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Can board environmental orientation improve US firms' carbon performance? The mediating role of carbon strategy

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Abstract

Overwhelming evidence from prior research suggests a positive association between corporate board characteristics and carbon performance; however, very little is known about the mechanisms linking the two variables. This study attempts to fill this gap by developing and empirically testing a conceptual model that highlights the role of carbon strategy in the relationship between board environmental orientation (BEO) and carbon performance. We argue that BEO can directly and indirectly influence carbon performance through carbon strategy. Using structural equation modelling to analyse data consisting of 2,301 US firm-year observations over the 2005-2015 period, we find that the greater the BEO is, the better its carbon performance (i.e., lower greenhouse gas emissions). The results also provide evidence of the mediating effect of carbon strategy on the relationship between BEO and carbon performance. Splitting the sample into high and low carbon-intensive industries shows a partial mediation effect in high carbon-intensive industries and a full mediation effect in low carbon-intensive industries. The findings of the study and its implications for scholars, policy makers, managers, investors and environmentalists are discussed.

Keywords: Board of directors, environmental sustainability orientation, environmental performance, greenhouse gas emissions, carbon strategy, US

1 INTRODUCTION

Over the last decade, firms have witnessed increased public scrutiny of their environmental performance in the pursuit of proactive environmental initiatives and green investments. As carbon performance and disclosure are integral parts of firms' environmental accountability, greenhouse gas (GHG) emissions information is becoming critical in making long-term investments (Vesty, Telgenkamp, & Roscoe, 2015). Sell-side analysts are 'primarily interested' in GHG emissions and their impact on firms' value (Eccles, Serafeim, & Krzus, 2011). Moreover, information about GHG emissions is becoming an essential component of assessing firms' risk profiles, and there is evidence of decreased firm value with increased GHG emissions (Matsumura, Prakash, & Vera-Muñoz, 2014).

The carbon performance of firms has also gained substantial attention due to the pressures exerted on firms by several statutes/initiatives, such as the Global Reporting Initiative and the Carbon Disclosure Project, to address environmental crises. It is reported that high carbon emissions firms can be subject to a penalty of 6.57% of their market capitalisation; however, despite its significance, it is argued that carbon performance and risks may not be fully understood by practitioners (Chapple, Clarkson, & Gold, 2013). Moreover, it is claimed that firms focus more on process-oriented environmental performance (Delmas, Etzion, & Nairn-Birch, 2013) and carbon reduction initiatives (Haque, 2017; Haque & Ntim, 2018) rather than actual environmental/carbon performance, which is probably due to the ease and speed associated with communicating these disclosures to stakeholders to improve the corporate image as a responsible business. Thus, more research is needed to improve our understanding of the carbon performance of a firm, such as its underpinnings and determinants, including the role of corporate boards and their environmental orientation in reducing carbon emissions and other pollution.

The role of corporate boards in environmental performance has become a focal point as a result of the renewed interest in corporate governance after a number of corporate scandals around the turn of the century. Firms can avoid multi-billion dollar losses that can be associated with environmental disasters, such as the BP oil disaster in the Gulf of Mexico in 2010 (approximately $40 billion). It is claimed that the BP oil spill could have been prevented or at least have its consequences minimised if the board had rigorously fulfilled its duties (de Villiers, Naiker, & Van Staden, 2011).

Hence, an increasing body of literature has recently focused on environmental management in an attempt to understand the determinants of environmental performance (Abdel-Maksoud, Kamel, & Elbanna, 2016; Post, Rahman, & McQuillen, 2015). Although the influence of board characteristics on the wider area of environmental performance has been examined in many of these studies (e.g., de Villiers et al., 2011; Dixon-Fowler, Ellstrand, & Johnson, 2017; Ortiz-de-Mandojana & Aragón-Correa, 2015; Shaukat, Qiu, & Trojanowski, 2016), very few have addressed the impact on the more specific area of carbon performance (Haque, 2017), which this study aims to contribute to.

Our knowledge of the impact of firms' carbon strategy on their actual carbon performance is also limited (Matsumura et al., 2014; Yunus, Elijido-Ten, & Abhayawansa, 2016). Moreover, it is believed that "the mechanisms linking board composition to corporate environmental performance, including carbon performance, are not well understood" (Post et al., 2015, p. 423). Although Haque (2017) examined the direct impact of board characteristics on carbon performance, to the best of our knowledge, no studies have examined the mechanisms through which board characteristics influence actual carbon performance. Accordingly, this is another gap that our study attempts to fill by investigating the mediating role of carbon strategy in the relationship between firms' board characteristics related to environmental orientation (hereafter, board environmental orientation (BEO)) and carbon performance. In addition, we investigate the role of carbon strategy based on emissions level, i.e., high versus low carbon-intensive industries.

The study makes a number of contributions to the literature on the relationship between BEO and environmental performance. Our results provide further evidence for policy makers on the link between the environmental orientation of boards and carbon performance. Previous research has focused on the direct link between board characteristics and either environmental performance (e.g., de Villiers et al., 2011; Glass, Cook, & Ingersoll, 2016) or environmental strategy (e.g., Haque, 2017; Shaukat et al., 2016) and the direct link between environmental strategy and environmental performance (e.g., Clarkson, Overell, & Chapple, 2011b; Czerny & Letmathe, 2017; Solovida & Latan, 2017). Our study is the first to examine the role of carbon strategy as a mediating factor on both conceptual and empirical levels. In addition, this study provides the first empirical evidence of the direct link between carbon strategy and carbon performance and provides further support for agency, resource dependence, and legitimacy theories.

The rest of this paper is organised as follows. The next section presents the research background leading to the hypothesis development before discussing the research design in Section 3. Our empirical results are presented in Section 4, followed by their discussion and implications in Section 5. The final section presents the conclusion, limitations, and directions for future research.

2 THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

In response to community pressures and government regulations, firms are encouraged to adopt strategies that lead to enhanced environmental performance and to achieve environmental legitimacy (Berrone & Gomez-Mejia, 2009, Galbreath, 2010). Dealing with GHG emissions has become an integral part of firms' environmental strategy. Firms endeavour to stay off "environmental blacklists" publicised by environmental groups (Matsumura et al., 2014). Furthermore, firms are taking further actions to minimise their carbon footprints, such as adopting new technologies, buying carbon credits, and guiding their suppliers to reduce emissions (Galbreath, 2017). Hence, several studies examined different governance mechanisms, including board characteristics, to develop our understanding of the determinants of environmental performance (Shaukat et al., 2016). In their quest to understand the link between board orientation towards environmental issues and environmental performance, scholars utilised several theories, including agency, resource dependence, and legitimacy theories. The main 'general' thesis of each of these theories is discussed below, leading to the hypothesis development.

According to agency theory, there is a conflict of interest between management's short-term interests and shareholders' long-term interests (Fama & Jensen, 1983; Jensen & Meckling, 1976). This conflict results in agency costs that can be minimised by having an effective board of directors that can monitor the management (Daily, Dalton, & Cannella, 2003; Hillman & Dalziel, 2003; Westphal, 1999). Effective monitoring can be achieved through enquiries about the rationale behind management's strategic directions (McNulty & Pettigrew, 1999). It is argued that board structure is a determinant of its effectiveness in monitoring management and reducing agency costs (de Villiers et al., 2011). For example, in line with the predictions of agency theory, Hillman & Dalziel (2003) find a positive association between a board's effectiveness in monitoring management and independent directors on the board.

Several studies draw on legitimacy theory (Berrone & Gomez-Mejia, 2009; Cho & Patten, 2007; Helfaya & Moussa, 2017; Hummel & Schlick, 2016; Liao, Luo, & Tang, 2015). The theory proposes that firms place significant emphasise on their social and environmental responsibilities towards different stakeholders to establish and improve their legitimacy (Cho & Patten, 2007; Mallin & Michelon, 2011). In addition to adhering to government regulations, firms seek to gain and maintain legitimacy by showcasing their good environmental performance (Bansal & Clelland, 2004). According to Bansal & Clelland (2004), environmental legitimacy could be linked to lower unsystematic risk for a few reasons: meeting institutional expectations (Suchman, 1995), better access to resources (Pfeffer & Salancik, 1978) and less exposure to scrutiny (Meyer & Rowan, 1977). Moreover, organisational legitimacy helps firms avoid negative consequences such as product boycotts (Elsbach, 1994) and enhance their reputations (de Quevedo-Puente, de la Fuente-Sabaté, & Delgado-García, 2007).

Under resource dependence theory, board composition is a critical determinant of firms' performance (Pfeffer & Salancik, 1978). Directors play an essential role in firms using their expertise to provide advice, network with external parties, and access external resources (Mallin & Michelon, 2011; Pfeffer & Salancik, 1978; Wang & Dewhirst, 1992). As a resource, directors play different roles and can accordingly be classified according to the role they play: 'business experts,' 'support specialists,' and 'community influencers' (Hillman et al., 2000). This classification suggests the suitability of specific directors to different environmental settings and has been supported in a number of studies (e.g., Jones, Makri, & Gomez-Mejia, 2008; Kroll, Walters, & Le, 2007). Accordingly, it is suggested that board composition should change as the environment within which the firms operate changes (Boeker & Goodstein, 1991; Peng, 2004).

