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Modeling board governance, environmental expertise, and social engagement effects on firm environmental performance: Panel data evidence

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ABSTRACT

Prior research establishes that board governance quality measures positively impact firm environmental performance. In this study, we propose an empirical model using structural equation modeling (SEM) to explore additional enhancements to board governance, namely board environmental expertise (BEE) and board social engagement (BSE) and show that they incrementally improve firm environmental performance (EN). Our proposed latent construct measure, BEE, goes beyond traditionally dichotomous measures used in the literature. BEE has a total effect on firm environmental performance that is over two thirds the size of effects arising from traditional governance quality measures (GOV). The second enhancement of our model is the focus on BSE, a novel construct to the CSR literature. In addition to possessing environmental knowledge enabling expertise, we demonstrate that a board with a deeper commitment to society will further improve firm environmental performance. Using SEM, we find that the indirect effects of GOV, BEE, and BSE on EN represent a substantial portion of the total effects on EN. Hence, ignoring these indirect effects would result in substantial understatement of the effects of improvements to governance on environmental performance.

Introduction

There is a strong sentiment among academics and the business community that the board of directors should be more involved in the firm's corporate social responsibility (CSR) activities (e.g., Hung, 2011; Jo and Harjoto, 2011; Shaukat et al., 2016).[1] In a survey conducted by the Massachusetts Institute of Technology and the Boston Consulting Group, 86 per cent of respondents said that "boards should play a strong role in their company's sustainability efforts" (Kiron et al., 2017). Nevertheless, board engagement in CSR is not common. In the same survey, only 30 per cent of respondents said their boards strongly oversaw their firms' sustainability activities.

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[1] See, for example, "Sustainability and the board: What do directors need to know in 2018?" by Deloitte (2018) available at https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Risk/gx-sustainability-and-the-board.pdf.

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Prior research establishes that board governance quality measures positively impact firm environmental performance. We explore additional enhancements to board governance, namely board environmental expertise and board social engagement, and show that they incrementally impact firm environmental performance as measured by ASSET4 environmental performance scores.[2] We explore these incremental impacts using structural equation modeling (SEM) and develop a board governance quality measure (GOV) that reflects traditional governance quality drivers. Using SEM, we find that a one standard deviation increase in GOV leads to a 16.4% increase in the average ASSET4 environmental performance score.

SEM offers a major advantage over traditional multiple regression approaches used by archival researchers to address our research question. The research results in the extant literature that address the importance of board environmental expertise for firm environmental performance have been mixed. This is due in part to the reliance in prior studies on dichotomous measures intended to capture board environmental expertise. In sharp contrast, we borrow from behavioral research and use confirmatory factor analysis to build a measure of board environmental expertise and other latent constructs explored in our study. To quote Farrar & Guo (2018), "regression models are unable to provide separate estimates of relations between latent constructs and their indicators. Conversely, SEM can be used to assess the psychometric properties of the measures of latent constructs, and subsequently study the relations among latent constructs." By using SEM's latent construct measurement approach, a key innovation in our paper is that we develop richer measures of the construct board environmental expertise as well as the new construct we introduce, board social engagement. In doing so, SEM allows us to reduce measurement errors in the independent variables we explore. SEM has other advantages described in later sections, including permitting path analysis, and addressing endogeneity.[3]

The first enhancement to board governance we focus on is board environmental expertise. Our proposed latent construct measure, Board Environmental Expertise (BEE), goes beyond traditionally dichotomous measures used in prior literature and captures the breadth and depth of the director's environmental expertise using multiple attributes. Our first finding is that BEE has a total effect on firm environmental performance that is over two thirds the size of effects arising from traditional governance quality drivers. We find that a one standard deviation increase in BEE leads to an increase of 11.2% in the average ASSET4 environmental performance score. Such effects are incremental to the total effects attributable to GOV. Hence, while environmental expertise acquisition at the board level can co-occur with traditional governance quality enhancements, a substantial incremental effect exists because of having board expertise and would not be enjoyed regardless of the quality of traditional governance measures in place.

The second enhancement to board governance is board social engagement (BSE), a construct which is new to the CSR literature. We posit that, in addition to possessing environmental knowledge enabling expertise, a board with a deeper commitment to society (i.e., higher intrinsic motivation) will further improve firm environmental performance. We look to the governance literature in applied psychology and organizational behavior to provide the conceptual underpinnings for measuring our BSE latent construct. A one standard deviation increase in BSE leads to an increase of 6.9% in the average ASSET4 environmental performance score. Such effects are incremental to the total effects attributable to GOV and would not be enjoyed regardless of the quality of traditional governance measures in place. Finally, in addition to the direct effects we report for BSE on EN, we observe a substantial indirect effect of BSE on EN via BEE (over 30% of total effect for BSE reported in our paper). The latter is clear evidence of the improvement that a socially engaged board provides both directly and indirectly through environmental expertise to overall firm level environmental performance.

The importance of appropriately modeling these factors is motivated by Endrikat et al. (2020) who conduct a meta-analysis of prior studies that investigate the relationships between board characteristics and CSR performance. Based on their findings of both direct and indirect effects of governance on CSR performance, they suggest the "need for future studies to use more complex models that acknowledge these joint effects." Based on theory, we develop a comprehensive governance model that includes traditional board quality measures, BEE, BSE, a CSR Committee, and a Chief Sustainability Officer (CSO). Using SEM, we establish that the indirect effects of GOV, BEE, and BSE on EN represent a substantial portion (25.1%, 9.9% and 31.4%, respectively) of the total effects of these predictor variables on EN. Hence, ignoring these indirect effects would result in substantial understatement of the effects of improvements to governance on environmental performance.

Finally, BEE, BSE and the existence of a CSR committee are endogenous choices based on the governance quality (GOV) that is in place and each co-determine EN. Given the presence of this endogeneity, the use of SEM is advantageous because all paths are simultaneously estimated.

Overall, our results point to a substantive role for board environmental expertise and board social engagement as a means of enhancing firm environmental performance. The remainder of the paper proceeds as follows. The next section contains our literature review, followed by a section discussing our hypothesis development. It is followed by the description of our model's development, measurement, and validation. Next, we discuss the empirical results. Finally, we present our conclusions.

[2] Social performance is multifaceted and addresses a wide range of constructs (including diversity, community, product, and employment quality), whereas environmental performance is a standalone construct within professional rating services such as ASSET4 and KLD data (e.g. see Jo and Harjoto 2011). We leave it to further studies to measure sustainability expertise more broadly and focus solely on environmental expertise in this study.

[3] As a caveat, SEM establishes empirical associations between dependent and predictor variables in the empirical model. It does not prove the existence of causal relationships.

