of equity capital. In order to decide whether pooled OLS, fixed effect or random effects panel models are suitable for our data, following Park (2011), as our data is a random sample from FTSE350 companies, we first conduct the Lagrange multiplier test (Breusch and Pagan, 1980), the result suggests that random effect model is more suitable compared to the OLS model (Dougherty, 2011; Park, 2011). We then perform Durbin-Wu-Hausman (DWH) test to see whether the random effect model or fixed effect model is suitable for our data. The result suggests that the fixed-effect model is preferable over the random-effect model[1].

Table 5- Column A presents the empirical results of fixed-effect regression models. The results show a negative and significant association between voluntary carbon disclosure (CDS_{it}) and the cost of equity capital (COE_{it}) both at the 1% significant level. Specifically, the fixed-effect regression result shows that the coefficient of the relationship between COEit and CDS_{it} is -0.0027. Consequently, a negative association between voluntary carbon disclosure (CDS_{it}) and cost of equity capital supports our hypothesis that voluntary carbon disclosure contributes to lowering firms' cost of equity capital. This corresponds with empirical results in prior studies (Lemma et al., 2019) that support and verify the negative association between carbon disclosure and cost of capital. Moreover, regarding the economic significance, the coefficient of -0.0027 in fixed-effect regression indicates that one standard deviation incorporating voluntary carbon disclosure could induce a 0.64% (-0.0027*2.366) decrease in the cost of equity capital.

[1] We also perform the heteroskedasticity test for the fixed-effect model using xttest3 command (Stata). The result indicates there is no problem with heteroskedasticity.

Our results provide a possible answer to the debate issue in relation to corporate climate-related reporting, whether firms should engage in disclosing more climate-related information, and how the stakeholders (such as fund providers) will react to this practice, as several studies argue that climate-related reporting may trigger more proprietary costs, resulting in negative economic outcomes for companies (Peters & Romi, 2014), or carbon information disclosed by firms could give rise to unfavourable outcomes in capital markets (Lee et al., 2015). However, our results suggest that stakeholders (i.e., fund providers) have a positive reaction to the transparency of climate-related reporting practice by businesses. This finding supports the argument of agency theory and signalling theory that the organizations are willing to disclose more climate-related information in order to enhance the transparency and reduce the information asymmetry, which enables stakeholders (i.e., fund providers) to gain more information to properly assess their investment risks caused by environment-related issues (Velte et al., 2020). In addition, in line with the legitimacy theory, disclosing more information about carbon performance reflects the social responsibility and legitimate commitment to society and community (including customers and competitors) (Bui et al., 2020). This practice also helps businesses to reduce pressure from government and other stakeholders to the current issues of climate change and global warming (Caruana & Chatzidakis, 2014).

Our results strengthen the positive impact of voluntary disclosure, which has been suggested by some prior studies to enhance transparency and information quality, which contributes to lower risk and better financial consequences by reducing information asymmetry for shareholders and other stakeholders (Lueg et al., 2019). Especially, in relation to climate-related reporting, stakeholders could capture more information about a firm's carbon practices based on the published environmental information. Therefore, investors are more willing to trade the securities and portfolios of firms that make credible and comprehensive carbon disclosure, especially when it comes to carbon-intensive sectors (Li et al., 2019; Francis et al., 2005)

In terms of the control variables, firm size (SIZE) proxied by the natural logarithm of total assets signifies a positive significant correlation with cost of equity, with a coefficient of 0.0117 at a 5% significant level. This result is consistent with the empirical results of prior studies (i.e., Lemma et al., 2019). Besides, it shows that the fixed-effects regression coefficient of profitability ($PRFT_{it}$) and the cost of equity capital (COE_{it}) is -0.0583, which is significant at 5%. This negatively significant correlation is in line with the prior studies, positing that firms with higher profitability tend to have lower default risk, leading to lower cost of capital (Lopes

& Alencar, 2010; Lemma et al., 2019). The positive relationship between beta ($BETA_{it}$) and cost of equity capital is also revealed in our results, with a positive regression coefficient (0.0004) at a 10% significant level. Surprisingly, the board gender diversity (BGD) and ESG score (ESGScr) present a positive correlation with the cost of equity.