Our rationale for adopting a multi-theoretical framework emanates from the lack of a comprehensive theory that encompasses all the aspects under investigation in our study. To the best of our knowledge, there is no single theory that can be utilised to explain the relationships among the main variables examined in this research. We argue that the three theories can be conceptually integrated through their focus on the board of directors' functions. Hillman & Dalziel (2003) classify the functions of the board of directors into monitoring management and the provision of resources. The monitoring function is linked to agency theory, whereas the provision of resources is linked to resource dependence and legitimacy theories. Accordingly,

using a multi-theoretical framework in our study provides a better understanding of the role of boards of directors in improving a firm's carbon performance.

2.1. Board environmental orientation and carbon strategy

A firm's carbon strategy is an array of activities intended to manage GHG emissions levels (Weinhofer & Hoffmann, 2010). The link between BEO and carbon strategy, from an agency theory perspective, can be explained by highlighting the agency costs usually associated with the adoption of carbon strategies. Evidence from previous research indicates that the costs associated with the adoption of environmental strategies are usually significant, as these strategies may usually lead to changes in product design and/or the adoption of new manufacturing technologies (Berrone & Gomez-Mejia, 2009). Hence, it takes a long time for the benefits of strong environmental performance to be realised (Aragón-Correa, 1998; Aragón-Correa & Sharma, 2003). Under agency theory, the significance of the required investments and long-term potential of any rewards can be in conflict with the short-term interests of managers. Although there is evidence that management may postpone spending on research and development projects if the return is not attainable in the short term (Lewellen, Loderer, & Martin, 1987), the environmental orientation of the board is expected to be a major factor in whether the board will establish and operationalise a proactive environmental (including carbon) strategy regardless of the potentially significant costs.

Monitoring a firm's environmental strategy (including carbon strategy) is the responsibility of its board of directors (Kassinis & Vafeas, 2002). Effective monitoring by the board can lead to minimising agency costs (Hillman & Dalziel, 2003). Evidence from prior research suggests that BEO is linked to board composition, with potential implications for a firm's environmental strategy. For example, some of the board characteristics examined in prior research include board independence (Shaukat et al., 2016), sustainability-based compensation policy, multiple directorships (Haque, 2017) and gender diversity (Glass et al. 2016; Shaukat et al., 2016).

Board independence is positively associated with a board's vigilance level and its monitoring effectiveness, as implied by agency theory (Hillman & Dalziel, 2003). Johnson & Greening (1999) advocate that, compared to executive members, non-executive members consider the long-term interests of stakeholders. Previous research suggests the existence of a strong association between firms' strategic choices and board vigilance (Hoskisson, Johnson, &

Moesel, 1994; Sanders & Carpenter, 1998). In other words, higher board independence leads to higher board vigilance, which influences firms' strategic choices.

Glass et al. (2016) report a positive link between gender diversity and firms' persuasion of an environmentally friendly strategy. Furthermore, based on the predictions of agency and resource dependence theories, Haque (2017) concludes that board independence and gender diversity have an impact on management's increased focus on carbon reduction initiatives.

An important corporate governance issue is the sustainability incentives scheme. Agency theory suggests that incentive-based mechanisms can motivate managers to work hard and can align the interests of managers and shareholders, which can minimise agency problems and improve performance (see Jensen & Meckling, 1976; Haque, 2017). In this context, firms can use environment-related compensation schemes to motivate management to address environmental concerns such as GHG emissions (Campbell, Johnston, Sefcik, & Soderstrom, 2007; Ji, 2015). For instance, Berrone & Gomez-Mejia (2009) find that CEO pay is positively related to pollution prevention strategies among US firms in polluting industries. In the same vein, Haque (2017) finds a positive association between sustainability-oriented incentive policy and carbon reduction initiatives among UK firms, implying that the adoption of a sustainable compensation policy can encourage management to develop and implement carbon reduction initiatives; however, it is not effective in reducing GHG emissions.

Under resource dependence theory, the board of directors can be considered a resource utilised in managing the business, including corporate social responsibility (CSR)-related challenges (Hillman et al., 2000; Pfeffer, 1972; Pfeffer & Salancik, 1978). Since carbon strategy formulation is one of the main contributions of the board as a resource (Hillman & Dalziel, 2003), formulating an effective carbon strategy is based on having directors with the requisite diverse expertise and a wider stakeholder perspective. Shaukat et al. (2016) report a positive link between a board's CSR orientation, including board gender diversity, independence and financial expertise on the audit committee, and the likelihood of developing a proactive and comprehensive CSR strategy. Financial experts on audit committees are more likely to be better equipped for supporting the board in developing environmental strategies that can help avoid and manage CSR-related financial and regulatory risks and that can budget for long-term environmental initiatives (e.g., Helfaya & Moussa 2017; Shaukat et al., 2016; Lee & Hutchison 2005).

Moreover, resource dependence theory suggests that, when board members hold multiple directorship, it increases the exposure of board members to a broad spectrum of strategic and governance issues of other firms related to environmental practices (de Villiers et al., 2011; Hillman & Dalziel, 2003; Pfeffer & Salancik, 1978). For instance, de Villiers et al. (2011) report that directors with more directorships enhance inter-organisational linkages and the knowledge base about environmental management, which increases managerial ability to adopt proactive environmental strategies and hence improve environmental performance. In contrast, Haque (2017) reports that multiple directorships have a negative relationship with a firm's carbon reduction initiatives, suggesting that busy directors have limited capacity and time to provide useful advice on strategic environmental decisions and to monitor ongoing projects for climate protection initiatives.

Given the above and based on the predictions of both agency and resource dependence theories, we hypothesise that more environmentally oriented boards are expected to have a larger impact on a firm's carbon strategies. Thus, the study's first hypothesis is as follows:

H1. *Board environmental orientation has a direct influence on carbon strategy.*

2.2. Carbon strategy and carbon performance

Previous research seems to focus on the relationship between environmental performance and firm performance, overlooking the role of having a proactive environmental strategy, although it has been reported that firm performance can be enhanced through a sound environmental strategy (Clarkson et al., 2011a; Solovida & Latan, 2017). Clarkson et al. (2011a), for example, report a positive link between environmental and financial performance, which is influenced by a proactive environmental strategy. Under agency theory, effective monitoring of management includes ensuring the establishment of proper strategies that can lead to enhanced carbon performance. As carbon performance is linked to firm value (Matsumura et al., 2014), setting a proactive carbon strategy is an integral part of a successful business strategy.

From an environmental legitimacy standpoint, in response to community pressures, government regulations, and initiatives such as the Carbon Disclosure Project, firms are encouraged to adopt strategies that enhance environmental performance to support their environmental legitimacy (Berrone & Gomez-Mejia, 2009). Moreover, the effectiveness of environmental strategies can be enhanced by adopting a legitimacy-based orientation (Hart,

1995). Enhancing the firm's reputation should reflect positively on its performance. Corporate legitimation strategies can be either proactive, aiming at establishing and enhancing the firm's social acceptance, or reactive, aiming at repairing the firm's legitimacy after an environmental incident, for instance (Cho, 2009; Menguc, Auh, & Ozanne, 2010; Suchman, 1995). Firms are expected to establish proactive carbon strategies geared towards enhancing their carbon performance as part of their efforts to enhance their social acceptance. Shaukat et al. (2016), for instance, report a positive link between CSR strategy and environmental performance. Accordingly, based on the above discussion, our second hypothesis is as follows:

H2. *Carbon strategy has a direct influence on actual carbon performance*.

2.3. Board environmental orientation and carbon performance: Direct and indirect effects

The direct impact of BEO on environmental performance has been addressed in a few studies. In accordance with agency theory, de Villiers et al. (2011) report that firms with more independent directors on the board have better environmental performance. Similarly, few studies report a positive association between corporate social performance and board independence (Jo & Harjoto, 2011; Mallin & Michelon, 2011; Post, Rahman, & Rubow, 2011); others show a positive link with gender diversity (Mallin & Michelon, 2011; Post et al., 2011; Shahab, Ntim, Chengang, Ullah, & Fosu, 2018; Walls, Berrone, & Phan, 2012; Webb, 2004). Moreover, Haque (2017) reports that board independence, board gender diversity and a sustainable compensation policy have a positive association with carbon reduction initiatives, which are a proxy for carbon performance. On the other hand, multiple directorships and CEO duality are reported to have a negative impact on corporate social performance (Mallin & Michelon, 2011).

Drawing upon resource dependence theory, the board of directors can be considered a resource utilised in managing the business, including CSR-related challenges (Hillman et al., 2000; Pfeffer & Salancik, 1978). A proper mix of board members with the requisite diverse expertise and a wider stakeholder perspective is essential in formulating an effective strategy that leads to strong environmental performance (Shaukat et al., 2016). The literature seems to support this view, as many studies report evidence of a positive link between board characteristics

related to environmental issues and both CSR performance (Dixon-Fowler et al., 2017; Mallin & Michelon, 2011; Post et al., 2011; Webb, 2004) and carbon performance (Haque, 2017).

