

Women in the boardroom and their impact on climate change related disclosure

Abstract

Purpose - *This paper aims to investigate the relationship between gender diversity and the Carbon Disclosure Project (CDP) score/index. Specifically, the study describes extant research on theoretical perspectives, and the impact of women on corporate boards (WOB) on carbon emission issues in the global perspective.*

Design/methodology/approach - *This study uses the carbon disclosure scores of the Carbon Disclosure Project (CDP) from 2011 to 2013 (inclusive). A total observation for the three year periods is 1175 companies. However, based on data availability for the model, our sample size totals 331 companies in 33 countries with firms in 12 geographical locations. We used a model which is estimated using the fixed-effects estimator.*

Findings - *The outcomes of the study reveal that there is a positive relationship between gender diversity (WOB) and carbon disclosure information. In addition to establishing a relationship between CDP score and other control variables, this study also found a relationship with Board size, asset size, energy consumption, and Tobin's Q, which is common in the existing literature.*

Research limitations/implications - *The limitations of the study mostly revolve around samples and the time period. To further test the generalizability and cross-sectional validity of the outcomes, it is suggested that the proposed framework be tested in more socially responsible firms.*

Practical implications - *There are increasing pressures for WOBs from diverse stakeholders, such as the European Commission, national governments, politicians, employer lobby groups, shareholders, Fortune and FTSE rankings and best places for women to work lists. The study offers insights to policy makers implementing gender quota legislation.*

Originality/value - *The study has important implications for putting into practice good corporate governance and in particular, gender diversity. The outcomes of our analyses advocate that companies that included women directors and with a smaller board size may expect to achieve a higher level of carbon emission performance and to voluntarily disclose the level of carbon information assessment requested by the CDP.*

Keywords *Climate change, Carbon disclosure project, GHG, Corporate social responsibility, Women on corporate board*

Paper type *Research paper*

1. Introduction

There is growing scientific evidence that carbon emissions are the major cause of global warming, which is a serious threat to the quality of human lives (Lash and Wellington, 2007; Allen *et al.*, 2009; Luo, *et al.*, 2012; Luo and Tang, 2014a; Luo and Tang, 2014b). According to the Intergovernmental Panel on Climate Change (IPCC), average temperatures have already risen by 0.85⁰C since 1880 (Luo and Tang, 2016). We are expected to experience significant increases in surface temperatures and atmospheric CO₂ concentrations. In addition, sea levels are projected to rise between 26 and 81 centimetres by 2100 (IIPCC, 2013). Therefore, corporations are expected to play an important role in stabilising climate change and in the control of greenhouse gas (GHG) emissions (interchangeably use the terms as ‘carbon’, ‘carbon dioxide CO₂’). This is essential for sustainable corporate development. Therefore, there is a growing demand for carbon-related information (Organisation for Economic Co-operation and Development [OECD], 2010; Rankin *et al.*, 2011; Luo and Tang, 2016). A variety of actions have been taken around the world to deal with GHG emissions. Some examples are the European Emissions Trading Scheme (EU ETS), the Kyoto Protocol, Australian Emissions Trading Scheme (AETS) and Carbon Disclosure Project (CDP).

This study explores the impact women on the corporate board of directors have on climate disclosure. It uses CDP’s, a nongovernmental and not-for-profit organization, ‘carbon-related disclosure score (CDS)’ in determining the extent to which global companies proactively address the climate change agenda and whether board diversity has a positive impact on this reporting process. The importance of this study derives from competing views such as women on corporate board can bring distinctive management style to improve board’s effectiveness, or women’s limited experience in leadership positions could have negative effect for board’s work practices (Nielsen and Huse, 2010). The strategic decision-making literature recognizes the composition of boards of directors as an important factor in corporate decision making (Post *et al.*, 2011; Fuente *et al.*, 2017). Surveys have revealed that

a significant majority of board members view their role as determining the strategic direction of the company (Demb and Neubauer, 1992). The role of women in board positions is also receiving increased attention in recent decades (Daily *et al.*, 1999; Hillman *et al.*, 2007; Terjesen *et al.*, 2009; Nielsen and Huse, 2010; Fernandez-Feijoo *et al.*, 2014; Ben-Amar *et al.*, 2015; Liao *et al.*, 2015; Hoang *et al.*, 2016). The literature has shown that women usually have a higher perception of risks and have been socialised to care for the needs of others. Based on these qualities, they have a closer feeling towards social responsibility (Ciocirlan and Pettersson, 2012). Women are also more likely to provide socially desirable responses and to be more sensitive to ethical issues than men (Bernardi, 2006). In order to understand the effect that women have on boards, it is important to consider not only their presence, but also their number. Given this fact, researchers (Prado-Lorenzo and Garcia-Sanchez, 2010; Lio *et al.*, 2014; Ben-Amar, *et al.*, 2015) have examined the effect of gender diversity on GHG emissions disclosures with mixed results.

For example, Prado-Lorenzo and Garcia-Sanchez (2010) do not find any effect of gender diversity in the boardroom on GHG disclosures based on a sample of 283 companies for the CDP 2008 project. In contrast, Liao *et al.* (2014) report a positive effect of female presence on 2010 carbon disclosures in the United Kingdom (UK), and Ben-Amar *et al.* (2015) find that female boardroom participation is positively related to the voluntary disclosure of climate change information based on a sample of Canadian firms over the 2008–2014 period. They also reveal that board gender diversity with more than two women directors influences board disclosures on GHG emission levels and climate change strategies. However, our study is different from the previous three studies with regards to the extended sample and global perspective. It, therefore, contributes to the understanding of whether women can influence the board by addressing current climate change risk issues as pressures come from different

stakeholders such as regulatory authorities, policy makers, international organisations and the media.

This study contributes to the literature on board diversity and climate change risk discourse in several ways. First, we analyse the relationship between female representation on corporate boards and CDP scores from an international context covering 33 countries, since it is the firm's decision to voluntarily disclose climate change related risk information and opportunities that have been requested by CDP as an institutional stakeholder. Institutional investors are actively seeking change on board diversity and climate change disclosure. Therefore, they need to explore how board gender diversity may shape corporate response to institutional investors' demands for increased public reporting about climate change risks (Ben-Amar *et al.*, 2015). This is important because GHG emissions and public disclosure to investors can be assumed as a first step toward addressing climate change issues and reducing the company's carbon footprint (Hoffman, 2005; Kolk and Pinkse, 2007; Reid and Toffel, 2009; Bocken and Allwood, 2012). Although Ben-Amar *et al.* (2015) examine this issue in the sample of 541 Canadian firms, our investigation is not limited to a specific country. By contrast, our study of climate change is global in nature.