Literature review

The role of corporate governance in enhancing firm environmental performance

Two major views explain managers' incentives for improved CSR engagement in the literature. Agency theory suggests that managers' commitment to CSR engagement can be motivated by the self-interest of managers who may use CSR to manipulate impressions for personal benefit (Tsang et al. 2023). This view is closely aligned with Friedman's (1970) view that firms should prioritize shareholders' interests over that of the stakeholders, also known as the shareholder expense view. Given agency theory, traditional drivers of governance quality and the governance enhancements we focus on, BEE and BSE would not be expected to improve firm environmental performance as the board's role is to curb agency costs. In contrast, the stakeholder value maximization view suggests that a firm's CSR engagement can play a positive role in firm value maximization. Given this view, one which is motivated by Freeman's (1984) stakeholder theory, CSR can contribute to firm performance through its favorable influence on a firm's relationship with important stakeholders, thereby improving firm reputation, customer and employee satisfaction, etc. (Radhakrishnan et al. 2018).[4]

According to Jo and Harjoto (2012, p. 54), "Freeman's (1984) stakeholder theory states that firms should use CSR as an extension of effective corporate governance mechanisms to resolve conflicts between managers and non-investing stakeholders." The authors hypothesize that, if stakeholder theory is valid, firms with better governance will be more likely to pursue CSR activities. The authors employ a number of traditional corporate governance mechanisms, including percentage of independent board members and percentage of institutional shareholding, and show that their one-year lagged corporate governance measures are associated with the number of CSR strengths, as assessed by KLD.

Board environmental expertise on firm environmental performance

As noted above, the results pertaining to the importance of board environmental expertise on firm environmental performance have been mixed. Homroy and Slechten (2019) define a director as having environmental experience (EED) if the director had a previous job whose description included environmental keywords, served on other firm's board subcommittees with an environmental focus or won awards for environmental issues. As such, their measure of director expertise is a dichotomous indicator variable. They find that the presence of EEDs on the board is associated with lower greenhouse gas emissions.

Rodrigue et al. (2013) examine the impact of board environmental expertise on firm environmental performance, measured using one-period-ahead KLD concerns for environmental problems. Using an indicator variable, they define a director to be "environmentally aware" if that person has experience in environmental organizations or experience in a peer industry company (i.e., experience in an industry with the same first two digits of the SIC code as the focal firm). Similar to Homroy and Slechten (2019), their measure of director expertise is dichotomous. Their results show there is no association between board awareness (i.e., board environmental expertise) and firm environmental performance.

Another study that explores the relation between director environmental expertise and firm environmental performance is Dixon-Fowler et al. (2017). They observe no association between the existence of director environmental expertise on the firm's board environmental committee and firm environmental performance.[5] Dixon-Fowler et al. (2017) measure director environmental expertise through "stakeholder representation" on the environmental committee (similar to our CSR committee). They define a "stakeholder director" as someone who has been employed in an environmental government agency or NGO, who holds or held directorships in such organizations, or who is an academic or a scientist working in environmental disciplines. Like the above two studies, their measure of director environmental expertise is also dichotomous.[6]

Following Homroy and Slechten (2019) and Rodrigue et al. (2013), we measure director environmental expertise at the board level. This approach is different from Dixon-Fowler et al. (2017) who measure expertise at the level of a committee reporting to the board.

In summary, the empirical results regarding the effect of director environmental expertise on firm environmental performance are mixed. Rodrigue et al. (2013) and Dixon-Fowler et al. (2017) show no relation exists, whereas Homroy and Slechten (2019) document a positive relation. We try to address this empirical dilemma by constructing an improved measure of director environmental expertise. Our proposed latent construct measure, Board Environmental Expertise (BEE), goes beyond traditionally dichotomous measures used in the literature and captures the breadth and depth of the director's environmental expertise using multiple attributes.

[4] For a comprehensive review of the stakeholder theory literature, see Parmar et al. (2010).

[5] Dixon-Fowler et al. (2017) observe that the existence of a board environmental committee enhances firm environmental performance (measured by the number of KLD strengths) and that the presence of a sustainability manager (like a CSO) enhances that mapping.

[6] We recognize that the term "stakeholder representation" is used by Dixon-Fowler et al. (2017) to capture not only expertise but also the stakeholder orientation of the director, a term used by Hillman et al. (2001), who also measure "stakeholder representation." However, expertise is at least one of the attributes reflected by Dixon-Fowler et al.'s (2017) measure, as indicated by the following quote from their study: (p. 429) "We expect environmental stakeholder directors on board environmental committees to provide specialized environmental knowledge and expertise, which will influence corporate environmental policy and strategic decision making.".

Board social engagement on firm environmental performance

Prior research shows that motivation complements expertise. Leblanc and Gillies (2005) argue that director competence, a key factor of director effectiveness, depends on their knowledge and skills (i.e., expertise) as well as their motivation. In addition to knowledge (i.e., expertise), Libby and Luft (1993) model motivation as one of the key ingredients to expert performance. According to the psychology literature, motivation can take extrinsic and intrinsic forms (see Cerasoli et al., 2014). While intrinsic motivation and extrinsic incentives jointly predict performance, we focus on the intrinsic motivation of directors, or in the aggregate, that of the board, because extrinsic motivation (i.e., monetary rewards) is likely to be similar in the large firms that we study.

We posit that, in addition to possessing environmental knowledge enabling expertise, a board with a deeper commitment to society (i.e., higher intrinsic motivation) will further improve firm environmental performance. Empathy is a key component of "social commitment" as explored in the emotional intelligence literature (e.g., Boyatzis and Sala, 2004; Goleman, 1997; Goleman et al., 2001). As defined by (Goleman, 1997, p. 285), "empathy involves taking another person's perspective . . . [which] leads to caring, altruism and compassion." Supporting the view, studies show that more empathic people tend to volunteer more, donate more to charity, and are more likely to help others in need and to do so for altruistic reasons (e.g., Davis, 1983; Konrath et al., 2016). Hence, we introduce to the CSR literature a novel measure of board social commitment that reflects director's motivation to act, which we term Board Social Engagement (BSE). Examples capturing a director's motivation to act include the affiliation of individual board members with non-governmental and public purpose-oriented organizations, such as medical, public service, and university affiliations.

We assert that directors with greater social engagement are more likely to respond to the needs of diverse firm stakeholders who value environmental performance (Dyck et al., 2019). Beyond having environmental expertise, boards must also want to deploy their expertise, and that expertise is amplified for boards with higher social engagement. To our knowledge, we are the first in the CSR literature to explore the consequences of BSE, our latent variable measuring board social commitment, on firm environmental performance.

Building on stakeholder theory, survey work in the CSR literature has measured a construct, "concern for stakeholders," which is close to what we term as a director's social engagement. Wang and Dewhirst (1992) observe that directors with a higher stakeholder orientation are more likely to have a concern for stakeholders. Hung (2011) observes that various director attributes explain a director's concern for stakeholders, including the director's perceived importance of the direction-setting, guardian, social-networking, and social-participation roles of directors.