The above discussion highlights a focus in previous research on the 'direct' influence of BEO on environmental and carbon performance. However, the discussion leading to developing our first two hypotheses above claims that BEO has an impact on carbon strategy, which in turn has an impact on carbon performance, suggesting an indirect relationship. Although we are not aware of any study examining the indirect impact of BEO on carbon performance, the discussion provided in this section leads us to posit that the influence of BEO on carbon performance can also be indirect through the strategies set by board. This indirect influence reflects whether, or not, the carbon strategies of a firm, which are influenced by its BEO, are effective in enhancing its carbon performance (i.e., lower GHG emissions). Building on the above, our third and fourth hypotheses are as follows:

H3. *Board environmental orientation directly influences actual carbon performance.*

H4. *Board environmental orientation indirectly influences actual carbon performance through the mediating role of carbon strategy.*

Figure 1 below illustrates the four hypotheses of this study, which are informed by the above three theories. These hypotheses examine the links among BEO, carbon strategy (CS), and carbon performance.

[FIGURE 1 HERE]

3 RESEARCH DESIGN

3.1. Sample selection and data sources

Our sample comprises S&P 500 companies for a period of 11 years (2005-2015). We chose the US for this study because it is the world's second largest carbon emitter after China, and climate-change issues are salient (BP, 2018). We selected this period because the development of national policies focused on measuring, reporting, and managing GHG emissions received greater attention. For example, in 2009, the US Environmental Protection Agency (EPA) introduced a rule mandating the reporting of GHG emissions.

Following related research (e.g., Haque, 2017; Helfaya & Moussa, 2017; Shaukat et al., 2016), this study collected data on firm-level GHG emissions, carbon strategy, and BEO from

Thomson Reuters ASSET4 database, which collects data from several sources (such as sustainability reports, company annual reports and the Carbon Disclosure Project). The ASSET4 database provides largely objective, relevant and systematic environmental, social and governance information, and its quality is scrutinised by experienced analysts. In addition, we collected firm-specific characteristics from the Worldscope database. We then excluded 2,196 firm-year observations due to missing GHG emissions data. We further eliminated 1,058 firm-year observations due to missing specific governance and financial data, resulting in a final sample of 2,301 firm-year observations. Table 1 depicts the industry-and-year-wise distribution of the sample.

[TABLE 1 HERE]

3.2. Variable measurement

Board environmental orientation (BEO). We define BEO as the extent to which the board of directors recognises a firm's environmental issues that matter to stakeholders. Prior studies propose a number of board characteristics that are linked to better environmental performance, including board independence, board gender diversity, financial expertise on audit committees (de Villiers et al., 2011; Mallin & Michelon, 2011; Shaukat et al., 2016), a sustainability-based compensation policy, and multiple directorships (Glass et al., 2016; Haque, 2017; Ji, 2015). To measure board orientation towards CSR issues, the works of Shaukat et al. (2016) and Helfaya & Moussa (2017) were relied on. Helfaya & Moussa (2017), for example, use a construct of three board attributes as an indicator of board CSR orientation: board independence, female board representation, and an audit committee's financial expertise. For the purposes of this study, we develop a multi-dimensional construct to measure the latent construct, i.e., BEO, consisting of five board characteristics. These characteristics are (i) board independence (i.e., % of independent directors), (ii) board gender diversity (i.e., % of female directors on the board), (iii) audit committee's financial expertise (i.e., % of audit committee with financial expertise), (iv) sustainability-based compensation policy (i.e., 1 if the firm adopts a compensation policy linked to environmental sustainability activities and 0 otherwise), and (v) multiple directorships (i.e., the average corporate affiliations of board directors; this is expected to have a negative relationship with the carbon performance of the firm) (see, for example, de Villiers et al., 2011; Haque, 2017; Liao et al., 2015; Mallin & Michelon, 2011; Shaukat et al., 2016). A higher mean score indicates more sustainable and environmentally conducive board attributes.

Carbon strategy. Following prior studies (Haque, 2017; Weinhofer & Hoffmann 2010), carbon strategy was defined as a set of proactive initiatives and policies to reduce firms' GHG emissions. Using the Thomson Reuters ASSET4 database, carbon strategy was measured by an unweighted index including eight variables, as shown in Table 2. A higher carbon strategy score indicates more carbon reduction initiatives and policies implemented by the firm to maintain corporate legitimacy and to positively manage stakeholders' perceptions. The score is stated as a ratio of the total possible score, i.e., 8 (each indicator out of the 8 indicators was coded as 0/1).

Carbon performance. We measured carbon performance using the natural logarithm of total GHG emissions (in tons), which reflects a firm's level of carbon pollution (see, for example, Haque, 2017; Luo, Tang, & Lan, 2013). A lower GHG emissions level indicates better carbon performance by the firm.

Control variables. We controlled for other factors that can influence carbon strategy and/or carbon performance (see their full definitions in Table 2). We control for firm size since the literature shows its significant impact on carbon performance, although the nature of this impact seems inconclusive. For example, some authors argue that large firms, which have a greater impact on communities and are subject to greater public and media scrutiny, are more likely to engage in environmentally friendly activities, including carbon reduction initiatives (de Villiers et al., 2011). Moreover, large firms are more likely to cause greater GHG emissions unless they invest in environmentally friendly technology, which requires massive capital investment (Haque & Ntim, 2018).

We also controlled for firm profitability since prior studies suggest that profitable firms are more likely to have enough resources to be able to be more proactive towards environmental concerns (de Villiers et al., 2011). As proposed by related research (Clarkson et al., 2011a; de Villiers et al., 2011), we controlled for the effect of firm leverage on carbon performance. Haque (2017), for instance, finds that highly leveraged firms show a greater focus on environmental engagement to meet stakeholders' expectations and gain legitimacy.

Since the related literature finds that firms with higher market-to-book ratios are likely to have greater investment opportunities and thus are more willing to pursue sound environmental policies and practices that can improve environmental performance (e.g., de Villiers et al., 2011), the impact of the market-to-book ratio is another variable for which we controlled.

Taking into consideration the findings of related research (e.g., Baboukardos, (2017) that loss-making firms are positively related to GHG emissions, we controlled for the effect of loss. We follow de Villiers et al. (2011), among others, in using capital expenditure as a control variable since firms with a higher capital expenditure are more likely to use eco-friendly technologies, which lead to better carbon performance.

We also controlled for the impact of other governance variables that might influence carbon performance. These variables include block shareholdings (Shaukat et al., 2016), board size (Haque, 2017), CEO-chair duality (de Villiers et al., 2011), and industry type and year (Petersen, 2009). The available literature, such as Shaukat et al. 2016, finds that block shareholders tend to focus mainly on their own interests, which leads to a decline in environment-related activism. However, Haque (2017) finds a positive relationship between ownership concentration and carbon performance, suggesting that block shareholders are likely to promote sustainable environmental policies and practices that can enhance long-term shareholder value. Given that a firm's carbon management requires immense long-term investment without financial gains in the short term, block shareholders might be unwilling to adopt environmentally responsible strategies. Therefore, we expect a positive relation between block shareholdings and the level of GHG emissions.

[TABLE 2 HERE]

3.3. Structural equation modelling

Structural equation modelling (SEM) with maximum likelihood estimation is employed to test the research model. SEM has some advantages that make it a powerful statistical technique, in our case, compared to multiple regression analysis. First, SEM addresses multi-equation regression models and multiple measures of concepts that fit well with our research model. Second, SEM allows all the variables to correlate (inter-correlations), and hence, the cause-effect relationships among variables can be inferred (Bagozzi & Yi, 2012). Finally, SEM simultaneously considers both direct and indirect structural effects between latent variables (Hair, Sarstedt, Ringle, & Mena, 2012).

4 EMPIRICAL RESULTS

4.1. Descriptive statistics and correlations

Figure 2 depicts the mean values of actual GHG emissions trends over the 2005-2015 period for the full sample and both high and low carbon-intensive industries sub-samples. The level of GHG emissions decreased steadily between 2006 and 2012 and increased slightly in 2013 and 2014 before decreasing again in 2015. This result offers evidence that S&P 500 firms have taken a proactive stance to reduce GHG emissions by adopting environmental policies and strategies as well as investing in environmentally friendly technologies. This approach helps firms to demonstrate their response to governmental regulations and thus gain legitimacy as well as maintain their survival and growth. Figure 2 also shows that the average GHG emissions are significantly higher in high carbon-intensive industries than in low carbon-intensive industries (11.89 and 4.92 million metric tons, respectively), which is consistent with the findings of Haque (2017) and Luo & Tang (2014).

[FIGURE 2 HERE]

In addition, Table 3 reports the descriptive statistics of the study variables. The average firm in the sample emits 8.4 million tons of GHG emissions, with a minimum of 0.001 and a maximum of 166 million tons per year. The carbon strategy score ranges from a minimum of 0 to a maximum of 100%, with an average of 44.4%. There is an increasing trend in carbon strategy from 2007 onwards, which can be explained by the argument that US firms still decide voluntarily to adopt environmental strategies and policies. Consequently, there is a real need for a set of rules and regulations to encourage high carbon-intensive firms to take more proactive actions towards reducing their GHG emissions as a contribution to a better society.