[Table 5-Column A is here]

5.4. Robustness test

We use an alternative proxy (COE-A) for the cost of equity capital to check the robustness of the regression results and findings[2]. Table 5- Column B presents the fixed-effect regression results of examining the impacts of voluntary carbon disclosure on cost of equity capital based on $COE\text{-}A_{it}$ as the proxy for the cost of equity. As the fixed-effects regression results show, the coefficient of voluntary carbon disclosure (CDS_{it}) and $COE\text{-}A_{it}$ is -0.214 at a 1% significant level, indicating the negatively significant correlation between voluntary carbon disclosure and cost of equity capital. This is consistent with the regression results with implied cost of equity capital as a proxy of COE in Table 5, where firms with a higher level of voluntary carbon disclosure benefit from a lower cost of equity among the sampled FTSE350 companies. In addition, our regression results also show a positive and significant relationship between firm size and cost of equity capital, while profitability is negatively associated with the cost of equity capital (proxied by COE-A), which suggests that fund providers appreciate positively firms with higher profitability (Lopes & Alencar, 2010; Lemma et al., 2019). This also indicates the consistency of our main findings, which are robust to alternative measures of cost of equity capital.

[Table 5- Column B is here]

6. Conclusion

With the background of growing environmental problems and public concerns towards climate change, this study focuses on the effects of voluntary carbon disclosure on the crucial economical implication for companies – the cost of equity capital. With an aim to investigate the association between corporate climate-related reporting (proxy by voluntary carbon disclosure) and the cost of equity capital in a UK setting, this research employs a sample of companies from the FTSE350 index, covering 543 firm-level year observations from 2015 to

[2] Several diagnostic tests have been conducted, for example, Breusch-Pagan Lagrange Multiplier (LM), and Hausman tests indicate that fixed-effect models are the best choice for our study.

2019. The companies listed on the FTSE350 index are the largest publicly listed firms on the LSE, which serves as an appropriate representation of the economy and carbon profile of the UK. We developed a regression model following prior empirical studies and then conducted fixed-effects regression for examining the relationship between voluntary carbon disclosure and cost of equity capital.

Underlined by a combination of agency theory, signalling theory and legitimacy theory, we find that voluntary carbon disclosure is negatively associated with the cost of equity capital. It indicates that firms with a higher level of corporate climate-related reporting (through voluntary carbon disclosure) will be rewarded with a lower cost of equity capital. Additionally, in order to ensure the robustness of the regression result, we adopt an alternative proxy for the cost of equity. In terms of the association between voluntary carbon disclosure and the cost of equity capital, the regression results show consistent results of a negatively significant association between these two factors. Consequently, the positive economic consequences of voluntary carbon disclosure facilitate a more transparent and comprehensive disclosure of climate-related information, such as carbon emissions and other carbon-related information by the corporate sector. From the perspective of investors, the better quality of CID helps them identify opportunities and estimate risks when making investment decisions. Furthermore, carbon disclosure with higher quality could appropriately manifest a company's carbon risk, leading to a lower cost of equity capital. Therefore, voluntary carbon disclosure appears as a win-win for investors and the corporate sector, and it benefits the whole of society.

This study's findings have significant implications for policymakers, business leaders and other stakeholders. First, the results suggest a positive recognition of stakeholders to the commitment of businesses to reducing the impact of climate change by disclosing more carbon information. Consequently, the business can obtain funding with a lower cost of equity. These findings demonstrate the serious attention of stakeholders (i.e., fund providers) to the engagement in the environmental activities of businesses, which encourages companies to get more involved in reducing the impact of climate change. Second, the negative association between profitability and cost of equity capital also suggests the positive reaction of fund providers to businesses based on the financial performance of companies. This indicates the stakeholders appreciate the importance of both financial (profitability) and non-financial (carbon disclosure) performance of businesses. Third, our results show a positive association between board gender diversity and cost of equity capital, which challenges findings from prior studies regarding the contribution of board gender diversity since the increase of female

directors on boards does not always help to reduce the cost of equity capital. This finding may motivate businesses and policymakers to act more seriously in enhancing the roles and functions of women on board to make a positive contribution to businesses.

However, this study only focuses on FTSE350 companies, the biggest firms listed on the LSE according to their market capitalization, hence the results could be skewed towards larger companies. Therefore, future studies could generalize the findings to other types of companies (i.e., small and medium enterprises) or use cross-country data to gain a bigger view of the reaction to the involvement in environmental activities of businesses.