Hillman et al. (2001) explore, for a sample of 250 S&P 500 firms, the impact of "stakeholder directors" on firm environmental performance (measured by a composite measure of KLD strengths). In their study, the term "stakeholder director" refers to the willingness of a director to represent the interests of specific stakeholders (suppliers, employees, customers and communities). Hillman et al. (2001) argue that stakeholder directors enhance the resource dependence role of directors, by representing the interests of various stakeholder groups. They assert that, consistent with stakeholder theory, overall good relations with stakeholders will benefit shareholders. They define a director as having a stakeholder orientation if the director is a customer, a supplier, or is a community representative.[7] However, the Hillman et al. (2001) stakeholder director construct is narrower than our construct. Social engagement can arise through multiple means without a single director being an all-or-nothing "stakeholder" director. Board social engagement conceptualizes that all directors will vary in their social engagement and our construct represents the intrinsic motivation of a particular board member to act on environmental concerns.

It is widely accepted that directors' social relationships "affect how both individual directors and the board as a whole function" (Johnson et al., 2013, p. 243). Johnson et al. (2013) divides social capital into several types, of which directors' "ties to other organizations" and "personal relationships and affiliations" are the most relevant to our construct of board social engagement. We posit that the board's social engagement encompasses a combination of ties to other organizations and personal relationships and affiliations. Both are important factors providing motivation for the organization to realize the potential of its environmental expertise and organizational abilities.

When transferred to the organizational milieu, group social engagement can be seen entailing an in-depth understanding of societal and communal set-ups, environments, problems, struggles, norms, and cultures in which the organization operates (Druskat and Wolff, 2001). Indeed, Druskat and Wolff (2001) suggest that "emotionally intelligent groups recognize they are part of a larger social system and work to develop contacts and relationships that can facilitate their effectiveness." Hence, we develop a comprehensive measure of board social engagement, conceptualizing it as a key factor that motivates directors to ensure that the board's environmental expertise and formal mechanisms, such as the existence of a CSR committee and the appointment of a CSO, improve environmental performance. We assert that directors with greater social engagement are likely to be motivated to respond to the needs of (i.e., show more empathy toward) firm stakeholders.

In summary, we argue that to be effective at improving corporate environmental performance, directors must have requisite environmental expertise and the motivation to employ that board level expertise for the firm's diverse stakeholders.

[7] Hillman et al. (2001, p. 308) observe that adding stakeholder directors has no significant effect on environmental performance.

Hypothesis development

In the environmental performance area, a strong positive relationship has been found between board governance quality and environmental/CSR performance (e.g., Johnson and Greening, 1999; Jo and Harjoto, 2012). Hence, the basis for our examination of board environmental expertise and board social engagement starts with replicating that our board governance quality measure (GOV), which reflects traditional governance quality drivers, will affect firm environmental performance. We then extend this to testing whether board environmental expertise and board social engagement will incrementally affect overall firm environmental performance.[8] Adopting stakeholder theory, as described above, we hypothesize the following:

H1a: A firm with higher board governance quality will have higher firm environmental performance, ceteris paribus.

H1b: A firm with higher board governance quality will have higher board environmental expertise, ceteris paribus.

H1c: A firm with higher board governance quality will have higher board social engagement, ceteris paribus.

Expertise aids directors in performing their duties (Fama and Jensen, 1983). Directors use their expertise to advise and monitor the firm's management, for the purpose of "overseeing the long-term investment strategy of the firm" (Klein, 1998). Therefore, we expect having environmental expertise on the board will impact the firm's environmental performance through better advice and monitoring. A board with environmental experts among its members (compared to another without any such experts) can better advise management to choose environmental projects that can produce the best outcome for a given amount of investment. Moreover, a board with environmental expertise will better monitor the chosen environmental capital project and thus improve the outcome.[9] These arguments lead us to the following hypothesis: (stated in the alternate form).

H2: A firm with higher board environmental expertise will have higher firm environmental performance, ceteris paribus.

As asserted in Dixon-Fowler et al. (2017), it is plausible to assume that having a dedicated board-level CSR committee conveys that the board is actively engaged in the firms' environmental strategies.[10] Hence the basic proposition again is that better board governance will be associated with the creation of a board level CSR committee (e.g., see Michelon and Parbonetti, 2012 for evidence). Therefore, we posit that a dedicated CSR committee amplifies a board's environmental expertise. These arguments lead us to the following hypotheses, which can be tested within our SEM model and are stated in the alternate form.

H3a: A firm with a higher board governance quality is more likely to have a CSR/environmental board committee, ceteris paribus.

H3b: A firm with higher board environmental expertise is more likely to have a CSR/environmental board committee, ceteris paribus.

H3c: A firm with a CSR/environmental board committee will have higher environmental performance, ceteris paribus.

Supporting the existence of complementarity between BSE, BEE, and CSR Committee, we posit that BSE has indirect effects on environmental performance via BEE and CSR Committee. Boards with an overall set of socially embedded and empathetic directors are more likely to ensure that the required level of board environmental expertise is in place and that a board CSR Committee exists. Such indirect effects reinforce the positive direct effects of having higher board social engagement. These arguments lead us to the following hypotheses, which can also be tested within our SEM model and are stated in the alternate form.

H4a: A firm with higher board social engagement will have higher firm environmental performance, ceteris paribus.

H4b: A firm with higher board social engagement will have higher board environmental expertise, ceteris paribus.

H4c: A firm with higher board social engagement is more likely to have a CSR/environmental board committee, ceteris paribus.

We examine whether the existence of a management-appointed chief sustainability officer (CSO) leads to improved environmental/CSR performance, as the CSR literature contends (e.g., Miller and Serafeim 2015). As the appointment of a CSO is a management decision, we control for the possibility that board governance, board environmental expertise, and board social engagement will lead to a greater likelihood of management appointing a CSO, but we do not state this as a formal hypothesis as this is not a board decision. In contrast it is the Board's prerogative to set up a committee structure that emphasizes

[8] Throughout this paper, the term board governance quality, denoted by GOV, reflects the effects of traditional governance quality drivers and such traditional drivers do not include any measures that are conceptually related to board environmental expertise or board social engagement, the drivers which are the focus of this study.

[9] Consistent with the arguments of Dyck et al. (2019), we argue that better environmental performance, achieved through better advising and monitoring by the board will bring more net surplus to the firms' stakeholders and improve firm value in the long run. However, investigating this relation is outside the scope of this study.

[10] Dixon-Fowler et al., (2017) measure the existence of a board environmental committee, whereas we measure the existence of a dedicated board-level CSR committee. We assume that multi-functioning committees, such as CSR committees, have, as one of their mandates, responsibility regarding environmental issues. Our study differs from the work of Dixon-Fowler et al., (2017) in that we focus on the environmental expertise of boards, rather than CSR committees.

matters that it wants oversight on such as CSR/environmental performance, leading to the creation of a CSR committee. These arguments lead us to the following hypothesis, which can also be tested within our SEM model and is stated in the alternate form.