Moreover, the mean firm size, which is measured by total assets, is $ 82.50 billion, with a minimum of $ 1.30 billion and a maximum of $ 2573.10 billion. The mean leverage is 26.10%, suggesting that S&P firms depend narrowly on external financing (i.e., they are lowly leveraged). The mean value of profitability in our sample is 9.82%. The mean of block shareholdings is almost 11.78%, with a range of 0% to approximately 81%, suggesting that shares held by block shareholdings vary significantly among the sampled firms. In addition, the mean values for other control variables are capital expenditure 4.62%, market-to-book value 4.13%, and loss-making companies (Loss) 0.06%, suggesting that a few firms reported negative earnings per share during the sample period. Finally, eleven directors, on average,

serve on the boards, with a minimum of five and a maximum of twenty, which is comparable with the findings of Liao et al. (2015).

Table 3 also displays the Pearson's correlations for all the dependent, independent and control variables. Given that the correlations among all the independent variables are relatively low, multicollinearity is less likely to be a problem for our analyses (Gujarati, 2009).

[TABLE 3 HERE]

4.2. Measurement model estimation and fit

Table 4 shows the results of the measurement model for both carbon strategy and BEO. Regarding carbon strategy, it was found that all the indicators were highly significant at the alpha level of 0.001. As shown in Table 4, the carbon strategy construct is satisfactory (GFI, AGFI, CFI and NFI > 0.90 and RMSEA < 0.07), suggesting that the hypothesised measurement model fits the data well. Furthermore, the results of the five BEO indicators of our measurement model are highly significant at the alpha level of 0.001 with the correct direction, except one indicator, i.e., audit committee financial expertise (BEO3 in Table 4), which was excluded from further analysis. Therefore, only four items represent BEO in the final analysis. For all the indicators of BEO, the standardised weights are highly significant and positive. The overall goodness fit indices of our measurement model (GFI, AGFI, CFI and NFI > 0.9 and RMSEA < .07) show a very good fit, and their indicators are within the desirable and acceptable range.

[TABLE 4 HERE]

4.3. Structural model results and hypothesis testing

Table 5 presents the results of the structural model to investigate the research hypotheses. The goodness of fit indices, as shown in Table 5, are well above the recommended values, suggesting that the structural model fits the data well (Bagozzi & Yi, 2012). Using Baron & Kenny's (1986) technique in testing for mediation, the relationships among the three main variables must be tested and satisfy the following four conditions: (1) the independent variable (BEO) significantly influences the dependent variable (carbon performance); (2) the independent variable significantly influences the carbon strategy (mediator); (3) the mediator variable significantly influences the dependent variable; and (4) the impact of the independent variable on the dependent variable must be reduced or must become statistically insignificant

after controlling for the effect of the mediator. If the first three conditions are significant and the relationship between BEO and carbon performance is still significant but reduced, this is called "partially" mediated, but if the relationship between BEO and carbon performance is not significant, the effect of the carbon strategy is called "fully" mediated.

The results of the structural model show that BEO is positively related to carbon strategy (β= *0.201, p-value <0.001*), suggesting that a greater environmental orientation by the board has a greater influence on carbon strategy and hence supports *H1*. We also find that carbon strategy is negatively related to actual GHG emissions, as a proxy for carbon performance (*β= -0.253, p-value<0.001*), implying that *H2* is empirically supported. Furthermore, the results reveal a negative and statistically significant effect of BEO on actual GHG emissions *(β=-0.136, p < 0.001*). This negative direct relationship lends support to *H3*.

Regarding the mediating effects of carbon strategy on the association between BEO and firm performance related to GHG emissions, the indirect results show a significant indirect effect (β= *-0.104, p-value <0.10*). This finding, along with the fact that the direct effect between BEO and actual GHG emissions performance is still significant but decreased, as in the basic model, suggests that BEO directly and indirectly affects a firm's carbon performance via the carbon strategy. The mediation model (with carbon strategy) also explains more variation in carbon performance than the basic model, namely, 61.2% vs 55.8%, respectively. These results offer empirical support for *H4*, suggesting that the relationship between BEO and firm carbon performance is partially mediated by carbon strategy.

[TABLE 5 HERE]

4.4. Additional analysis: High versus low carbon-intensive industries

Although we control for industry effects, the discovered association among the study variables can still vary between industries based on their sensitivity to carbon pollution. Previous studies (e.g., Baboukardos, 2017; Haque, 2017; Jaggi, Allini, Macchioni, & Zagaria, 2018) show a positive relationship between high GHG emissions and specific energy-intensive industries, such as manufacturing, mining, chemicals and basic materials. This study follows, among others, Jaggi et al. (2018) in classifying the whole sample into two categories: high carbon-intensive industries and low carbon-intensive industries. High carbon-intensive industries (N = 1246) include firms belonging to the oil and gas, basic materials, industrials, consumer goods and utilities sectors, whereas low carbon-intensive industries (N = 1055) include firms

belonging to the health care, consumer services, financial, telecommunications and technology industries. We then re-run our models by splitting the full sample into two sub-samples.

The results, as shown in Table 6, show a different image of the role of carbon strategy in high versus low carbon-intensive industries. More specifically, in low carbon-intensive industries, the results (Table 6 - Model 1) document a significant positive relationship between BEO and carbon strategy (*β= 0.304, p-value<0.001*) and a significant negative relationship between carbon strategy and GHG emissions as a proxy for carbon performance (*β= -0.019, p-value<0.001*). More importantly, the full mediation effect of carbon strategy is also evident for low carbon-emissions industries (*β= -0.096, ns*). These results suggest that, in low carbon-intensive industries, the higher the BEO is, the more proactive and comprehensive the firm's carbon strategy, and the better its carbon performance in terms of lower GHG emissions. This evidence suggests that a firm's carbon strategy is a mechanism through which BEO influences its carbon performance.

Regarding high carbon-intensive industries, we find that the direct effect of BEO on carbon strategy (*β= 0.446, p-value<0.001*) is significant. Additionally, the results show a significant and negative direct effect of carbon strategy on actual GHG emissions (β= -0.133, p-value<0.001) as well as a significant effect of carbon strategy on the BEO- GHG emissions relationship (*β= -0.082, p-value<0.05*). These results show that a firm's carbon strategy partially mediates the relationship between BEO and actual carbon performance.

[TABLE 6 HERE]

4.5 Robustness checks

We carry out a number of analyses to ascertain the results' robustness. First, to investigate whether the findings are sensitive to the winsorisation operation (see Haque, 2017; Luo, Lan, & Tang, 2012), we re-run our models by winsorizing all the data at the 1% and 99% levels, and the results (not shown) are similar to those shown in Table 5. Second, we use an alternative measure for actual GHG emissions, which is the carbon intensity. The carbon intensity is measured by the ratio of total GHG emissions to total assets (see Luo & Tang, 2014). The results using this alternative measure (not reported) confirm our previous findings contained in Table 5. Third, we also use market capitalisation as an alternative measure of firm size (e.g., Haque, 2017), and the results (not reported) remained unchanged, suggesting that our evidence is rigorous. Fourth, we re-run our models by replacing carbon strategy with the CSR strategy

score, which is available on the Thomson Reuters ASSET4 database. This index captures firm-level CSR policies and initiatives, with higher scores demonstrating higher firm commitment to CSR activities and more comprehensive and proactive CSR strategies (e.g., Helfaya & Moussa, 2017; Shaukat et al., 2016). The results (not shown) are essentially similar to those presented in Table 5. Finally, to additionally address potential simultaneity concerns, we re-run our results by including a one-year lag of the independent and control variables to allow time for the impact of BEO and carbon strategy to show up in the corporate carbon performance (see, for example, Post et al. 2015). Our results remain qualitatively the same as those reported in Table 5.

5 DISCUSSION

Our results support the hypothesised relationship between BEO and carbon strategy (*H1*), which is in line with the predictions of our multi-theoretical framework that integrates insights from agency, legitimacy and resource dependence theories. One theoretical implication of this finding is that boards with a greater environmental orientation are not only able to be involved in greater managerial monitoring to encourage management to develop and implement carbon reduction initiatives (agency theory) but also can help to signal their congruence with national environmental initiatives and policies (legitimacy theory) and facilitate access to critical resources (resource dependence theory). Additionally, this result is consistent with that of prior research (e.g., Clarkson et al., 2011a; Haque, 2017; Glass et al. 2016; Shaukat et al., 2016), which suggests that firms with greater environmentally oriented boards (i.e., independent directors with the requisite diverse expertise and a wider stakeholder perspective) tend to adopt carbon reduction strategies. One possible explanation for this result is the board's desire to develop a positive corporate image due to their environmental responsibility to legitimise their existence and manage stakeholders' perceptions.