Second, the study emphasises that an effective diversified board is necessary to address issues raised by various stakeholders in relation to climate change risk disclosure. This concept contributes to the corporate governance literature since we investigate firm level board diversification. Corporate governance mechanisms encourage firms to disclose voluntary information about carbon emissions. From a study of global companies and different economic environments, it is imperative to observe whether corporate governance mechanisms address carbon emission disclosure and to what extent they do this. Third, our paper also contributes to the voluntary disclosure literature on climate change disclosure scores by CDP rather than general sustainability disclosures. The CDP data are derived from

a set of complete questionnaires (Luo *et al.*, 2012), while sustainability disclosure data relies on annual reports, sustainability reports, environmental reports and company websites (Post *et al.*, 2011; Fernandez-Feijoo *et al.*, 2014; Seto'-Pamies, 2015). The CDP report is a stand-alone carbon statement that requires the company to provide comprehensive and specific carbon information (Luo and Tang, 2014). In the absence of internationally accepted standards, the CDP has adopted a set of rules that participating firms must follow and thus significantly reduces the opportunity for managers to manipulate carbon data (Luo and Tang, 2014). Finally, the findings of the study may contribute to the understanding of regulators and policy makers about taking steps forward in accommodating women directorship in the board and to what extent. This will provide firms with direction, either mandatorily or voluntarily to include women in the board of directors. For example, in the UK, FTSE 100 boards should aim for a minimum of 25% female representation by 2015. The European Commission has set a 40% target for female representation by 2020, while the Australian ASX Corporate Governance Council recommends that companies establish a policy concerning diversity and disclose in their annual reports, the proportion of women in the whole organisation, in senior executive positions and on the board (Ben-Amare *et al.*, 2015).

Within this context and based on the discussion above, the present study develops the following hypotheses in terms of management's motivation about carbon emission disclosure and the strategies to deal with climate change in response to the CDP survey. This study uses the lens of gender to explore the role of director preferences in the selection of corporate strategies with regard to corporate climate change risk issues.

2. Theoretical orientations

The social responsibility of businesses has been influenced by various theories (Carroll and Buchholtz, 2000). In this study, we have developed our theoretical orientations in the lens of corporate governance and diversity as well as stakeholder theory and resource dependence

theory. In other words, we need to explore how diversity especially on the number of women on boards contributes to corporate governance mechanism and also how it reflects to the CDP score. In recent years, corporate governance reforms emphasise diversity in boardrooms (Davies Report, 2015; European Commission, 2014; Higgs Report, 2003). Also increased demand for gender diversity on boards has led researchers to examine the factors which influence the presence of women directors in the boardrooms (Saeed et al. 2016). The presence of female directors on boards can reinforce mechanisms of stakeholder engagement (Al-Shaer and Zaman, 2016) and increase the credibility of corporate reports (Manetti and Toccafondi, 2012). The arguments for increasing the number of women on boards can be grouped into three categories: theoretical, moral and business arguments (Walt and Ingley, 2003). In terms of theoretical arguments for board diversity are based on the question of whom the board should report to, whose interests it protects and by whom the board can be held accountable (Lückerath-Rovers, 2009), which include agency theory (Jensen and Meckling, 1976), stakeholder theory (Freeman, 1984), resource dependence theory (Pfeffer and Salancik, 1978) and stewardship theory (Donaldson and Davis, 1991).

The above theories have different approach on the role of the board (monitoring versus advice, shareholders versus stakeholders), and the importance of the independency of directors. So, diversity is argued to improve independency while people with a different gender, ethnicity or cultural background might ask questions. Therefore, gender is argued, as one of the most-debated diversity issues in the corporate governance literature, and, given that women are expected to offer value that is different from that of men, numerous calls have been made to increase the number of women on boards (Singh et al. 2008; Terjesen et al. 2009) be posed by directors with more traditional backgrounds (Carter *et al.*, 2003). Regarding moral argument, it is based on the social responsibility of companies and their boards such as being a good corporate citizen (Walt and Ingley, 2003; Lückerath-Rovers,

2009; Carroll, 1991, Galbreath, 2016). The moral obligations of businesses to society begin with its obligations to uphold the perfect rights afforded in its stakeholder relationships (Brown and Forster, 2013). Carver (2002) argues that the rationale for diversity in the boardroom lies within the concept of ownership and the [moral] obligation of boards in their stewardship role. Representing ownership requires that a board represent the diversity within the ownership (Walt and Ingley, 2003). According to Carver (2002), in the bracket of humankind and human opinion in the ownership to find its way into governance, which constitute the board to be a reflection of the ownership as social justice is a dominant governance value. Thus, the stakeholder theory has grown into a theory for both corporate governance and corporate social responsibility (Kaptein and Wempe, 2002, Walt and Ingley, 2003). Finally, the improvement of company performance is used as a business argument for diversity. Diverse groups consider a greater range of perspectives and generate more high-quality solutions. This could ultimately lead to higher company performance and company value (Burgess and Tharenou, 2002; Singh and Vinnicombe, 2004; Kang *et al.*, 2007). Lückerath-Rovers (2009) argue that both stakeholder theory and resource dependence theory question who should serve on corporate boards in order to give the board legitimacy, and to what extent this contributes to corporate governance and thus, a brief discussions on theoretical orientations is made in the following paragraphs.

2.1 Stakeholder theory

The underlying rationale behind GHG emission disclosures has been enunciated under various socio-political and non-social political theories (Patten, 2002), of which stakeholder theory is particularly appropriate. Researchers advocate that stakeholder theory is fundamental to the study of business and society (Galbreath, 2016; Liao *et al.*, 2015; Clarkson, 1995; Donaldson and Preston, 1995; Freeman, 2014). Stakeholder theory is based on the premise that an organisation has many stakeholders rather than a single group of

shareholders, or groups of financial stakeholders, such as creditors (Momin, 2013). As an organisation needs to manage its relationship with many stakeholder groups that affect, or are affected by, its business decisions (Clarkson, 1995; Freeman, 1984), therefore, such relationships produce different arguments, leading to a number of variations of the stakeholder theory (Momin, 2013). The literature discusses three main variants of stakeholder theory: a normative (ethical), a managerial (instrumental) and the descriptive versions. (Donaldson and Preston, 1995; Jamali, 2008). The normative variant suggests that management might address stakeholder concerns from an accountability perspective, the instrumental and descriptive variants suggest that businesses might manage powerful stakeholders strategically by identifying them with the self-interest of the business (Donaldson & Preston, 1995; Momin, 2013). Within the stakeholder model, several groups of stakeholders have expressed their concern about the absence of women board directors (Hillman et al., 2007). Moreover, Al-Shaer and Zaman (2016) argued that female directors are more likely to be stakeholder oriented, concerned about ethical practices and socially responsible behaviour and also be inclined to take actions to reduce perceived risks (Adams and Ferreira, 2009; Carter et al., 2003). They find that gender diverse boards are associated with higher quality sustainability reports. Nielsen and Huse (2010) also argued that women on board can reduce the level of conflict and ensure high quality of board development activities and strategic decision.

In the context of this study, Liao *et al.* (2015) argue that “GHG emissions are ubiquitous and persistent, and the climate-change legislation may influence a firm either directly or indirectly, and favourably or unfavourably” (p. 412). Authors also argue that in order to have far-reaching impact on their future development, firms must make strategic decisions. The extent of a company’s social disclosure depends on its social performance (Ullmann, 1985). In this case, social performance refers to an organisation’s responses to anticipated or existing

social demands (Strand, 1983). Managers continually encounter demands from multiple stakeholder groups to devote resources to corporate social responsibility (McWilliams and Siegel, 2001). Hence, stakeholders need to be managed to maintain their continued support and ultimately ensure that corporate objectives and strategic decisions are taken which consider existing social demands as well as recognize the relevance of multiple stakeholders (Donaldson and Preston, 1995; Mitchell *et al.*, 1997; McWilliams and Siegel, 2001). Therefore, this implies that companies have identified their target audience and are providing information that will influence (or distract from) this group (Gray *et al.*, 1996). Moreover, it is argued that organizations could not survive if they were not responsive to the demands of the groups in their environments, who are thus enabled to influence organizational outcomes (Pfeffer and Salancik, 1978). In this case, women are more sensitive to social and ethical issues (Bear *et al.*, 2010; Hafsi and Turgut, 2013; Isidro and Sobral, 2015; Al-Shaer and Zaman, 2016). It is thus likely that due to females' higher concerns for social responsibility issues and greater stakeholder orientation a gender diverse board may affect sustainability reporting quality (Al-Shaer and Zaman, 2016, p. 212) which might have positive impact in the CDP project.