H5: A firm with a CSO will have better firm environmental performance, ceteris paribus.

Fig. 1 Panel A shows the overall conceptual model (i.e., the basis for our SEM's structural model) that we test. We show the hypothesized paths (in bold) and controlled for paths in unbolded lines.

Research design

Testing our structural model using SEM

SEM consists of two components: a measurement model and a path model (Hinson and Utke, 2021). The measurement model uses confirmatory factor analysis to build measures of our three latent constructs in Fig. 1 (i.e., GOV, BEE, BSE). The path model tests hypothesized relationships between the latent and observed predictor variables and our dependent variable, EN. In Fig. 1, GOV is assumed to be an exogeneous latent construct whereas BEE and BSE are endogenous latent constructs (see: Gefen et al., 2000 for a discussion of latent constructs and SEM methodology). Further, CSR committee is an observed endogenous variable. We posit that BEE, BSE and the existence of a CSR committee are endogenous choices given the governance quality (GOV) that is in place and co-determine EN. Given the presence of this endogeneity, the use of SEM is advantageous because all paths are simultaneously estimated rather than one at a time (Gefen et al., 2000).

In the section that follows, we describe our measurement model which uses confirmatory factor analysis to build measures of our three latent constructs. We then describe the results of our hypothesis testing using our Path Model.[11]

Developing our measurement model

To test the hypotheses in our structural model we need to further specify the measurement model that underlies it, validate the measures in that model, and validate the overall measurement model as a prelude to such tests. Hence, we need to measure three main latent variables—board governance quality (GOV), board environmental expertise (BEE), and board social engagement (BSE), two observed variables (CSR Committee and CSO) as well as control variables. We discuss below how we develop and validate the three latent variables including the observed indicator variables that are inputs into the construction of those latent variables.[12] In addition, we describe how we measure our observed variables and our control variables.

Sample

Our sample consists of a balanced panel of 600 firms over the six years from 2010 through 2015, totaling 3,600 observations. We begin our sample construction using S&P 1500 firms. Among them, we retain only firms that have no missing variables during the six-year period.[13] This allows us to compare, across the sample, the evolution of the relationship over time without the confounding effects of firms' entering and leaving the sample. An alternative approach would be to impute averages for the missing values, but, given the presence of a large number of missing values for many potential firms in the S&P 1500 where data is available, the inferences drawn from data with excessive imputed averages would likely be misleading in ways that cannot be predicted. Hence, we use the panel of data with a complete set of measures.

Measure construction and data collection

Measure construction has its roots in Churchill's (1979) model.[14] There are three phases involved in developing a robust measure of a latent construct. First is item development that identifies the potential set of indicator variables of the latent construct. We rely on prior research to identify potential items for inclusion. Second is measure refinement which subjects the potential indicators to exploratory factor analysis on a sample (i.e., 2012 data as one of six years). Third is measure validation where independent samples that are different from those that created the variables are used to assess its measurement characteristics (i.e., rest of data by year and pooled across years). Hence, we initially develop our latent construct using 2012 and confirm the construct properties across the other five years, individually and pooled. In addition, we follow the suggestions

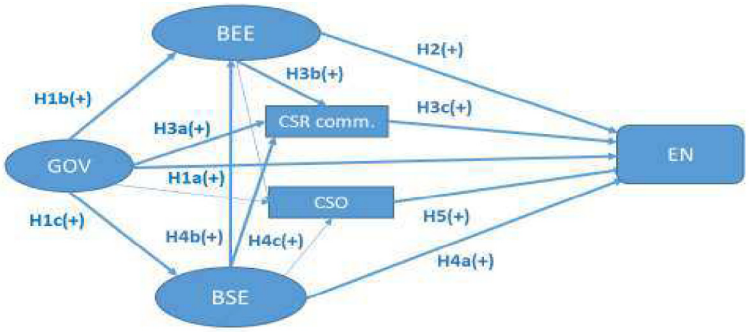
[11] To implement SEM, we use IBM SPSS Amos.

[12] Note that the use of the term indicator variable in this section means an observed measured variable that can either be continuous or dichotomous.

[13] Berg et al. (2021) find that after ASSET4's acquisition by Refinitiv, frequent and repeated changes to the historical ESG score of Refinitiv can be observed. To reduce the concern that retroactive changes to ESG scores could impact our findings, we use original ASSET4 data ending in 2015 that is directly from Thomson Reuters (prior to the acquisition by Refinitiv) in conducting all empirical analyses.

[14] The authors have a research note (available on request from the authors) that discusses the application of Churchill model in this context. That note provides more detail on our measure development approach including our measure validity tests.

Panel A: Hypothesized Relationships and Controls



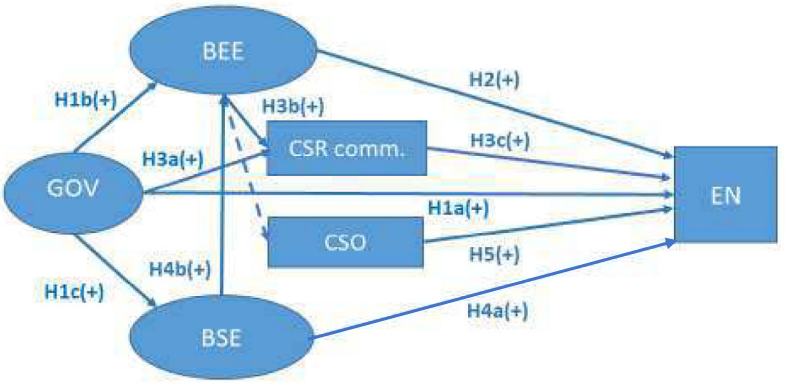
Legend:

Measured indicator | Latent variable | Observed variable

Hypothesized relationships

Controlled for relationships

Panel B: Results of Hypotheses tests



Legend: Results supporting hypotheses are denoted

$p<0.01$

Controlled for but not hypothesized ($p<0.0001$)

Lack of line indicates non-significant path

Note: Model variables are described in Appendix A.

Fig. 1. The Structural Model Note: Model variables are described in Appendix A.

in scale development and validation in the CSR survey research (e.g. Öberseder et al., 2014) to the extent such approaches can be generalized to archival data.

Board governance quality (GOV)

To select candidate items for inclusion in our board governance proxy, we follow the literature by initially considering six items that have been shown to correlate with strong governance (Larcker and Tayan, 2021). Board independence, which denotes the proportion of independent directors (Zahra et al., 1993); board size (de Villiers et al., 2011); female director on the board, which equals to 1 if there is at least one female director (Lu and Herremans, 2019; Post et al., 2011); majority voting standards (Kassinis and Vafeas, 2006); an indicator variable board chair/CEO duality (Dyck et al., 2019); and institutional ownership (Dyck et al., 2019), measured as a percentage of outstanding shares owned by institutional investors. See Appendix B.