Our results also reveal that carbon strategy has a negative relationship with actual GHG emissions (*H2*). This finding is consistent with the view that a carbon strategy is a key part of a successful business strategy, which in turn improves corporate environmental performance (e.g., Clarkson et al., 2011b; Hart, 1995). This evidence is consistent with the predictions of legitimacy theory in that carbon reduction strategies can mitigate climate-related risks and improve firms' public image and reputation actions, which in turn enhances their

environmental performance. This result is consistent with those reported in previous studies (e.g., Journeault, 2016; Shaukat et al., 2016; Solovida & Latan, 2017), which concluded that carbon reduction initiatives (as part of an environmental strategy) have a positive effect on environmental performance.

Our study shows a negative relationship between BEO and actual GHG emissions *(H3)*. This finding is broadly in line with resource dependence theory in that firms with more environmentally oriented boards can attract human and relational capital resources and thus make positive contributions to society through enhancing firms' long-term sustainability performance. Furthermore, agency theory suggests that the effective monitoring of management, which includes the adoption and implantation of carbon strategies, can enhance firms' carbon performance. This result also offers empirical support for the findings of de Villiers et al. (2011), Dixon-Fowler et al. (2017), Shahab et al. (2018), and Shaukat et al. (2016), suggesting that, as board orientation towards environmental accountability increases, environmental performance appears to improve, which manifests as reduced GHG emissions.

The study results show that carbon strategy partially mediates the relationship between BEO and carbon performance *(H4)*. This result suggests one pathway (i.e., carbon strategy) through which boards of directors may indirectly influence a firm's environmental performance in terms of lower GHG emissions. This result offers empirical support for the findings of related research (e.g., de Villiers et al., 2011; Dixon-Fowler et al., 2017; Post et al., 2015; Shaukat et al., 2016), suggesting that boards with directors who are independent, have diverse expertise and are of diverse gender backgrounds tend to adopt environmentally responsible activities that in turn can lead to sound environmental performance.

Interestingly, splitting our sample into high and low carbon-intensive industries to further examine the role of carbon strategy shows mediation (effects of carbon strategy in both industries). This finding provides support for the suggestion by Solovida & Latans (2017) that the board can promote strategic carbon initiatives as a pathway to strengthen corporate environmental performance. This result also provides empirical support for legitimacy theory, which suggests that firms in high carbon-intensive industries are likely to adopt carbon-emissions strategies and initiatives to gain and maintain corporate legitimacy and avoid public accountability. However, the mediation effects vary in both industries since our results show partial mediation in high carbon-intensive industries and full mediation in low carbon-emissions industries. A possible explanation of the partial mediation in high carbon-sensitive

industries may be due to the role of other factors, such as pressure generated from stakeholders, regulations and/or best practices, in encouraging firms to strengthen their carbon performance.

6 CONCLUSION, IMPLICATIONS AND LIMITATIONS

The study examines the mediating effect that a firm's carbon strategy has on the relationship between its board environmental orientation (BEO) and carbon performance. The investigation is based on data from all S&P 500 firms for the 2005-2015 period. The results provide evidence that a firm's carbon strategy is a mechanism through which the BEO influences its actual carbon performance. A firm's BEO and carbon strategy are important factors in reducing its GHG emissions. Having a board of directors with the proper mix of skills, knowledge and experience leads to developing a proactive carbon strategy, which in turn leads to enhanced carbon performance. These results lend support to agency, resource dependence and legitimacy theories.

On a practical note, this study has a number of implications for managers and policy makers. First, in line with the recommendations of previous studies, it is crucial to enhance firms' BEO through board design to bring diversified monitoring skills and access to resources. Specifically, firms' BEO can be enhanced by having more independent directors, a lower presence of busy directors, and greater representation by female directors. Our findings give more support to calls to increase female representation in the corporate boardroom by introducing gender quotas such as those in the Iceland, Norway and France (Deloitte, 2017).

Second, our findings highlight one mechanism (i.e., carbon strategy) that might explain how corporate boards affect environmental performance in both high and low carbon-incentive industries. Therefore, it is vital for managers to promote strategic carbon-reduction initiatives, which in turn could improve environmental performance and send a positive signal to stakeholders, such as environmental activists, that their firms are seriously concerned about the environment. This evidence also has practical implications for socially responsible investors who believe that more attention should be paid to firms engaging in environmental sustainability initiatives.

Third, as investors are becoming more interested in investing in environmentally friendly firms, our results deliver a clear message to investors about the important role of a proactive carbon

strategy as a mechanism that the board can use to improve carbon performance and potentially increase profitability. Hence, the proactiveness of a firm's carbon strategy should be considered by investors when making investment decisions.

Fourth, the results provide further evidence for policy makers of the link between corporate BEO and environmental performance in general and carbon performance in particular. When developing new regulations, not only should policy makers consider the inclusion of board members with a greater potential for environmentally friendly perspectives but also should consider the role of carbon strategy. Issuing sets of guidelines and rules for firms to develop proactive carbon strategies with relevant emissions reduction targets can lead to enhancing firms' carbon performance and create more environmentally responsible business practices. More initiatives, such as the US' mandatory Regional Greenhouse Gas Initiative are called for, as they have been successful in reducing GHG emissions in the US.

The development of sets of guidelines and rules for firms to develop proactive carbon strategies will lead to a "win-win" strategy instead of the narrow thinking of the traditional "zero-sum game" for climate solutions. Firms win because they can develop clearer visions and relevant strategic objectives to tackle climate change as well as be recognised for their environmental leadership. Investors win because they can allocate their resources with an awareness of carbon-related impacts, and the planet wins because a carbon strategy can encourage green technologies and energy efficiency and can promote eco-friendly business practices.

Our findings also shed light on one of the mechanisms (i.e., carbon strategy) through which board characteristics may affect corporate carbon performance. Future research can build upon this relationship by examining other aspects of firm performance in addition to environmental outcomes. Moreover, the partial mediation of carbon strategy suggests that there may be other strategic initiatives that boards of directors endorse to improve corporate environmental performance. Hence, researchers may investigate other mechanisms, such as environmental alliances, to explain the board attributes-performance relationship.

Nonetheless, our results are subject to some limitations. The scope of our study is limited to all S&P 500 US firms; future research can extend this study by replicating it in other economic areas, such as China, Australia, or the EU. Another limitation is related to the measurement of BEO, which can be criticised for including/excluding certain board attributes from our measure. Additionally, the measurement of board independence does not necessarily reflect

the real level of directors' independence when carrying out their responsibilities (de Villiers et al., 2011). A similar argument can be made for the measurement of audit committee financial expertise. Hence, future research can consider the inclusion of other factors that are not included in the current measure of BEO.

Moreover, since carbon emissions reporting was mainly voluntary in the US until 2009 and then became mandatory, good environmental performers may have reported their good carbon performance, while firms with poor environmental performance masked or did not report their less favourable results (higher levels of GHG emissions). This fact partially raises the issue of a self-reporting bias in the sample because carbon emissions and strategies data may be available only from those companies that voluntarily reported this information. Further research might investigate carbon emissions and strategies under mandatory reporting environments.

Finally, our examination focused on firm GHG emissions and did not consider the supply chain. For example, firms may outsource their most polluting operations to other entities, and accordingly, these are not included in the emissions figures examined in our study. This issue can be addressed in future research.

To conclude, our study shows that a firm's BEO and carbon strategy are important factors in reducing its GHG emissions. Having a board of directors with the proper mix of skills, knowledge and experience leads to developing a proactive carbon strategy, which in turn leads to enhanced carbon performance. These results lend support to agency, resource dependence, and legitimacy theories. The findings also have some important limitations and raise additional questions that researchers need to consider in the future.

REFERENCES

Abdel-Maksoud, A., Kamel, H., & Elbanna, S. (2016). Investigating relationships between stakeholders' pressure, eco-control systems and hotel performance. *International Journal of Hospitality Management*, *59*, 95–104.

Aragón-Correa, J. A. (1998). Strategic proactivity and firm approach to the natural environment. *Academy of Management Journal*, *41*(5), 556–567.

Aragón-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. *Academy of Management Review*, *28*(1), 71–88.

Baboukardos, D. (2017). Market valuation of greenhouse gas emissions under a mandatory reporting regime: Evidence from the UK. *Accounting Forum*, *41*(3), 221–233.

Bagozzi, R. P., & Yi, Y. (2012). Specification, evaluation, and interpretation of structural equation models. *Journal of the Academy of Marketing Science*, *40*(1), 8–34.

Bansal, P., & Clelland, I. (2004). Talking trash: Legitimacy, impression management, and unsystematic risk in the context of the natural environment. *Academy of Management Journal*, *47*(1), 93–103.

Berrone, P., & Gomez-Mejia, L. R. (2009). Environmental performance and executive compensation: An integrated agency-institutional perspective. *Academy of Management Journal*, *52*(1), 103–126.

Boeker, W., & Goodstein, J. (1991). Organizational performance and adaptation: Effects of environment and performance on changes in board composition. *Academy of Management Journal*, *34*(4), 805–826.

BP. (2018). *BP Statistical Review of World Energy*. Retrieved from https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf

Campbell, K., Johnston, D., Sefcik, S. E., & Soderstrom, N. S. (2007). Executive compensation and non-financial risk: An empirical examination. *Journal of Accounting and Public Policy*, *26*(4), 436–462.