2.2 Resource dependence theory

Resource dependence theory offers the rationale for the board's function of providing critical resources to the firm including legitimacy, advice, and counsel (Hillman and Dalziel, 2003). These board resources offer the corporation support in understanding and responding to its environment (Boyd, 1990) that can help it better manage CSR issues (Bear *et al.*, 2010). Moreover, resource dependence has two major implications regarding boards of directors. First, composition of the board should be affected by environmental pressures and demands. Second, differences in board composition should affect a firm's performance (Boyd, 1990). As we are concerned in this study environmental issue, i.e. climate change, therefore, our

discussion is limited to the first concern. Indeed, from the perspective of resource dependence theory, the board of directors is a primary linking mechanism for connecting a firm with external resources (Hillman *et al.*, 2007). In addition, as per stakeholder model, the board of directors might be a linking mechanism for connecting a firm with external stakeholders (Lückerath-Rovers, 2009).

In the context of resource dependence theory, using the board of directors as a linkage mechanism towards stakeholders provides companies with at least four benefits (Pfeffer and Salancik, 1978, p.145): firstly, linkage may provide the organisation with useful information, secondly, linkage provides a channel for communication purposes, thirdly, linkage is an important step in obtaining commitments of support from important elements of the environment and fourthly, linkage has a value in legitimizing organisations (Lückerath-Rovers, 2009). Hillman *et al.*, (2007) add that legitimacy and conformity to societal expectations are considered key components of organisational survival.

In this study, the focus will be on the fourth benefit of board linking: providing legitimacy to an organisation. Resource dependence argues that external pressures- such as competition, regulation, and social forces-will cause firms to seek out environmental linkage which is measured by board size (Boyd, 1990). In this case, CDP scores might have influence from the board's role as corporate boards do respond to environmental pressures and demands. Moreover, board's influence on CSR is facilitated by the activities of monitoring and support (Hillman and Dalziel, 2003), which are dependent upon specialised human capital resources. Therefore monitoring at the board level is an activity that requires the oversight of management, corporate resources, and firms' outcomes. However, effective boards do more than monitoring; they also advise. Their advice can assist management to make high-quality decisions (Hillman and Dalziel 2003). The presence of women directors has been linked to various outcomes and having women on boards does exert some influence on non-financial

performance and in particular CSR (Stanwick and Stanwick 1998; Wang and Coffey 1992; Williams 2003; Bernardi and Threadgill, 2010; Smith *et al.*, 2001; Siciliano, 1996). In addition, women are more oriented toward supporting and maintaining relationships than men (Hisrich and Brush 1984), are strong in the areas of idea generation and innovation (Rosener 1995), and have been noted as having higher moral and ethical atonement than men (Betz *et al.* 1989). Therefore, women through their specialised human capital, bring a high level of skill at idea generation and innovation (Triana *et al.*, 2013; Torchia *et al.* 2011), both of which would be expected to help boards to make appropriate and necessary decisions to improve CSR. Here, the resources offered by women are expected to help boards, enabling them to innovate more readily around CSR initiatives. The resources of women on boards are also expected to be engaged to carefully consider and respond to stakeholders who have varied interests in the firm, such as environmental and social interests (Galbreath, 2016).

2.3 Agency theory

Based on Jensen and Meckling (1976)'s agency theory, Barnea and Rubin (2010) consider CSR engagement as a principal-agent relation between managers and shareholders (Li *et al.*, 2016). Moreover, agency theory explains how principals efficiently organise exchanges with agents by employing mechanisms - incentive alignment and monitoring - in appropriate combinations (Eisenhardt, 1989; Jensen & Meckling, 1976) and also hold their organisations to higher ethical standards (Pan and Sparks 2012). However, in order to avoid the agency conflict, the management should avoid the cost of dealing with environment problems, namely, reducing high-energy consumption, activities to reduce GHG emission, and air and water treatment before being released to the environment (Terjesen *et al.*, 2016). In other words, agents or the firm management would carry out such activities to benefit them, however, in return, it will be at the cost of the shareholders. Firms need to take up activities and initiatives to tackle the known global warming issues and impose solutions to minimize

the impact on the environment (Amran et al., 2014). Climate change disclosure is one way of providing evidence, which can increase the confidence of the stakeholders. Therefore, the firms should use sustainability reporting to publicise to stakeholders that individual firms are undertaking activities to curb global warming issues (Amran et al., 2014). Hence, to mitigate the agency dispute between the agent and principal, additional disclosure in reporting will ease the increasing concern. It is the firms' duty to handle the climate change issue in a more professional manner to avoid an unfavourable image and legal expenses, (i.e. agency cost). There is evidence that boards with more women have greater levels of public disclosure (Gul et al. 2011) and research supports that women's ability to influence board decisions increases with their numbers, particularly boards with more than one woman (Fondas and Sassalos 2000).

2.4 Discussion on theoretical underpinning

The above discussion leads us to posit that the CDP's score may be affected by the gender diversity on board under the umbrella of above theories. It is also noted that the current literature emphasises the importance of carbon relevant risk disclosure of firms given the planetary boundaries, which are perceived as resource scarcity (Deegan, 2002; Parker, 2005; Islam and Deegan, 2008; Liao *et al.*, 2015; Guenther *et al.*, 2016). Therefore, it is useful for a firm to be held accountable to the relevant stakeholders who have a stake in knowing how the resources entrusted to a firm are used (Schaltegger and Burritt, 2000), to obtain a "contract to continue its operations" (Deegan, 2002, p. 293). Guenther *et al.*, (2016) discuss another issue of 'stakeholder salience' (Neville *et al.*, 2011) in explaining stakeholder relevance in relation to carbon disclosure. Eesley and Lenox (2006, p. 765) define salience "in terms of whether firms are likely to respond to stakeholder requests for action and by proposing that power, legitimacy, and urgency arise out of the nature of stakeholder-request-firm triplets". Carbon disclosure is a way of satisfying salient stakeholders and reflects an adaptive management

approach to address a dynamic, multidimensional environment, and an ability to meet social pressure and respond to societal needs (Hackston and Milne, 1996). Moreover, Liao *et al.* (2015) argue that agency and legitimacy theories, although widely applied, are inadequate to explain GHG-reporting phenomena. Therefore, in this context, stakeholder and resource dependence theories are a more valid theoretical perspective, because the preferences of one interest group with regard to climate-change activities may not be congruent with those of other groups (Liao *et al.*, 2015). Indeed, stakeholders are a common antecedent, moderator or mediator variable (Guenther and Hoppe, 2014) in the related research field of corporate environmental (carbon) disclosure (Clarkson *et al.*, 2008; Huang and Kung, 2010). On the hand, within the framework of resource dependence theory, women on board brings specialised human capital (Miller and Triana, 2013) and help board to address the environmental concern with particular in climate change risk issue in the CDP project.