We subject these six traditional governance drivers (i.e., our candidate items for inclusion into the latent variable GOV) to an exploratory factor analysis using the data for a randomly selected year (2012) from our six years of data. We obtain board independence, board size, Chair/CEO duality, and female director from BoardEx. Data sources for majority voting standards

and institutional ownership are ISS RiskMetrics and Thomson-Reuters Institutional (13F) Holdings database, respectively. This led us to identify the following set of indicators for GOV (bolded items are those that are in the final measure):

- Board Chair/CEO duality
- Board independence
- Board size (log)
- Female director on the board
- Institutional ownership percentage
- Majority voting standards

Using confirmatory factor analysis, we find that the four bolded variables consistently load onto the same latent variable in the other five years of data, by year and when pooled across years. Table 2 Panel A shows the factor loadings for the above four items and Fig. 2 shows the four indicators composing the latent construct GOV. The latent variable extracts 44.7% of the variance.[15] While this is relatively low for an established measure it is consistent with the difficulty in defining how to measure governance quality (e.g., Dey, 2008; Gompers et al., 2003).

Board environmental expertise (BEE)

Environmental knowledge or expertise is a multi-dimensional construct that can be acquired in a variety of ways. Geiger et al. (2019) suggest that knowledge can be gained through instruction (i.e., education), task specific experience (i.e., working in a domain), or general domain experience (i.e., through overseeing others that are performing the task or being part of organizations whose mandate relates to the task), and is reinforced by multiple opportunities to do these activities (Bonner and Walker, 1994; Libby and Luft, 1993; Tan and Libby, 1997). Consistent with the operationalization of expertise based on the accounting literature (Tan and Libby, 1997), we seek archival measures that reflect the breadth and depth of experience of individual board members. We also consider prior research in the area (e.g., Dixon-Fowler et al., 2017; Homroy & Slechten, 2019; Rodrigue et al., 2013) for items they consider. Based on this analysis we developed nine potential indicators of the latent construct of Board Environmental Expertise (BEE). Using the environmental knowledge framework of Geiger et al. (2019), we identify the following set of indicators for BEE at the individual director level (bolded items are those that are in the final measure):

General domain knowledge about environmental issues

a. Number of board-level CSR committees served
b. Total cumulative years of experience on all board-level CSR committees
c. Number of environmental non-profit affiliations

Task specific knowledge about environmental issues

d. Number of boards served in environmentally sensitive industry firms
e. Total cumulative years of board experience at environmentally sensitive industry firms
f. Number of environmental regulatory (governmental) agency appointments
g. Number of CEO positions at environmentally sensitive industry firms

Formal education related to environmental matters

h. PhD
i. Law degree

We use BoardEx as our primary data source, supplemented by various other data sources, including proxy statements downloaded from the SEC EDGAR, and environmental regulatory agency websites to collect this data. The three bolded attributes are measured at the firm-director-year level. For these items, we count only experiences from firms other than the focal (i.e., sample) firm in our calculation of expertise, as we want to focus on the ability of the firm to improve its board's performance and hence focus on exogenous sources of director experience and expertise. To capture (h) and (i), we use indicator variables. Since these three board member attributes are unlikely to change during directors' tenure, we measure them at the director level.

[15] The note to Table 2 contains additional information about support for a reliable measure.

Table 1
Descriptive statistics.

Panel A: Summary

Variables	N	Mean	Std. Dev.	Min	p25	Median	p75	Max
GOV	3600	0	1	−4.495	−0.47	0.203	0.71	2.726
BEE	3600	0	1	−1.539	−0.772	−0.162	0.607	4.63
BSE	3600	0	1	−2.03	−0.709	−0.135	0.584	6.728
EN	3600	0.547	0.318	0.081	0.213	0.589	0.87	0.954
FIRMSIZE	3600	9.237	1.454	5.822	8.191	9.015	10.095	14.761
FIRMAGE	3600	36.585	18.007	5	20	32	53	66
ROA	3600	0.058	0.074	−1.227	0.023	0.054	0.093	0.361

Panel B: Pearson/Spearman correlations for dependent, predictor and control variables

Variable	Mean	Std. Dev.	GOV	BEE	BSE	CSRCom	CSO	EN	FirmSize	FirmAge	ROA
GOV	0	1	1.000	0.305***	0.392***	0.217***	0.196***	0.412***	0.551***	0.339***	−0.101***
BEE	0	1	0.266***	1.000	0.279***	0.216***	0.148***	0.355***	0.256***	0.307***	−0.018
BSE	0	1	0.378***	0.263***	1.000	0.131***	0.148***	0.344***	0.463***	0.252***	−0.051***
CSRCom	0.134	0.341	0.196***	0.224***	0.131***	1.000	0.153***	0.228***	0.172***	0.203***	−0.034**
CSO	0.11	0.313	0.175***	0.150***	0.159***	0.153***	1.000	0.305***	0.242***	0.194***	−0.004
EN	0.547	0.318	0.381***	0.329***	0.329***	0.236***	0.299***	1.000	0.373***	0.334***	0.115***
FirmSize	9.237	1.454	0.500***	0.247***	0.504***	0.156***	0.244***	0.366***	1.000	0.297***	−0.314***
FirmAge	36.585	18.007	0.345***	0.316***	0.268***	0.213***	0.201***	0.345***	0.280***	1.000	−0.044***
ROA	0.058	0.074	−0.079***	−0.075***	−0.020	−0.056***	0.000	0.059***	−0.195***	−0.044***	1.000

Note: See Appendix A for variable descriptions. As latent variables, by construction, GOV, BEE, and BSE are mean centered with a standard deviation of 1. ***, **, * denote two-tailed significance at 1%, 5%, and 10% levels, respectively.

Table 2
Latent variables descriptive statistics.

Panel A: Board Governance Quality (GOV)

Factor (see Appendix B for underlying variable measures)	**Average Factor Loading (see Note)**	**Standardized Coefficient Pooled Sample**
Board independence	0.680	0.431
Board size (log)	0.743	0.397
Female director on the board	0.690	0.477
Majority voting standards	0.549	0.707
Average % Variance Extracted for Four Factor GOV over six years	44.79%	

Panel B: Board Environmental Expertise (BEE)

Factor (excluding the focal firm; see Appendix C for underlying variable measure)	**Average Factor Loading (see Note)**	**Standardized Coefficient Pooled Sample**
Average Number of CSR committees that directors served on	0.829	0.637
Average years of experience on Board level CSR committees	0.728	0.521
Average Number of environmentally sensitive industry firms' boards that directors served on	0.852	0.658
Proportion of Board with service on environmentally sensitive industry firms' boards	0.834	0.715
Average % Variance Extracted for Four Factor BEE over six years	65.96%	

Panel C: Board Social Engagement (BSE)