Chapple, L., Clarkson, P., & Gold, D. L. (2013). The cost of carbon: Capital market effects of the proposed emission trading scheme (ETS). *Abacus*, *49*(1), 1–33.

Cho, C. H. (2009). Legitimation strategies used in response to environmental disaster: A French case study of Total SA's Erika and AZF incidents. *European Accounting Review*, *18*(1), 33–62.

Cho, C. H., & Patten, D. M. (2007). The role of environmental disclosures as tools of legitimacy: A research note. *Accounting, Organizations and Society*, *32*(7–8), 639–647.

Clarkson, P., Li, Y., Richardson, G., & Vasvari, F. (2011a). Does it really pay to be green? Determinants and consequences of proactive environmental strategies. *Journal of Accounting and Public Policy*, *30*(2), 122–144.

Clarkson, P., Overell, M., & Chapple, L. (2011b). Environmental reporting and its relation to corporate environmental performance. *Abacus*, *47*(1), 27–60.

Czerny, A., & Letmathe, P. (2017). Eco-efficiency: GHG reduction related environmental and economic performance. The case of the companies participating in the EU Emissions Trading Scheme. *Business Strategy and the Environment*, *26*(6), 791–806.

Daily, C. M., Dalton, D. R., & Cannella, A. A. (2003). Corporate governance: Decades of dialogue and data. *Academy of Management Review*, *28*(3), 371–382.

de Quevedo-Puente, E., de la Fuente-Sabaté, J. M., & Delgado-García, J. B. (2007). Corporate social performance and corporate reputation: Two interwoven perspectives. *Corporate Reputation Review*, *10*(1), 60–72.

de Villiers, C., Naiker, V., & Van Staden, C. J. (2011). The effect of board characteristics on firm environmental performance. *Journal of Management*, *37*(6), 1636–1663.

Delmas, M. A., Etzion, D., & Nairn-Birch, N. (2013). Triangulating environmental performance: What do corporate social responsibility ratings really capture? *The Academy of Management Perspectives*, *27*(3), 255–267.

Deloitte. (2017). *Women in the boardroom: a global perspective* (pp. 1–84). Deloitte Center for Corporate Governance London.

Dixon-Fowler, H. R., Ellstrand, A. E., & Johnson, J. L. (2017). The role of board environmental committees in corporate environmental performance. *Journal of Business Ethics*, *140*(3), 423–438.

Eccles, R. G., Serafeim, G., & Krzus, M. P. (2011). Market interest in nonfinancial information. *Journal of Applied Corporate Finance*, *23*(4), 113–127.

Elsbach, K. D. (1994). Managing organizational legitimacy in the California cattle industry: The construction and effectiveness of verbal accounts. *Administrative Science Quarterly*, *39*(1), 57–88.

Fama, E. F., & Jensen, M. C. (1983). Separation of ownership and control. *The Journal of Law and Economics*, *26*(2), 301–325.

Galbreath, J. (2010). Corporate governance practices that address climate change: An exploratory study. *Business Strategy and the Environment*, *19*(5), 335–350.

Galbreath, J. (2017). The impact of board structure on corporate social responsibility: a temporal view. *Business Strategy and the Environment*, *26*(3), 358–370.

Glass, C., Cook, A., & Ingersoll, A. R. (2016). Do women leaders promote sustainability? Analyzing the effect of corporate governance composition on environmental performance. *Business Strategy and the Environment*, *25*(7), 495–511.

Gujarati, D. N. (2009). *Basic econometrics*. New York: McGraw-Hill Education.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, *40*(3), 414–433.

Haque, F. (2017). The effects of board characteristics and sustainable compensation policy on carbon performance of UK firms. *The British Accounting Review*.

Haque, F., & Ntim, C. G. (2018). Environmental policy, sustainable development, governance mechanisms and environmental performance. *Business Strategy and the Environment*, *27*(3), 415–435.

Hart, S. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, *20*(4), 986–1014.

Helfaya, A., & Moussa, T. (2017). Do Board's Corporate Social Responsibility Strategy and Orientation Influence Environmental Sustainability Disclosure? UK Evidence. *Business Strategy and the Environment*, *26*(8), 1061–1077.

Hillman, A. J., Cannella, A. A., & Paetzold, R. L. (2000). The resource dependence role of corporate directors: Strategic adaptation of board composition in response to environmental change. *Journal of Management Studies*, *37*(2), 235–256.

Hillman, A. J., & Dalziel, T. (2003). Boards of directors and firm performance: Integrating agency and resource dependence perspectives. *Academy of Management Review*, *28*(3), 383–396.

Hoskisson, R. E., Johnson, R. A., & Moesel, D. D. (1994). Corporate divestiture intensity in restructuring firms: Effects of governance, strategy, and performance. *Academy of Management Journal*, *37*(5), 1207–1251.

Hummel, K., & Schlick, C. (2016). The relationship between sustainability performance and sustainability disclosure–Reconciling voluntary disclosure theory and legitimacy theory. *Journal of Accounting and Public Policy*, *35*(5), 455–476.

Jaggi, B., Allini, A., Macchioni, R., & Zagaria, C. (2018). The factors motivating voluntary disclosure of carbon information: Evidence based on Italian listed companies. *Organization & Environment*, *31*(2), 178–202.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360.

Ji, Y.-Y. (2015). Top management team pay structure and corporate social performance. *Journal of General Management*, *40*(3), 3–20.

Jo, H., & Harjoto, M. A. (2011). Corporate governance and firm value: The impact of corporate social responsibility. *Journal of Business Ethics*, *103*(3), 351–383.

Johnson, R. A., & Greening, D. W. (1999). The effects of corporate governance and institutional ownership types on corporate social performance. *Academy of Management Journal*, *42*(5), 564–576.

Jones, C. D., Makri, M., & Gomez-Mejia, L. R. (2008). Affiliate directors and perceived risk bearing in publicly traded, family-controlled firms: The case of diversification. *Entrepreneurship Theory and Practice*, *32*(6), 1007–1026.

Journeault, M. (2016). The influence of the eco-control package on environmental and economic performance: A natural resource-based approach. *Journal of Management Accounting Research*, *28*(2), 149–178.

Kassinis, G., & Vafeas, N. (2002). Corporate boards and outside stakeholders as determinants of environmental litigation. *Strategic Management Journal*, *23*(5), 399–415.

Kroll, M., Walters, B. A., & Le, S. A. (2007). The impact of board composition and top management team ownership structure on post-IPO performance in young entrepreneurial firms. *Academy of Management Journal*, *50*(5), 1198–1216.

Lewellen, W., Loderer, C., & Martin, K. (1987). Executive compensation and executive incentive problems: An empirical analysis. *Journal of Accounting and Economics*, *9*(3), 287–310.

Liao, L., Luo, L., & Tang, Q. (2015). Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *The British Accounting Review*, *47*(4), 409–424.

Luo, L., Lan, Y.-C., & Tang, Q. (2012). Corporate incentives to disclose carbon information: Evidence from the CDP Global 500 report. *Journal of International Financial Management & Accounting*, *23*(2), 93–120.

Luo, L., & Tang, Q. (2014). Does voluntary carbon disclosure reflect underlying carbon performance? *Journal of Contemporary Accounting & Economics*, *10*(3), 191–205.

Luo, L., Tang, Q., & Lan, Y. (2013). Comparison of propensity for carbon disclosure between developing and developed countries: A resource constraint perspective. *Accounting Research Journal*, *26*(1), 6–34.

Mallin, C. A., & Michelon, G. (2011). Board reputation attributes and corporate social performance: An empirical investigation of the US best corporate citizens. *Accounting and Business Research*, *41*(2), 119–144.

Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review*, *89*(2), 695–724.

McNulty, T., & Pettigrew, A. (1999). Strategists on the board. *Organization Studies*, *20*(1), 47–74.

Menguc, B., Auh, S., & Ozanne, L. (2010). The interactive effect of internal and external factors on a proactive environmental strategy and its influence on a firm's performance. *Journal of Business Ethics*, *94*(2), 279–298.

Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, *83*(2), 340–363.

Ortiz-de-Mandojana, N., & Aragón-Correa, J. A. (2015). Boards and sustainability: the contingent influence of director interlocks on corporate environmental performance. *Business Strategy and the Environment*, *24*(6), 499–517.

Peng, M. W. (2004). Outside directors and firm performance during institutional transitions. *Strategic Management Journal*, *25*(5), 453–471.

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies*, *22*(1), 435–480.

Pfeffer, J. (1972). Size and composition of corporate boards of directors: The organization and its environment. *Administrative Science Quarterly*, 218–228.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. New York: Harper and Row.

Post, C., Rahman, N., & McQuillen, C. (2015). From board composition to corporate environmental performance through sustainability-themed alliances. *Journal of Business Ethics*, *130*(2), 423–435.

Post, C., Rahman, N., & Rubow, E. (2011). Green governance: Boards of directors' composition and environmental corporate social responsibility. *Business & Society*, *50*(1), 189–223.

Sanders, W. G., & Carpenter, M. A. (1998). Internationalization and firm governance: The roles of CEO compensation, top team composition, and board structure. *Academy of Management Journal*, *41*(2), 158–178.