3. Related literature and Hypotheses development

The CDP has made significant contributions in obtaining greater corporate disclosure of risks related to climate change (McFarland, 2009). Its voluntary efforts encourage standardised voluntary reporting for companies to provide investors with relevant information about climate change-related business risk (Kolk *et al.*, 2008). The intention to provide this climate change-related business risk information depends on the board of directors since it is a company's main governance body and acts the entity responsible for safeguarding the interests of the stakeholders in the company by carrying out its duties (Hill and Jones, 1992; Prado-Lorenzo, and Garcia-Sanchez, 2010).

3.1 Gender diversity

Diversity is a characteristic of an organization's board of directors, which is related to the existence of differences in its members' traits (Prado-Lorenzo and Garcia-Sanchez, 2010).

Gender diversity is one of the more interesting human aspects that has been the focus of

many studies (Willims, 2003; Nalikka, 2009; Lückerath-Rovers, 2009; Adams, and Ferreira, 2009; Post *et al.* 2011; Bear *et al.*, 2010; Fernandez-Feijoo *et al.*, 2014; Al-Shaer and Zaman, 2016; Chen *et al.*, 2016; Galbreath, 2016; Liao *et al.*, 2015; Rao and Tilt, 2016; Saeed *et al.*, 2016). This is because diversity among board directors improves the chances that different knowledge domains, perspectives and ideas will be considered in the decision-making process (Post *et al.*, 2011; Liao *et al.*, 2015). The board of directors is primarily responsible for monitoring the behaviour of management (Fama and Jensen, 1983). Board directors are also participating more actively in decision making about corporate environmental policies (Kassinis and Vafeas, 2002). Boards influence firm performance (Peng, 2004), strategic decision making (Golden and Zajac, 2001; Jensen and Zajac, 2004; Westphal and Fredrickson, 2001), internationalization strategies (Datta, *et al.*, 2009), R&D investment strategies (Kor, 2006), share price (Filatotchev and Bishop, 2002), CSR (Frias-Aceituno *et al.*, 2013; Post *et al.*, 2011), sustainability reporting (Amran *et al.*, 2014; Al-Shaer and Zaman, 2016) and corporate governance (Farber, 2005; Monem, 2014).

Board gender diversity could improve the quality of board discussions and increase the ability of the board to provide better oversight of the firm's disclosures and reports. It could also reduce board effectiveness by increasing internal divisiveness and constraining its ability to act (Gul *et al.*, 2011). The study of Lückerath-Rovers (2009) indicate that the presence of female directors on company boards provides legitimacy to the outside world regarding the company's values on diversity. Saeed *et al.* (2016) observe that board gender diversity is positively related to the firm size, and it is inversely related to corporate risk across both emerging and developed economies. Galbreath (2016) suggests based on secondary data from Australia's largest firms that the resources of outsiders and women on boards appear to complement each other in impacting on CSR. Al-Shaer and Zaman, (2016) find that gender diverse boards are associated with higher quality sustainability reports and independent

female directors have greater effect on sustainability reporting quality than male directors. Chen et al. (2016) suggest that female directors improve board effectiveness in risk management with respect to R&D investment. Rao and Tilt (2016) observe that board composition seems to be a major factor which can be assumed to have some influence on both CSR activities and CSR reporting. The study of Bear et al. (2010) extends current theory by demonstrating that the number of women on the board has a positive relationship with the strength ratings for CSR. Saeed et al. (2016) note that board gender diversity is positively related to the firm size, and it is inversely related to corporate risk across both emerging and developed economies.

There are also differences in the company board of directors' decision making, including CSR policies, due to its gender composition (Fernandez-Feijoo *et al.*, 2014). Introducing gender diversity to corporate boards also has important implications for board dynamics (Ruigrok *et al.*, 2007). Women bring different characteristics to boards where they are perceived to have a more participative, democratic, and communal leadership style (Eagly *et al.*, 2003; Eagly and Johnson 1990; Rudman and Glick 2001). This may lead to improve board effectiveness as a result of the improved quality of board deliberations and better supervision of the firm's disclosures (Gul *et al.*, 2011). Gul *et al.* (2011) argue that gender-diverse boards improve the quality of public disclosure through better monitoring. The current literature also suggests that female directors provide greater oversight and monitoring of managers' actions and reports (Hillman *et al.*, 2007; Adams and Ferreira, 2009) through promoting better board attendance, assuming monitoring positions on audit, nominating, and corporate governance committees, and demanding greater accountability from managers for poor performance (Gul *et al.*, 2011). Gender diversity has also been found to facilitate creativity within groups (Hoffman and Maier, 1961; Nemeth, 1986). By taking a broader view, the board will have a better understanding of the complexities of the business

environment and thus improve decision-making. A more gender diverse board may also improve a firm's competitive advantage if it improves the firm's image (Campbell and Mínguez-Vera, 2008).

Academic research has advanced gender board composition from different perspectives and with different results. A comprehensive discussion, especially about women directors on corporate boards, is included in the study of Terjesen *et al.* (2009). Their study supports the position that women directors contribute to important firm level outcomes since they play direct roles as leaders, mentors, and network members as well as indirect roles as symbols of opportunity for other women. They inspire them to achieve and stay with their firms. Willims (2003) finds that female directors may be more inclined to use the firm's profit to help others, i.e. engage in charitable giving activities based on 185 *Fortune 500* companies in 1994. Webb (2004) tests the effect of gender composition of the board on a range of measures of social responsibility including environmental responsiveness. Adams and Ferreira (2009) suggests that female directors have a significant impact on board governance, i.e. board inputs and firm outcomes based on 1,939 firms for the period 1996-2003. Post *et al.*, (2011) find that the boards with a higher proportion of outsiders and those with three or more female directors have more favourable environmental disclosure strength scores, based on a sample of 78 companies (only electronic and chemical) that were on the list of 2006 and 2007 *Fortune 1000* companies. The study by Liao *et al.* (2015) suggests that the small number of female directors make a difference in GHG disclosure decisions in the sample of the 329 largest companies in the United Kingdom based on 2011 CDP data.

Given the evidence, some scholars have argued that women's more protective attitude toward the environment is due to their reproductive role, while others have argued that, as a group, women may be more aware of environmental exploitation because of their experience in a cultural system of paternalistic exploitation (Wehrmeyer and McNeil, 2000). A large body of

evidence supports the view that women are more concerned than men about perceived health and environmental risks (Bord and O'Connor, 1997; Davidson and Freudenburg, 1996). Accumulated research findings show that women tend to express higher levels of concern about technology and the environment than do men (Davidson and Freudenburg, 1996). Moreover, women receive more positive rewards than men for altruistic behaviour including caring and concern for others (Gilligan, 1982). The topic of female intelligence was addressed in 19th century psychology via phrenology and the neuroanatomists (Shields, 1975). Haier *et al.* (2005) study finds that on neuroanatomical basis, the general level of intelligence is the same in men and women. However, the psychology of women in acquiring the character of an academic entity was witnessed by the proliferation of research on sex differences (Shields, 1975). Women are typically socialized into communal values reflecting a concern for others, selflessness, and a desire to be at one with others. Men are usually socialized into agentic values involving self-expansion, self-assertion, competence and mastery (Eagly, 1987). As a result, women tend to be more aware and concerned than men about the links between environmental harm and personal well-being (Stern *et al.*, 1993).