Factor (excluding the focal firm; see Appendix D for underlying variable measures)	**Average Factor Loading (see Note)**	**Standardized Coefficient Pooled Sample**
Average number of government affiliations per director	0.632	0.494
Average number of university affiliations per director	0.767	0.659
Average number of other non-profit affiliations per director	0.801	0.712
Average number of awards per director	0.688	0.609
Proportion of board with government affiliations	0.622	0.478
Proportion of board with university affiliations	0.721	0.604
Proportion of board with medical affiliations	0.409	0.377
Proportion of board with other non-profit affiliations	0.752	0.650
Proportion of board of receiving awards	0.716	0.704
Average % Variance Extracted for Nine Factor BSE over six years	47.26%	

Note - Factor loadings: Stevens (1992) suggests using a cut-off of 0.4, irrespective of sample size, for interpretative purposes, which we meet in for all indicators. Tabachnick and Fidell (2007) follow Comrey and Lee, 1992 in suggesting using more stringent cut-offs going from 0.32 (*poor*), 0.45 (*fair*), 0.55 (*good*), 0.63 (*very good*) or 0.71 (*excellent*). By these interpretations all our loadings are in the very good to excellent range with three exceptions: Majority voting standards (in the fair to good range), Proportion of board with government affiliations (in the good range to very good), and Proportion of board with medical affiliations (in the poor to fair range). Sensitivity analysis was performed excluding Proportion of board with medical affiliations and the results are statistically and substantively the same.

Fig. 2

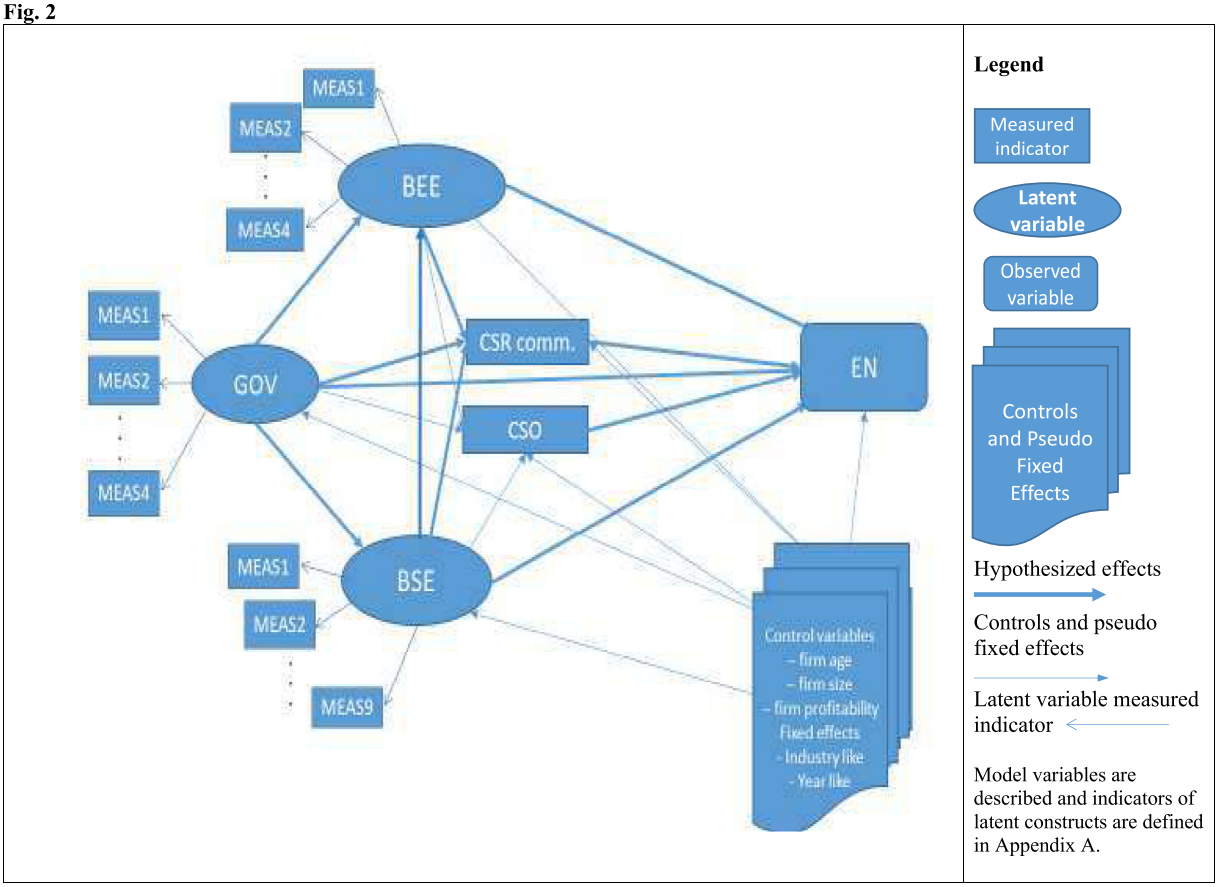


Fig. 2. Mixed SEM Measurement Model Estimated.

To calculate (a) and (b), directors' board-level CSR committee experience, we first manually identify board CSR committees from BoardEx, using the Board and Director Committees file.[16] We then obtain the committee appointment date (either as a committee chair or as a member, whichever comes first) from the same file for each director's board committee memberships. From this dataset, we calculate the number of current or past board committees served on and the cumulative years of service outside the focal firm. We compute these items using the exact date of the appointment to the committee and the focal firm's fiscal year end date (i.e., record date) to avoid bias that leads to overestimation.

To measure (d), (e), and (g), board experience or CEO experience in environmentally sensitive industries, we use three BoardEx datasets: Director Characteristics, Board Characteristics, and Company Profile Details. We only count board experience at North American public firms.[17] We use the industry classification proposed by Barth et al. (2005): of the 22 industries, those whose average industry KLD environmental concern score is above the median (i.e., top 11) are defined as environmentally sensitive.[18] As we did above, we quantify director tenure using the effective date of appointment to the board and the focal firm's fiscal year-end date.

We quantify director tenure using the effective date of appointment to the board and the focal firm's fiscal year-end date. For CEO experience, we follow Kim et al. (2020) and include co-CEOs but exclude interim CEO positions. We compute item

[16] The BoardEx (North American) Board and Director Committees file contains all board committee membership of 11,517 unique North American firms at the firm-year-director level, with meaningful coverage beginning in fiscal year 2000. The file we used contains 1,839 unique committee names. We manually review the committee names and identify 210 of them as CSR committees. Since board *environmental* committees are rare, we consider all CSR committees, except those that focus only on *social* mandates. We include committees that have a dual function if they seem to have CSR oversight roles. Using this method, we find that 820 unique firms (7.1% of the BoardEx universe) have a CSR committee on the board at any point in time.

[17] Because our BoardEx datasets primarily contain North American firms, we could be missing some experience at foreign firms. This could result in attenuation bias and underestimate the board's true environmental expertise (and social engagements) but works against our finding results.