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Tables

Table 1. Summary of variables and measurements

Variables	**Symbol**	**Variable Measurement**
Cost of equity capital	COE_{it}	Implied cost of equity capital. According to Easton's (2004) model, it is calculated by square-rooting the ratio of forecasted short-term growth of earnings to the current share price. Measured in percentage.
	coe_{it} (Alternative measure)	Derived by the Capital Asset Pricing Model (CAPM). Calculated by Risk-free rate (Rf) plus the product of Beta and risk premium.
Voluntary carbon disclosure	CDS_{it}	Carbon disclosure score (CDS) reported on Carbon Disclosure Project
Firm size	$SIZE_{it}$	Natural logarithm of total assets
Profitability	PRFTit	Net income with respect to total assets
Leverage	LEVit	Total liabilities divided by total assets
Board gender diversity	BGDit	Percentages of female directors on boards
Environmental, social, and governance disclosure score	ESGScrit	The weighted percentage score of three percentage sub-scores, incorporating environmental, social, and governance disclosure scores.
Firm value	TOBINQit	The aggregate of the market value of total equity and book value of total liabilities divided by the book value of total assets
Beta	BETAit	Beta coefficient, measuring the volatility of the stock price relative to the volatility of the market.
Interest coverage	ICOVit	Operating income (EBIT) divided by interests paid
Growth rate	GRWit	Sustainable growth rate
Av.Bid-Ask Spread%	ABASit	The average closing bid-ask percentage serves as a proxy for liquidity.

Source: Created by authors

Table 2 Number of voluntary carbon-disclosing firms

	2015	2016	2017	2018	2019
Number of disclosing firms	220	135	132	154	255
Number of non-disclosing firms	130	215	218	196	95
Disclosing Rate	62.85%	38.57%	37.71%	44.00%	72.86%
Total	350	350	350	350	350

Source: Created by authors

Table 3: Descriptive Statistics

VARIABLE	N	Mean	Median	Sd	Min	Max
COE	543	0.102	0.10	0.023	0.037	0.198
CDS	543	4.941	6.00	2.366	0.00	8.00
SIZE	543	8.47	8.445	1.536	4.586	13.52
PRFT	543	0.07	0.059	0.064	-0.158	0.433
LEV	543	0.555	0.546	0.194	0.119	1.117
BGD	543	26.35	25.00	10.46	0.00	50.00
ESGScr	543	42.60	41.32	10.32	14.88	66.94
TobinQ	543	1.942	1.581	1.297	0.725	10.77
Beta	543	0.403	0.977	3.764	-14.12	12.03
ICOV	543	53.73	8.688	248.4	-35.05	3911
GRW	543	9.255	7.008	16.52	-31.05	97.45
ABAS	543	0.249	0.143	0.319	0.028	3.06

Source: Created by authors

Table 4: Pairwise correlation of variables

Variables	COE	CDS	SIZE	PRFT	LEV	BGD	ESGScr	TobinQ	Beta	ICOV	GRW	ABAS
COE	1											
CDS	0.136***	1										
SIZE	0.311***	0.520***	1									
PRFT	-0.165***	-0.134***	-0.309***	1								
LEV	0.167***	0.143***	0.410***	-0.310***	1							
BGD	0.165***	0.257***	0.166***	0.049*	0.104***	1						
ESGScr	0.299***	0.515***	0.528***	-0.205***	0.089***	0.233***	1					
TobinQ	-0.068***	-0.232***	-0.414***	0.533***	0.060**	0.118***	-0.254***	1				
Beta	0.192***	0.113***	0.151***	-0.087***	0.004	0.145***	0.198***	-0.089***	1			
ICOV	-0.056**	-0.069*	-0.191***	0.227***	-0.184***	0.05	-0.180***	0.192***	-0.008	1		
GRW	0.003	-0.098***	-0.185***	0.417***	0.069***	0.014	-0.023	0.323***	-0.037	0.060**	1	
ABAS	-0.252***	-0.413***	-0.478***	0.002	-0.132***	-0.213***	-0.280***	0.024	-0.078***	0.052*	0.024	1

Note: *** p<0.01, ** p<0.05, * p<0.1

Source: Created by authors

Table 5: Main test & Robustness test results (based on fixed effect regressions)

Variables	**Column A** **Main test results** **(Dependent variable: COE)**	**Column B** **Robustness test** **(Dependent variable: COE-A)**
CDS	-0.0027*** (-3.33)	-0.214*** (-2.63)
SIZE	0.0117** (2.26)	1.218** (2.39)
PRFT	-0.0583** (-2.13)	-11.534*** (-3.43)
LEV	0.0093 (0.51)	1.31 (0.71)
BGD	0.0002** (2.15)	0.015* (1.77)
ESGScr	0.0005* (1.7)	0.086*** (2.66)
TobinQ	0.0014 (0.6)	0.217 (0.83)
Beta	0.0004* (1.76)	0.045* (1.65)
ICOV	0 (0.84)	0.003 (1.34)
GRW	0.0001 (1.31)	0.015 (1.57)
ABAS	0.008* (1.66)	0.647 (1.21)
Constant	-0.0223 (-0.48)	-4.017 (-0.86)
N	543	543
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
R-squared	0.125	0.151
F-test	4.555	5.611
Prob > F	0	0

*** p<.01, ** p<.05, * p<.1

Source: Created by authors