It has also been argued that women's experience of motherhood gives them a heightened sense of morality that contributes to a more responsible and ethical use of power and authority (Sinclair, 1998). In this regard, in the typical masculine environments driven by competition, individualism, hierarchy and technical outcomes, feminine values are commonly viewed as being based on mutual empowerment, empathy and authenticity (Dillard and Reynolds, 2008). Tremblay *et al.* (2016) argue that if such gender-based sensitivity and skills really exist, then the economic logic of efficiency should lead businesses to diversify their boards' gender composition. In addition, a meta-analysis of gender differences in moral orientation (Jaffee and Hype, 2000) shows that women are somewhat more likely than men to use care reasoning. However, men and women use similar principles of fairness and equity

(Post *et al.*, 2011). It can be argued, therefore, female participation in the boardroom increases the likelihood of voluntary disclosure of climate change-related risks in the CDP. Therefore, the main hypothesis is stated as follows:

H1: There is a positive relationship between gender diversity and carbon disclosure score.

3.2 Size of the Board of Directors:

Board of directors have recently received considerable attention, in both practitioner and academic venues (Fama and Jensen, 1983; Baysinger and Butler, 1985; Boeker and Goodstein, 1991; Goodstein and Boeker, 1991; Daily and Dalton, 1994a, 1994b; Hillman *et al.*, 2000; Adams and Ferreira, 2007; Rose, 2007; Prado-Lorenzo and Garcia-Sanchez, 2010; Liao *et al.*, 2015 and Ben-Amar *et al.*, 2015). The board of directors plays a key role in monitoring management and in constructing mechanisms that align managers' objectives with shareholders' interests (Armstrong *et al.*, 2015). They also play a crucial role in corporate policy formulation, as well as its implementation and reviews (William, 2003). From an institutional perspective, larger boards are assumed to be beneficial (Judge and Zeithaml, 1992). Jensen (1993) argues that boards with more than about seven to eight members are unlikely to be effective.

The allocation of decision (or control) rights within an organization is a fundamental building block of organizational structure (Jensen and Meckling, 1990). Therefore, the size of board is important because larger boards are more likely to include more qualified directors (in terms of education and business experience) and, therefore, allow board members to offer the management high-quality advice (Zahra and Pearce, 1989). Lu *et al.* (2015) argue that this could contribute to the firm's image and relationships with stakeholders. However, their findings do not support that hypothesis. Nevertheless, scholars have found a larger board to be better (Gales and Kesner, 1994; Dalton *et al.*, 1999). In this case, the climate change risk issue could be considered by larger number of board members as their background skills

(education, experience) help of understanding and evaluating a firm's social roles (Chang *et al.*, 2015). They can bring a wealth of knowledge and experience to the board and can also increase the element of independence and objectivity in the board's strategic decision-making (Fama and Jensen, 1983). Having more directors also increases the pool of expertise and advice that executives can capitalize on. Pfeffer and Salancik (1978) contend that "for proponents of resource dependency, larger boards increase the company's ability to deal with environmental uncertainty and to form links with business partners" (p. 172). Ruigrok *et al.* (2006) argue that if environmental complexity and uncertainty have risen, boards have to deal with higher information-processing demands. They find that one way of meeting this demand is to enlarge the board size. In our context, CPD's concerned with global warming or reduction of GHG emissions, firms need to invest in green technology in order to create long-term economic value through energy savings and improved environmental image. Therefore, carbon pollution control is largely considered a social responsibility (Liao *et al.*, 2015) and the directors' collective decisions (Luo and Tang, 2014). These observations imply that having larger number of directors on a board with diversified directors' knowledge could limit the board's ability to contribute to the strategy development process. This leads us to our second hypothesis.

H2: There is a positive relationship between board size and carbon disclosure score.

3.3 CEO duality

The situation where the CEO is also the chairman of the board is called CEO duality (Ruigrok *et al.*, 2006; Rechner and Dalton, 1991). From an agency perspective (Fama, 1980), CEO duality involves an inherent role conflict for the CEO-chair and enhances the power of the CEO relative to the board. This compromises the board's functions of monitoring and disciplining the CEO (Tang, 2016). Boards of directors are charged with ensuring that CEOs carry out their duties in a way that serves the best interests of shareholders (Finkelstein and

D'aveni, 1994). Duality offers the clear direction of a single leader, and a resulting faster response to external events (Boyd, 1995, p. 301). Proponents of duality also characterise the board chair position as 'being relatively less powerful and more ceremonial and symbolic than the CEO's position' (Harries *et al.*, 1988, p. 214). In a review of the CEO duality literature, Krause *et al.* (2015, p. 268) conclude that "the literature has produced almost no evidence suggesting that CEO duality reduces a board's ability to hold its CEO accountable". The literature also suggests that duality enables the CEOs to pursue their own agenda due to greater power and influence over firm decision-making. However, that power does not reduce their vulnerability to dismissal (Martin *et al.*, 2017). As a key organizational decision maker, CEOs evidently hold greater accountability and take initiative regarding corporate social responsibility policies (Oh *et al.*, 2014). It is also likely that CEO duality increases the CEO's bargaining power (Monem, 2013).

However, agency theory is more critical towards CEO duality (Ruigrok *et al.*, 2006). Their assumptions rely on three issues: first, the CEO-chairman is responsible for organizing board meetings which gives the CEO a significant influence on the meeting agenda and on the information provided to directors (Pearce and Zahra, 1991). Second, duality gives the CEO more influence on the nomination of new directors or executives (Westphal and Zajac, 1995). Third, as companies face increasing environmental instability, the separation of the two roles might be one way to cope with higher information processing demands. Therefore, if a CEO is too powerful it hinders outside directors from opposing and challenging strategic propositions of the CEO (Golden and Zajac, 2001). We, therefore, argue that a strong CEO arising from the CEO duality will have a negative impact on strategic board involvement and we arrive at our third hypothesis.

H3: There is a negative relationship between CEO duality and the carbon disclosure score.

4. Research Design

4.1 Sample and Data

We use CDP's data together with firm characteristics and corporate governance data for 2011 to 2013 for companies by searching the Bloomberg data set. Several previous research studies on the CDP database were completed for the 2007 to 2010 time period. Our sample is extended to the 2011-2013 periods. The total observations for the three year period are 1175 companies. However, based on corporate governance and firm characteristics data availability for the model, our sample includes 331 companies from 10 industry sectors in 33 countries with firms in 12 geographical locations (see Appendix). Table 1 shows the sample size and the sample selection procedures for the study.