Shahab, Y., Ntim, C. G., Chengang, Y., Ullah, F., & Fosu, S. (2018). Environmental policy, environmental performance, and financial distress in China: Do top management team characteristics matter? *Business Strategy and the Environment*, *27*(8), 1635–1652.

Shaukat, A., Qiu, Y., & Trojanowski, G. (2016). Board attributes, corporate social responsibility strategy, and corporate environmental and social performance. *Journal of Business Ethics*, *135*(3), 569–585.

Solovida, G. T., & Latan, H. (2017). Linking environmental strategy to environmental performance: Mediation role of environmental management accounting. *Sustainability Accounting, Management and Policy Journal*, *8*(5), 595–619.

Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, *20*(3), 571–610.

Vesty, G. M., Telgenkamp, A., & Roscoe, P. J. (2015). Creating numbers: carbon and capital investment. *Accounting, Auditing & Accountability Journal*, *28*(3), 302–324.

Walls, J. L., Berrone, P., & Phan, P. H. (2012). Corporate governance and environmental performance: Is there really a link? *Strategic Management Journal*, *33*(8), 885–913.

Wang, J., & Dewhirst, H. D. (1992). Boards of directors and stakeholder orientation. *Journal of Business Ethics*, *11*(2), 115–123.

Webb, E. (2004). An examination of socially responsible firms' board structure. *Journal of Management and Governance*, *8*(3), 255–277.

Weinhofer, G., & Hoffmann, V. H. (2010). Mitigating climate change–how do corporate strategies differ? *Business Strategy and the Environment*, *19*(2), 77–89.

Westphal, J. D. (1999). Collaboration in the boardroom: Behavioral and performance consequences of CEO-board social ties. *Academy of Management Journal*, *42*(1), 7–24.

Yunus, S., Elijido-Ten, E., & Abhayawansa, S. (2016). Determinants of carbon management strategy adoption: Evidence from Australia's top 200 publicly listed firms. *Managerial Auditing Journal*, *31*(2), 156–179.

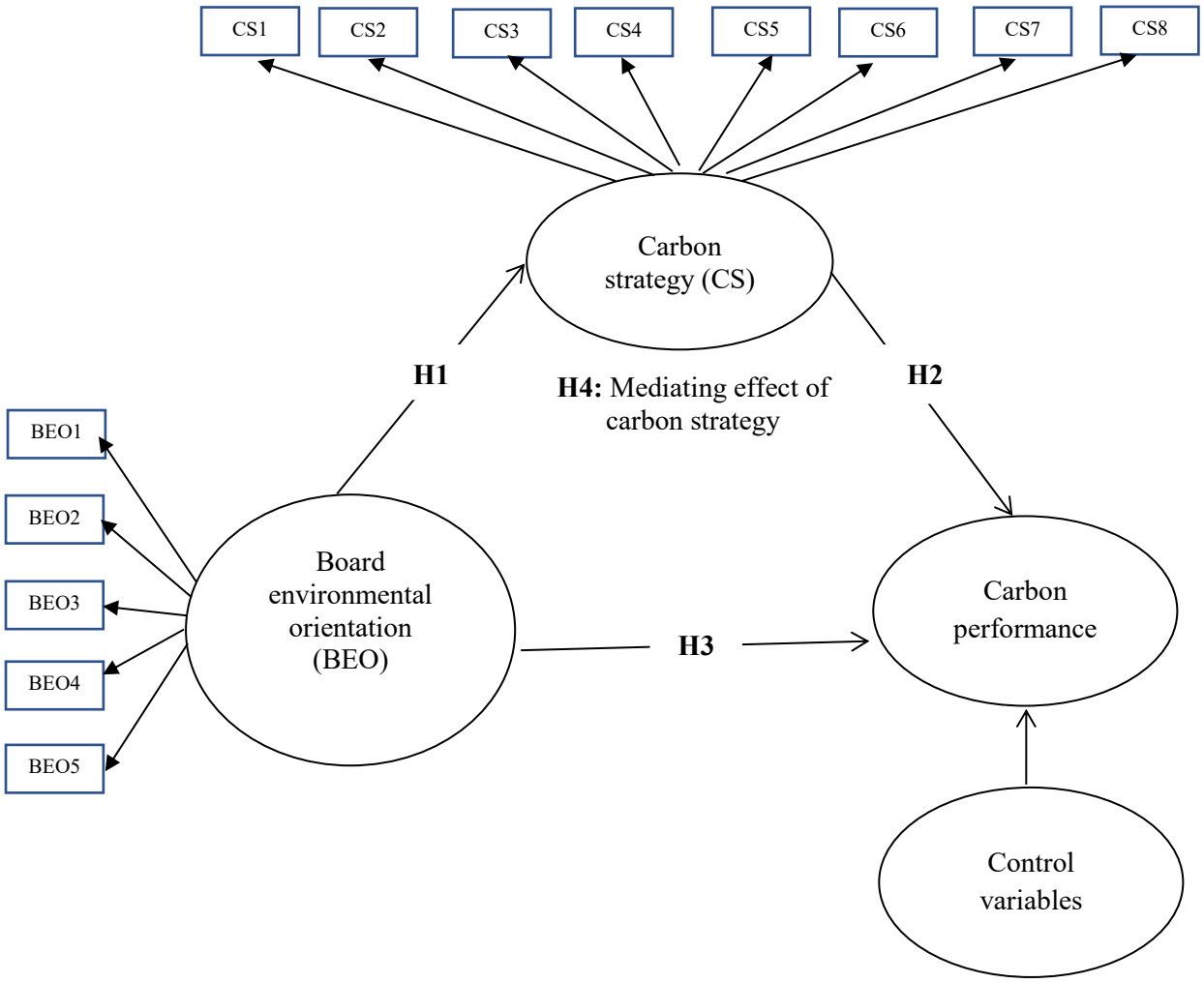

Figure 1. Conceptual model of research

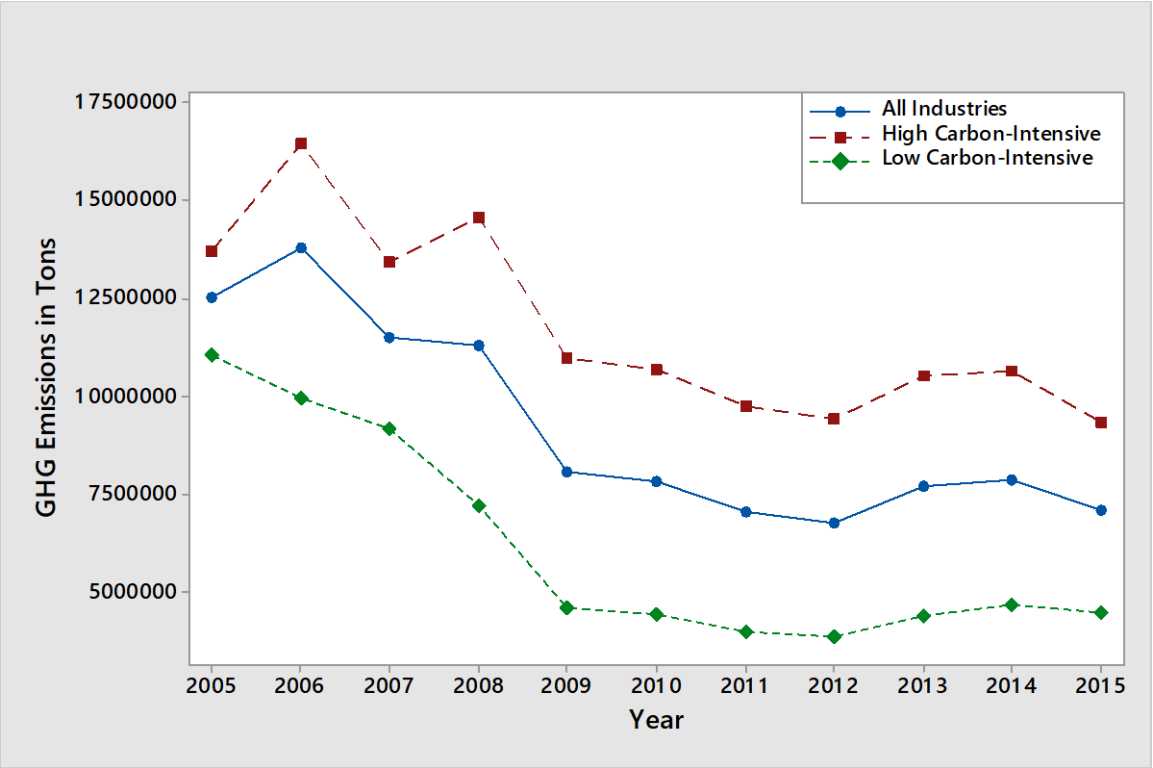

Figure 2. Year-wise distribution of GHG emissions

Table 1: Distribution of sample companies across years and industries

Industry	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Percent
Oil and gas	8	7	9	13	18	15	19	23	20	21	19	**172**	**7.5**
Basic materials	7	8	8	9	15	15	17	19	17	15	12	**142**	**6.1**
Industrials	14	17	25	27	37	39	43	44	37	36	37	**356**	**15.5**
Consumer goods	11	12	15	28	34	39	41	41	39	36	35	**331**	**14.4**
Health care	10	11	11	13	20	21	25	24	21	22	20	**198**	**8.6**
Consumer services	4	6	10	17	28	32	32	33	31	28	30	**251**	**10.9**
Telecommunications	1	1	1	1	2	3	3	3	2	3	3	**23**	**1.0**
Utilities	8	17	15	22	26	28	27	28	26	25	23	**245**	**10.6**
Financials	8	14	13	17	34	38	44	47	37	36	33	**321**	**14**
Technology	9	10	14	19	28	31	36	33	30	28	24	**262**	**11.4**
Total	**80**	**103**	**121**	**166**	**242**	**261**	**287**	**295**	**260**	**250**	**236**	**2301**	**100.0**