[18] The 11 environmentally sensitive industries are utilities; extractive; chemicals; manufacturing: transport equipment; mining/construction; food; manufacturing: metal; manufacturing: machinery; textiles/print/publish; manufacturing: rubber/glass/etc.; and manufacturing: electrical equipment. Barth et al.'s (2005) industry classification is based on SIC. However, BoardEx does not provide SIC; it uses FTSE ICB (Industry Classification Benchmark) sectors. We therefore convert each FTSE ICB sector to a corresponding SIC sector. In summary, among our BoardEx public firms, 3,494 unique firms (35.4%) are considered environmentally sensitive, whereas 6,381 (64.6%) are not.

(c) based on the procedures discussed in the text when measuring not for profit engagement in developing our board social engagement measure.

We obtain directors' (f) environmental regulatory agency experience, (h) doctoral degrees, and (i) legal expertise, by conducting textual analysis on the director's biography as disclosed in the firms' proxy statements. For environmental regulatory agency experience, we search for past or current associations with federal or state government environmental agencies or regulators. We take any doctoral degree as the biographical data frequently does not indicate the field of study. The importance of a law degree for ensuring a firm's environmental compliance is discussed in de Villiers et al. (2011).

To develop board level measures, we aggregate the director level items to the board level. For example, the total number of board-level CSR committees served is the summation across all directors on a particular board (i.e., item (a) of the 9-item list). To derive the number of directors with CSR committee experience, we create an indicator variable that takes the value of 1 if the director has at least some CSR committee experience. We then sum this indicator variable across all directors on a particular board. To derive total cumulative years of experience on all board-level CSR committees, we sum the total cumulative years of experience on all board-level CSR committees across all directors on the board. To further illustrate, we sum the number of boards served on in environmentally sensitive industries across all directors on a particular board. To measure the number of directors with board experience in environmentally sensitive firms, we create an indicator variable that takes the value of 1 if the director has at least some environmentally sensitive board experience. We then take the summation of this indicator variable across all directors on a particular board. We then standardize these items across boards given that boards have varying numbers of directors.

Hence, candidates for BEE items are transformed into proportion of the focal board that possesses the attribute (i.e., the number of board members with attribute divided by board size) and average amount of the attribute (i.e., the total number of attributes divided by board size). This process resulted in the creation of 14 potential board level indicators variables that could represent the BEE latent variable (see Appendix C). Following the same process as we did with refining the GOV latent variable, we subject these indicator variables from the 2012 year sample to an exploratory factor analysis. The exploratory factor analysis identified four board-level environmental expertise characteristics to construct BEE. The four items are as follows.

- Average number of CSR committees that directors served on
- Average years of experience on board-level CSR committees
- Average number of boards of environmentally sensitive firms that directors served on
- Proportion of board members with service on environmentally sensitive firms' boards

We then carry out a confirmatory factor analysis on the other five years of data, both at the year level and pooled across all six years. This analysis suggests a strong stable construct. Table 2 Panel B shows the factor loadings for the above four items for the six year pooled data set for the four indicators of the latent construct BEE in Fig. 2. BEE extracts 65.9% of the variance for the four retained observed variables.[19]

Board social engagement (BSE)

To construct a measure of a board's social engagement we seek measures of community and social engagement of the individual directors. According to Boyatzis and Sala (2004), measurement of the construct social engagement is at the individual level and has focused on the following items.

- Orientation: Anticipating, recognizing, and meeting stakeholder needs
- Empathy: Sensing others' feelings and perspectives and taking an active interest in their concerns
- Organizational Awareness: Reading a group's emotional currents and power relationships

Hence, we gather individual board member data on the seven attributes described below (bolded items represent those retained in final measure):

Orientation

a. Number of government affiliations

b. Number of military affiliations

Empathy

c. Number of university affiliations

d. Number of religious non-profit organization affiliations

e. Number of medical organization affiliations

f. Number of other non-profit organization affiliations

Organizational Awareness

[19] For sensitivity we constructed plausible alternative measures of BEE using different subsets of the 14 measures. All were highly correlated with BEE. Hence using these plausible alternatives all the inferences reported, including levels of significance, did not change.

g. Number of awards

We consider only *current* affiliations for a focal director for a given year as this better reflects the *current* level of one's engagement with society. The exception is number of awards, which we quantify using the cumulative sum of awards received up to the current period. All items are measured at the firm-director-year level. Again, we focus our discussion on how we measured the items retained and on the aggregation process to board level measures.

To collect these seven items, we combine four different BoardEx Board Associations files: Not-for-profit, Education, Other, and Unlisted (see Appendix D). We exclude public/private companies from this combined association dataset. We use the following organization types, as categorized by BoardEx: government, universities, and medical to identify directors' (a) government, (c) university, and (e) medical affiliations, respectively. In addition, we further segregate organizations classified as "charities" by BoardEx into two groups. Using the IRS Exempt Organizations Business Master File Extract (a data file oriented to not-for-profit organizations), we exclude environmentally focused charities as they are used in the construction of BEE (see item (c) in BEE). We classify the non-environmentally related not-for-profit (charitable) organizations into two groups: (d) religious, and (f) other.[20] Lastly, information about (g) directors' awards come from the BoardEx Director Profile Achievements file.

We aggregate these individual director items into candidate measures that capture board level social engagement. We transform the individual attributes into the proportion of the board members who possessed the attribute (i.e., number of members with attribute divided by board size) and the average amount of the attribute (i.e., total number of attributes divided by board size). In total we developed 14 potential board level indicators of BSE (see Appendix D). Again, using the year 2012 data, we subject these to an exploratory factor analysis. After eliminating items which did not load, we retain nine board-level social engagement characteristics. We again validate this subset of items through confirmatory factor analysis across the other five years in our sample, both individually and pooled. The nine items we retain as indicators of BSE are:

- Average number of government affiliations per director
- Proportion of board with government affiliations
- Average number of university affiliations per director
- Proportion of board with university affiliations
- Proportion of board with medical affiliations
- Average number of other non-profit affiliations per director
- Proportion of board with other non-profit affiliations
- Average number of awards per director
- Proportion of board of receiving awards

Table 2 Panel C shows the factor loadings for the above nine items that compose the indicators for the latent construct BSE in Fig. 2. The latent BSE extracts 47.3% of the variance. This is considered good for a new measure. To further validate this measure, we examine carefully the seven subindices of social performance (SO) provided by ASSET4. Based on our inspection of definitions in the ASSET4 manual, the subindices that should be most strongly associated with our BSE measure are diversity and opportunity (DO) and training and development (TD). Both of these measures focus on management's commitment to improving the opportunities available for employees through ensuring both the opportunity to develop and the training to realize that opportunity. We find consistently that our BSE one-year lag measure is strongly positively associated with the one-year-ahead performance on these two social performance measures with substantially less positive association for the other subcomponents of the SO measure (e.g., employee benefits, product responsibility, health and safety, etc.).[21]