Table 1: Sample size and sample selection

Number of firms available in the CDP data set (2011-13)	1175	
Less, Missing data for empirical tests	844	
Total number of firms in the sample	331	
Industry sector	No. of firms	Percentage
Consumer discretionary	50	15.10
Consumer staples	39	11.77
Energy	16	4.83
Financials	52	15.70
Health care	36	10.87
Industrials	39	11.77
Information technology	51	15.40
Telecommunication services	04	1.21
Materials	23	7.00
Utilities	21	6.35
Total	331	100

5. Research Design and Variables

5.1 Model

We test the hypotheses of this study by employing the main regression model as below. Table 2 provides a description/definition of our dependent, independent, and control variables.

$$\text{CDP Score} = \alpha + \beta_1 \text{WOB} + \beta_2 \text{BSIZE} + \beta_3 \text{CEODU} + \beta_4 \text{BOM} + \beta_5 \text{TOBQ} + \beta_6 \text{ROA} + \beta_7 \text{R\&D} + \beta_8 \text{ENGC} + \beta_9 \text{TAS} + \varepsilon$$

Table 2: Description of dependent, independent and control variable and expected sign

Dependent variable		
CDP Score: The company's carbon disclosure score (CDS), measured by Carbon Disclosure project (CDP)		
Independent variables	Sign	Definition
WOB	+	Number of women directors in the board
BSIZE	+	Number of members in the board
CEODU	-	If CEO is the chair of the board of directors
Control variables		
BOM	+	Number of board meetings held during the calendar year
TOBQ	+	Tobin's Q is the total market value of the company based on the year end price and the number of shares outstanding, plus preferred stock, book value of long term debt and current liabilities, divided by the book value of total assets.
ROA	+	Return of asset
R&D	+	Research & development expenditure divided by total asset
ENGC	+	Amount of energy consumed by a particular firm
TAS	+	Natural logarithm of the company's total assets

5. 2 Dependent variable

This study uses the carbon disclosure scores of the Carbon Disclosure Project (CDP) from 2011 to 2013 (inclusive). We have selected the CDP as the base of our sample given the fact that the CDP is an independent non-profit entity that facilitates the collection of emission-related data for institutional investors and they provide data for major global companies. The CDP was formulated in response to institutional shareholder requests for firm-specific greenhouse gas (GHG) information. Each year, CDP asks the top executive managers of the world's largest public companies to disclose information about the risks and opportunities posed by climate change, the strategies being pursued to address them, and company-wide

greenhouse gas emissions. Their questionnaire focuses on how the company is affected by global warming or by the need to reduce its emissions of GHG. The CDP questionnaire covers five sections: Risks and Opportunities, Emissions Accounting, Verification and Trading, Carbon Reduction Performance, and Climate Change Governance (CDP Report, 2013). The disclosure score assesses the completeness and quality of a company's response. Its purpose is to provide a summary of the extent to which companies have answered CDP's questions in a structured format. A high disclosure score signals that a company provided comprehensive information about the measurement and management of its carbon footprint, its climate change strategy and risk management processes and outcomes (CDP Report, 2015). A score (from 0 to 100) is applied to most of the company responses to the CDP, which are assessed for disclosure and performance. On the basis of firm response, the CDP prepares a carbon disclosure score (CDS) which is publicly available.

5.3 Independent and control variables

The main variable of interest of the study is women directors on the board (WOB) and their influence on CDP disclosure. Our sample includes only firms having women's presence on corporate boards to observe their specific effects on CDP disclosure after separating from firms without women director on the board. Therefore, our focus is particularly on the role of women on the board in the climate change disclosure. Since women on the board (WOB) is integral part of the board structure, without the functions of the board women director cannot influence or make a difference in decision making process. The number of female directors and their share among board members are important in this regard to play a role along with other members in the board including the CEO being the chairman of the board. CEO with chairman role attached becomes more powerful than any other board members. Therefore, we have included both board size (BSIZE) and CEO duality (CEODU) as independent variables in the regression model to see whether women directors' role on CDP disclosure is mediated

by other board variables or not. As such hypotheses are developed for these three independent variables in reference to related literature in Section 3.

In regards to control variables, previous studies (Waddock and Graves, 1997; Brammer and Millington, 2009; Bear *et al.*, 2010; Galbreath, 2011; Post *et al.*, 2011; Setó-Pamies, 2015) argue that firm size and profitability, can exert influence on a firm's responsible behaviour. We control firm size (TAS) and profitability (ROA and TOBQ) variables in our study. Firm size is controlled with a measurement of total tangible assets, and is transformed logarithmically due to the positively skewed distribution. The firm's success is explained by its performance over a certain period of time (Bauwhede, 2009). There is evidence that a firm's financial performance strongly influences its level of social responsibility. This is because a firm with higher profits also has more resources to spend on the quantity and quality of carbon disclosure (Brammer and Pavelin, 2006). According to slack resources theory (Waddock and Graves 1997), higher levels of CSR might be driven by better financial conditions such as high profitability. In contrast, Tobin's Q refers to a market value measure of expected long-run firm performance (Bozec *et al.*, 2010). ROA only reflects past corporate performance. However, Tobin's Q has the advantage of reflecting shareholders' share. This makes it easier to compare companies which reflect future profit through an evaluation of investors (Chung and Pruitt, 1994). We, therefore, include this control variable because it is forward-looking and is a reflection of the expectations of the shareholders concerning the firm's future performance (Hutchinson and Gull, 2004) and corporate social accountability. Frequency of board meetings may have an impact on monitoring and strategic decisions about carbon emissions. They also allow more time for directors to confer, set strategy, and monitor management. If firms have fewer board meetings than are necessary, by overemphasizing costs, board meeting frequency will be positively associated with firm value (Vafeas, 1999). Conger *et al.* (1998) also suggest that board meeting time is an important

resource in improving the board's effectiveness. R&D is included as control variable by considering how the R&D fits within the firm's overall activities, and by revealing the firm's strategic vision (Entwistle, 1999). It also reflects the extent of information asymmetry associated with R&D (Aboody and Lev, 2000). We also include ENGC (energy consumption) as a control variable. This is because it is assumed that economic growth depends on energy consumption (Shen and Sun, 2016). The external pressures that are often considered as motivation for firms to adopt environmental management practices (Gualandris and Kalchschmidt, 2014) and in order to comply with regulatory requirements (Jones, 2010) they are grouped into three different institutional isomorphic categories: coercive pressure (Zhu *et al.*, 2007), mimetic pressure (Jorgensen *et al.*, 2010; Liu *et al.*, 2013) and normative pressure (Zhang *et al.*, 2012; Zhang, Wang & Lai, 2015). In addition, in order to balance economic and environmental performance in response to these external pressures, many industrial firms have recognized the importance of being low-carbon and environmentally-proactive by developing and implementing so-called 'green' strategies (Fisher-Vanden and Thorburn, 2011; Gale, 2006).

6. Results and discussion

6.1 Univariate results and discussion

Table 3 presents descriptive statistics of CDP score, corporate governance and financial variables. It can be seen in Table 3 that the average CDP scores are 75.45, indicating high score for the sample firms. The average board size is 12 members, which is relatively high, with maximum of 25 and minimum 5 members. The women on the boards account for an average of 2 members of our sample with maximum 7 and minimum 1 member, which is much higher than the figure of 1 reported by Prado-Lorenze and Garcia-Sanchez (2010) in 2007 CDP data. While CEO duality is 33%, i.e. one-third of the sample firms have CEO-chair duality, the average board meeting is 10 times in a year. In regards to profitability, TOBQ is high while ROA is relatively low at around 7% on average. The R&D mean value is

\$102,722.67 million while total asset is 6,880,000.00 million and the average energy consumption is \$32,976 thousands ton.