Table 2: Variable definition and measurement

Variable	Measurement
Carbon performance	Natural log of total greenhouse gas (GHG) emissions in tones
Carbon strategy	A set of policies and initiatives to manage the effects of firms' activities on climate change that is related to whether the firms did any of the following (each item was coded as 0/1): – participate in any emissions trading initiative (CS1) – reduce, reuse, recycle, substitute, phase out or compensate for CO2 equivalents in the production process? (CS2) – evaluate the commercial risks and/or opportunities related to climate change (CS3) – recycle, reduce, reuse or phase out fluorinated gases such as HFCs (hydrofluorocarbons), PFCs (perfluorocarbons) or SF6 (sulphur hexafluoride) (CS4) – recycle, reduce, reuse or replace ozone-depleting (CFC-11 equivalents, chlorofluorocarbon) substances (CS5) – make use of renewable energy (CS6) – improve their energy efficiency (CS7) – reduce, reuse, substitute or phase out toxic chemicals or substances (CS8).
Board environmental orientation	A composite measure consisting of five elements regarding board attitudes towards the environment and climate change: board independence (BEO1), board gender diversity (BEO2), financial expertise on audit committee (BEO3), sustainability-based compensation policy (BEO4), and multiple directorships (BEO5).
Firm size	Natural log of total assets.
Leverage	Percentage of total debt to total assets.
Profitability	Return on Assets
Capital expenditure	Percentage of firm capital expenditure to total assets.
Market-to-book ratio	The ratio of market to book value of equity.
Loss	A dummy variable that equals 1 if EPS is negative and 0 otherwise.
Block shareholdings	Percentage of strategic shareholdings (when 5% or more) that are not available to ordinary investors.
Board size	Natural log of the number of directors serving on the board.
CEO-chair duality	A dummy variable that equals 1 if the chief executive officer (CEO) is serving as board chair and 0 otherwise.
Industry	Dummies, representing ten industries, based on the Industry Classification Benchmark.
Year	Dummies for each of the eleven years from 2005 to 2015 inclusive.

Table 3: Descriptive statistics and Pearson's correlation matrix for all variables

	1	2	3	4	5	6	7	8	9	10	11	12
Mean	8.40	44.40	64.10	82.50	26.10	9.82	4.62	4.13	0.06	11.78	11.47	0.78
Std. Dev.	21.50	22.14	11.88	257.40	15.02	9.41	4.15	28.23	0.24	11.04	2.03	0.41
Min.	0.00	0.00	25.60	1.30	0.00	-148.37	0.00	-232.79	0.00	0.00	5.00	0.00
Max.	166	100	89.50	2573.10	83.87	53.71	36.60	905.18	1.00	81.00	20.00	1.00
1. GHG emissions (in million metric tons)	1											
2. Carbon strategy (%)	-0.40***	1										
3. Board environmental orientation (%)	-0.28***	0.19***	1									
4. Firm size ($billion)	0.30***	0.21***	0.12***	1								
5. Leverage (%)	0.23***	0.07***	0.05***	-0.06***	1							
6. Profitability (%)	-0.09***	0.05**	-0.03	-0.24***	-0.15***	1						
7. Capital expenditure (%)	-0.47***	0.08***	0.15***	-0.10***	0.10***	-0.07***	1					
8. Market-to-book ratio	-0.03	0.01	0.01	-0.04	0.03	0.08***	-0.02	1				
9. Loss	0.03	-0.02	-0.05**	0.02	0.08***	-0.43***	0.09***	-0.01	1			
10. Block shareholdings (%)	0.09***	-0.12***	-0.14***	-0.25***	0.11***	-0.02	-0.02	0.01	0.06***	1		
11. Board size	0.20***	0.16***	0.06***	0.39***	0.03	-0.07***	-0.06***	0.01	-0.03	-0.01	1	
12. CEO-chair duality	0.07***	0.02	0.01	0.06***	0.01	-0.01	0.06***	-0.01	-0.02	-0.13***	0.07***	1

*Note: * significant at the 0.05 level, ** significant at the 0.01 level, and *** significant at the 0.001 level. All variables with full definitions are presented in Table 2.*

Table 4: Construct indicators and measurement model of carbon strategy and BEO

Constructs and Items		Standardised weights	Goodness of fit indicators		Acceptable standard fit
Carbon strategy (CS)	CS1	0.432***	GFI	0.997	>0.90
	CS2	0.288***	AGFI	0.990	>0.90
	CS3	0.383***	CFI	0.989	>0.90
	CS4	0.456***	NFI	0.982	>0.90
	CS5	0.329***	RMSEA	0.026	<0.07
	CS6	0.242***			
	CS7	0.346***			
	CS8	0.615***			
Board environmental orientation (BEO)	BEO1	0.346***	GFI	1.00	>0.90
	BEO2	0.237***	AGFI	1.00	>0.90
	BEO3	0.019	CFI	1.00	>0.90
	BEO4	0.290***	NFI	0.997	>0.90
	BEO5	0.392***	RMSEA	0.000	<0.07

*Note: * significant at the 0.05 level, ** significant at the 0.01 level, and *** significant at the 0.001 level.*

Table 5: Results of structural equation models

Hypothesis	Description of path	Basic model	Mediation model
H1	Board environmental orientation → Carbon strategy		0.201***
H2	Carbon strategy→ GHG emissions		-0.253**
H3	Board environmental orientation → GHG emissions	-0.136***	
H4	Board environmental orientation → Carbon strategy→ GHG emissions		-0.104*
	Control variables		
	Firm size	0.349***	0.316***
	Leverage	0.176***	0.162***
	Profitability	-0.016	-0.030*
	Capital expenditure	-0.365***	-0.346***
	Market-to-book ratio	-0.016	-0.015
	Loss	0.010	0.022
	Block shareholdings	0.022	0.035**
	Board size	0.065***	0.032**
	CEO-chair duality	0.026*	0.029*
	Year dummies	-0.117***	-0.178***
	Industry dummies	-0.348***	-0.334***
	R2	*55.8*	*61.2*
	Goodness-of-fit indices		
	GFI	*0.999*	*0.998*
	AGFI	*0.992*	*0.992*
	CFI	*0.999*	*0.999*
	NFI	*0.996*	*0.995*
	RMSEA	*0.015*	*0.011*

*Notes: - * significant at the 0.05 level, ** significant at 0.01 level, and *** significant at 0.001 level.*
- Goodness-of-Fit Index (GFI); Adjusted Goodness of Fit Index (AGFI); Comparative Fit Index (CFI); Normed Fit Index (NFI); Root Mean Square Residual (RMSEA).

Table 6: Additional analysis: High versus low carbon-intensive industries

Description of path	Low carbon-intensive industries	High carbon-intensive industries	Z statistics
	Model (1)	**Model (2)**	
Board environmental orientation → Carbon strategy	0.304***	0.446***	-0.1849*
Carbon strategy→ GHG emissions	-0.019***	-0.037***	1.336
Board environmental orientation → GHG emissions	-0.102***	-0.133***	1.098
Board environmental orientation → Carbon strategy→ GHG emissions	-0.096	-0.082**	-1.592*
Control variables			
Firm size	0.494***	1.149***	-9.476***
Leverage	0.005***	0.011***	-2.719***
Profitability	-0.051	-0.026	-0.395
Capital expenditure	-0.113***	-0.063***	-6.377***
Market-to-book ratio	-0.009	-0.007	-0.017
Loss	0.019	0.013	0.641
Block shareholdings	0.006***	0.002***	2.358**
Board size	0.206	0.199	0.019
CEO-chair duality	0.016	0.105**	-1.759*
Year dummies	-0.043***	-0.078***	2.822***
Industry dummies	-0.105***	-0.136***	-8.967***
R2	*48.5*	*51.3*	
Goodness-of-fit indices			
GFI	*0.990*	*0.994*	
AGFI	*0.981*	*0.984*	
CFI	*0.982*	*0.986*	
NFI	*0.972*	*0.979*	
RMSEA	*0.027*	*0.029*	

*Note: - * significant at the 0.05 level, ** significant at 0.01 level, and *** significant at 0.001 level.*
- Goodness-of-Fit Index (GFI); Adjusted Goodness of Fit Index (AGFI); Comparative Fit Index (CFI); Normed Fit Index (NFI); Root Mean Square Residual (RMSEA)