Table 3: Descriptive statistics

Variables	Mean	Median	SD	Min	Max
CDP	75.45	80.00	19.14	0.00	100.00
WOB	2.36	2.00	1.18	1.00	7.00
BSIZE	12.41	12.00	3.03	5.00	25.00
CEODU	0.33	0.00	0.47	0.00	1.00
BOM	9.72	8.00	7.03	1.00	12.00
ROA	6.63	5.32	6.47	-24.41	54.72
TOBQ	1.76	1.36	1.17	0.54	10.26
R&D (in million \$)	102722.67	1182.50	874207.83	0.30	14800000.00
ENG (in thousands Ton)	32976.14	3266.34	90513.39	9.39	778758.00
TAS (in Million \$)	6880000.00	91192.00	43200000.00	3248.40	733000000.00

Table 4 provides the correlation matrix. The results of pair-wise correlation for CDP score and all other variables indicate that multicollinearity is not present. This is because the highest significant correlation coefficient is 0.36 between women on board (WOB) and board size (BSIZE). According to the table, BSIZE, WOB, CEODU, and BOM variables have significant positive correlations with the dependent variable CDP score at a 1% level except CEODU which is significant at the 5% level. Since WOB and BSIZE are positively associated with CDP score, it indicates that women on board and board size have positive effects on firms in dealing with environmental issues and/or climate change related-risk and, therefore, participating in the CDP project. However, it is not clear here how CEO duality can positively influence social responsibility. The other two performance characteristics variables, ROA and TOBQ, are negatively correlated with CDP score. It may be the case that carbon emission task is expensive for the sample firms, given that the average ROA is 6.63 in Table 3. Although average TOBQ is at good share (i.e. 1.76) in Table 3, market investors may not response positively to firm's carbon emission activities because of the associated cost issue.

Table 4 Correlation Matrix:

	CDP	BSIZE	WOB	CEODU	ROA	TOBQ	R&D	ENG	Log TAS	BOM
CDP	1.000									
BSIZE	0.095***	1.000								
WOB	0.123***	0.362***	1.000							
CEODU	0.057**	-0.036	0.026	1.000						
ROA	-0.075***	-0.227***	-0.107***	0.016	1.000					
TOBQ	-0.013	-0.232***	-0.077***	0.022	0.743	1.000				
ENG	0.043	-0.010	-0.035	0.075***	-0.089***	-0.175***	1.000			
R&D	0.001	-0.046	0.022	0.035	0.1524***	0.248***	-0.243***	1.000		
Log TAS	-0.039	0.068***	0.034	-0.100***	-0.289***	-0.377***	-0.186***	0.092***	1.000	
BOM	0.119***	0.1352***	0.101***	-0.376	-0.075***	-0.111***	-0.316***	0.049	0.220***	1.000

***Represent significance at the 1% level; ** Represent significance at the 5% level; * Represent significance at the 10% level

6. 2 Multivariate regression results and discussion

The model is estimated using the fixed-effects estimator since OLS generally leads to biased estimates of β (Berkey *et al.*, 1995). Table 5 below presents the regression results in 5 different models where Model 3 and Model 5 are the final models of the study denoting the explanatory power of the model in terms of R^2 and F-statistics. In Model 1, we consider dependent variable CDP and the main variable of interest women on board (WOB) (i.e. CDP Score = $\alpha + \beta_1$ WOB). The results shows positive significant effect of women (WOB) on CDP disclosure, as predicated. In Model 2, we consider CDP and all control variables (i.e. CDP Score = $\alpha + \beta_1$ BOM + β_2 TOBQ + β_3 ROA + β_4 R&D + β_5 ENG + β_6 TAS + ε), which indicates CDP is positive significantly influenced by Tobin's Q (TOBQ) and firm size (TAS) and negatively, though weak, by profitability (ROA). In Models 3, we combine Model 1 and Model 2 to observe the effect of WOB on CDP in the presence of control variables (i.e. CDP Score = $\alpha + \beta_1$ WOB + β_2 BOM + β_3 TOBQ + β_4 ROA + β_5 R&D + β_6 ENG + β_7 TAS + ε). Our results confirm significant positive effect of women (WOB) on CDP disclosure, as reported in Model 1. Therefore, hypothesis 1 (H1) is accepted, based on theoretical directions in Section 2.

Since women on board is integral part of the board, it is important to see their impact on CDP disclosure still exist as the same in the presence of other board members as well as CEO's

dual role as chairman of the board or mediated by other board variables. So, in Models 4, we extend Model 1 by adding board size and CEO duality variables (i.e. $CDP\ Score = \alpha + \beta_1 WOB + \beta_2 BSIZE + \beta_3 CEODU$). The findings remain consistent for WOB showing positive significant effect on CDP disclosure, while contrary to expectation negative significant effect of board size (BSIZE) on CDP and no effect of CEO duality (CEODU) are evident. These results indicate that WOB's role on CDP disclosure is not mediated or influenced by other board variables. Women directors can take stand in favour of CDP independently. However, we find a strong negative significant relationship between board size (BSIZE) and CDP, although following the literature we expected more board members will support more CDP disclosure. The CEO duality (CEODU) also reveals insignificant result, though with negative sign, while we expected that strong CEO in chairman role of the board would restrain CDP disclosure. Thus, hypothesis (H2) and hypothesis 3 (H3) are rejected.

Table 5: Fixed effects regression results

	Model 1	Model 2	Model 3	Model 4	Model 5
Determinant		Coefficient	Coefficient	Coefficient	Coefficient
Constant	67.7362*** (0.7616)	-229.2455*** (74.7298)	-167.2564** (84.3860)	107.8108*** (14.9204)	-80.257 (76.390)
WOB	3.6368*** (1.8944)		2.0868** (1.0211)	3.9862*** (0.6791)	3.0490*** (1.0262)
BSIZE				-16.19*** (5.955)	-14.421* (8.2132)
CEODU				-0.2225 (2.52)	1.4599 (3.6830)
BOM		-1.8384 (3.0255)	-0.0047 (0.1415)		-0.4115 (0.1476)
ROA		-0.2928* (0.1787)	-0.3179* (0.1789)		-0.2717 (0.1731)
TOBQ		9.5193*** (2.1722)	8.7145*** (2.2593)		9.2446*** (2.2706)
ENGC		1.2696 (4.2497)	1.2652 (4.5859)		0.0032*** (0.000)
R&D		-185.9579 (135.8817)	-179.3969 (134.0988)		1.3185 (0.9642)
TAS		24.8940*** (6.3217)	19.924*** (7.6217)		14.755** (6.6439)
	R ² = 0.04; F-statistic: 6.39; P=0.000	R ² = 0.16; F-statistic: 5.81; P = 0.000	R ² = 0.16; F-statistic: 5.68; P=0.000	R ² = 0.05; F-statistic: 6.45; P=0.000	R ² = 0.26; F-statistic: 7.36; p=0.000

***Represent significance at the 1% level; ** Represent significance at the 5% level;

* Represent significance at the 10% level; Standard error is shown in the parenthesis.

Finally, in Model 5, we extend Model 4 by adding all control variables to observe individual effect of each independent variable on CDP. The regression results confirm that WOB has significant positive association with CDP score, which is consistent with the result in the in Models 1, 3 and 4. Thus, H1 is supported, indicating that women in the boardroom increases the voluntary disclosure of climate change-related disclosure in the CDP project, which is consistent with previous studies of CSR or sustainability (Chang *et al.*, 2015; Set-Pamies, 2015; Post, *et al.*, 2011; Prado-Lorenzo and García-Sánchez, 2010; Bear *et al.*, 2010). This result confirms the theoretical arguments that women tend to be economically less self-interested than men (Ibrahim and Angelidis, 1995); and their presence favours problem solving, increases leadership effectiveness, and fosters efficiency in the establishment of global relationships (Adams and Ferreira, 2009; Robinson and Dechant, 1997). This focuses on gender diversity implicit to accounts emphasizing social networks (Westphal and Milton, 2000), Critical Mass Theory (Kramer *et al.*, 2006; Bear *et al.*, 2010) and team dynamics (Woolley *et al.*, 2010; and Hoogendoorn *et al.*, 2013). The spin-off benefits arising from diversity include enhanced monitoring, more incisive decision-making and greater transparency (McGuinness, *et al.*, 2016).

Further, in Model 5 we find a negative but weak significant relationship between CDP and board size (BSIZE), as compared to Model 4. So, H2 is not supported. Jensen (1993) suggests that board size is negatively related to the ability of the board to pursue long term strategic goals. Jensen (1993) also suggests that the board of directors can do their tasks effectively when the board size is not more than seven or eight members. In our study, average size of the board is 12 and due to this reason, board size is negatively associated with CDP score. In order words, it suggests that it is difficult for a large board to co-ordinate and be involved in strategic decision-making (Bonn *et al.*, 2004). Moreover, Lindgreen *et al.* (2010), who found that boards do not have a significant influence on the extent of CSR disclosures. As

climate change related risk decisions involve with firms long term strategic goals, therefore, it is likely that the small size of board is effective in social and environmental strategic decision-making. Firstenberg and Malkiel (1994, p. 34), contend that a small board size of eight or fewer members ‘engenders focus, participation, and genuine interaction and debate’ for directors to advise management on company issues which satisfied under agency perspective (Ong and David, 2008). Again, in Model 5, the CEO duality (CEODU) shows insignificant result though with positive sign against negative sign in Model 4, that is no association with the CDP score as found in Model 4. So H3 is also not supported. This means that CEODU is less prevalent in making decisions on climate change related-risk issues in our sample firms. Taken overall, our results suggest that a woman on board (WOB) has strong positive significant association with CDP disclosure but board size and CEO duality have not.

In regards to control variables in Model 5, it is noted that the coefficient of board meetings (BOM) is not significant, suggesting that there is no direct link between the overall activities of the board and carbon disclosure. This is also supported by Liao *et al.* (2015) who notice that it is true even in the presence of environmental committee. Firm size (TAS) is positive and significant. It is assumed that due to their scale, large firms are more visible, perceived to be more polluting, and thus are more likely to be expected to engage in environmental related reporting (Hackston and Milne, 1996). Results also show that R&D is insignificant. However, ENGC and TOBQ are positively significant at level 1%. The reason for insignificant R&D is that it is neither related to the climate change issue nor has involvement to create or invest in any technology to reduce carbon emissions. It is also interesting that ENGC (energy consumption) is positive and significant with CDP score. This indicates that firms with an energy consumption policy are more concerned with environmental issues and as a result, they are willing to respond to the CDP project. TOBQ is positively significant, meaning that

market-based profitable firms are concerned with climate change-related risks, although accounting-based profitability (ROA) is not significant. However, it does indicate that profitability is a factor in taking any decisions, especially those related to climate and environmental issues.

7. Conclusion

The motivation for this study is to examine how the gender composition (women on board) affect corporate climate change related disclosure. Our paper examines the effect of gender diversity on Carbon Disclosure Project (CDP) score/index, in particular the impact of women on corporate boards (WOB) on carbon emission disclosure (CDP) from a global perspective of 33 countries for the period of 2011-2013. As we mentioned earlier that CDP project has been working since 2000 on climate change risks and opportunities and there are currently 5,500 companies that disclose to CDP covering climate change related disclosure including global warming, greenhouse emissions, water and forest-risk commodities (CDP Report, 2015), therefore, board composition seems to be a major factor which can be assumed to have some influence on both CSR and CSR reporting (Rao and Tilt, 2016) as well as the climate change related risk issue.

We document that woman on board plays a vital role in CDP disclosure. Our study extends current theory, in particular resource dependence theory, by demonstrating that the presence of women on the board has a positive relationship with the CDP score. The strong explanatory power of WOB on CDP disclosure provides evidence of need for gender diversity in corporate boards. Our study is, therefore, unique in identifying the corporate characteristics for addressing the CDP's climate change program. Again, we report that board size (BSIZE) has negative significant effect on CDP while CEO duality (CEODU) has no real effect. In regards to control variables, we find market-based financial performance Tobin's Q (TOBQ), energy consumption (ENGC) and firm size (TAS) appear to have positive

significant effect on CDP disclosure, however, board meetings (BOM), research and development (R&D) and accounting-based profitability (ROA) indicate no explanatory power on CDP.

Our empirical results have certain policy implications that shed light on how to upgrade the response to these issues. Our findings also have important implications for instituting good corporate governance and in particular, gender diversity. The outcome of our analysis advocates that companies that include women directors with a larger board size, may expect to achieve better carbon performance and voluntarily disclose of the level of carbon information requested by the CDP. The study of Luo and Tang (2014) also indicates that good governance performers in the market are more forthright in reporting their commitment to carbon control using the CDP disclosure code. Therefore, our study is relevant to investors and other stakeholders in evaluating the accountability of companies in relation to strategies for managing climate risk. This study also offers policy makers' insights into corporate governance practices in relation to global warming risks and opportunities in order to meet the needs of a low-carbon economy. Because, good corporate governance practices lead to reduced agency costs, and good governance performance is likely to disclose more and distinguish themselves for their investors and other stakeholders (Clarkson *et al.*, 2008; Al-Tuwaijri *et al.*, 2004). In fact, corporate governance mechanisms are usually design to protect both shareholders and stakeholders interests in the firms. Our study supports both resource dependence and stakeholder theories that boards of directors serve as a linking mechanism between companies and their stakeholders, and that they provide legitimacy to different stakeholder groups in the society. The positive impact of gender diversification is significant as having women directors who can enhance critical analysis in board decision making process. Our results contribute to the growing body of literature highlighting the importance

of board diversity and governance variables when considering climate change related risk issue at the firm level.

As with all empirical research, this study is not without limitations. First, the study sample was composed of CDP data which include 10 different industry sectors, though diversity of board may be different by the nature of industry. However, we did not control this industry sector variable. Future research can be expanded to examine women on board against industry nature of the firms, i.e. sensitive industry, for example health care firm, mining etc. Second, we do not consider the effect on CDP scores each year against number of women increases in the board room. Third, due to non-availability of data for large number of countries, we did not classify women directors as independent or non-independent, so further research can be extended by considering directors who may be classified as independent but who are actually affiliated with the firm through prior employment or ongoing business relations.

Note:

In this article, we interchange different terms of climate change related risk such as CSR, social responsibility, carbon emission, GHG and sustainability, which ultimately concretely covers all aspects of climate changes. The same concept is also supported by Prado-Lorenzo and Garcia-Sanchez (2010).

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Appendix:

List of sample companies and their geographical locations

Industry sector	Total	Geographical location							
		Africa - south Africa	America - Latin & Caribbean	America - North and Canada	Asia- Australia and New Zealand	Europe - North & Western	Europe - Eastern	Southern &	
Consumer discretionary	50	1	21	1	14	1	12	0	
Consumer staples	39	0	20		3	1	15	0	
Energy	16	0	7	2	3	1	2	1	
Financials	52	1	10	3	13	5	19	1	
Health care	36	0	25		2	0	9	0	
Industrials	39	0	16	1	10	1	11	0	
Information technology	51	1	23	2	12	0	12	1	
Materials	23	2	7	3	4	1	5	1	
Telecommunication services	04	2	0	0	0	2	0	0	
Utilities	21	3	4	0	6	0	8	0	
Total	331	10	133	12	67	12	93	4	