Observed variables: board CSR committee and chief sustainability officer

Aside from the three main variables of interest, we collect data about two key institutional features: the existence of a Board CSR committee (CSRCOM), an indicator variable denoting whether a board has established a CSR committee, and whether firm management appointed a chief sustainability officer (CSO), an indicator variable showing whether the firm has a CSO. We use the same procedures that we described in developing BEE to identify director involvement in other firm's CSR committees to identify when our focal firm has a CSR Committee. From our sample, we find that 13.1% of firm years have a CSR committee at the board level. This statistic is close to the findings of Kiron et al. (2017, p. 15), who state that "no more than 10% of U.S. public company boards have a committee dedicated solely to corporate responsibility." We use Factiva to

[20] Using the fuzzy name matching algorithm, we match organization names of BoardEx Affiliations data and IRS Exempt Organizations Business Master File Extract. We then use IRS's National Taxonomy of Exempt Entities (NTEE) classification to identify religious (NTEE classification: C) not-for-profit organizations. The IRS Exempt Organization Business Master File Extract is available at https://www.irs.gov/charities-non-profits/exempt-organizations-business-master-file-extract-eo-bmf.

[21] In addition, as would be expected, BEE is not significantly associated with DO. However, BEE is positively associated with TD but the size of the standardized coefficient is 60% of that for BSE.

manually search for CSO-related title keywords in all our sample firms' press releases and news articles over the six-year sample period.[22] We consider the year an article first mentions a CSO as the first year the firm employs the CSO. In our sample, we identify that 10.3% of firm years have CSOs.

Dependent variable: firm environmental performance (EN)

To measure firms' environmental performance, we use Refinitiv ESG Data (formerly known as Thomson-Reuters ASSET4).[23] Our primary measure of environmental performance is the environmental performance score (EN) produced by ASSET4. ASSET4′s EN score captures three broad categories—resource reduction, emission reduction, and product innovation—of environmental performance measures with each category measuring a broad array of environmental performance indicators. In our study, we choose to use ASSET4′s ESG data because of the depth of its assessments and its comprehensive ESG data (e.g., it includes more than 400 raw data items for each firm). ASSET4′s broad array of environmental impacts is advantageous relative to the alternative of using one-dimensional measures of performance such as carbon emissions or toxics release inventory.

ASSET4 data is obtained from a large range of different sources, such as annual reports and other stock exchange filings, reports from nongovernmental organizations, surveys, and popular newswires in addition to those obtained from firms' sustainability disclosures (Bettinazzi and Zollo, 2017; Eccles et al., 2014; Ioannou and Serafeim, 2012).[24] Lending support to the validity of ASSET4 data in measuring firms' environmental performance, a large number of prior studies employ ASSET4′s data to measure corporate environmental performance (see: de Villiers et al., 2022).

Consistent with prior studies, EN is measured at t + 1.[25] According to our discussions with Refinitiv, the indicators used in calculating specific environmental performance scores vary from sector to sector. Some indicators are industry-specific and thus not relevant for all companies. In addition, the ASSET4 score calculation methodology is such that percentile ranks are calculated relative to other peers in the firm's industry sector. The aggregate scores for each of the three categories range between 0 and 100%. For example, a percentile score for emission reduction for a given firm of 66% indicates that the firm's performance is superior to 66% of its industry peers in regard to emission reduction.[26] Thus ASSET4 scores can be readily pooled across industries without the need for further adjustments.[27]

Control variables

We control for three covariates that could affect firms' environmental performance: firm size (FirmSize), measured as log of book value of assets (Hegde and Mishra, 2019; Jo and Harjoto, 2011); firm age (FirmAge) (Hegde and Mishra, 2019; Jo and Harjoto, 2011); and return on assets (ROA), measured as net income divided by book value of assets (Hegde and Mishra, 2019; Ioannou and Serafeim, 2012). These control variables are obtained from Compustat. We also control for industry using the twenty-two industry classification of Barth et al. (2005) as well as firm year.[28]

Results

The mixed SEM measurement model fit

We now turn to evaluating the fit of our overall pooled SEM model as exhibited in Fig. 2.[29] We have discussed how we developed and validated our primary latent variable measures — GOV, BEE, and BSE — in the previous section. The mixed model (i.e., a combination of latent and observed variables) fit in an SEM world has no single accepted measure (Bollen, 1989). Hence,

[22] We use CSO-related title keywords employed by Peters et al. (2019): "sustainability officer," "sustainability vice president," "responsibility officer," "corporate responsibility officer," "environmental officer," "environmental director," or "environmental health and safety officer." For each firm in our sample, we search for these keywords in Factiva across all years. From the search output, we read press releases or news articles to manually verify that individuals with these titles are indeed an employee of our sample firm.

[23] Throughout the paper, we refer to Refinitiv ESG data as ASSET4 because of its familiarity to academic scholars.

[24] As mentioned in Clarkson et al. (2020), our conversation with Mr. Duncan Houston at Refinitiv confirms that ASSET4 constructs EN using not only firm-disclosed data but also third-party sources.

[25] Our SEM model results are robust when we explore a two-year lag model (i.e., EN measured at t+2).

[26] We are grateful to Erik Foo, client success manager at Refinitiv, for helpful discussions regarding the ASSET4 scoring methodology. For elaboration on the points made above, see the Refinitiv June 2019 publication entitled: Environmental, Social and Governance (ESG) Scores from Refinitiv.

[27] In untabulated pooled SEM analyses, we observe that the benefits of Board Environmental Expertise exist for both environmentally sensitive and non-sensitive industries whereas the benefits of Board Social Engagement exist for environmentally sensitive industries only. Further details are available upon request.

[28] We denote industry and year in Fig. 2 as pseudo fixed effects in that they are consistent with the concept of controlling for cross-sectional differences in industry and year effects but due to differences in SEM modeling are not computed under linear modeling assumptions that underlie OLS fixed effects. We discuss our OLS findings including fixed effects for years and industry in Section 5.6.1.

[29] We follow the commonly accepted practice in the CSR literature of pooling data over a period of years in an SEM model (e.g., Shaukat et al., 2016). We note that pooling such data is subject to controversy in the underlying SEM literature (Little et al., 2007; McArdle and Nesselroade, 2014). Hence, we also run the model on a year by year basis. The fit statistics year by year are almost identical to those of the pooled data indicating that the model is robust. The inferential statistics vary in strength on a year by year basis, but the average total effects are similar for GOV, BEE and CSO. There is greater variation in the year by year models for the effects of BSE and CSR Committee.

in common with others in the literature we use multiple fit measures to demonstrate that our measurement model is acceptable (see Table 3 Panel A and its footnotes). Overall, the fit measures show that the measurement model has a good to excellent fit.[30]

The squared multiple correlations (SMC) for the EN dependent variable (see Table 3 Panel B) indicate acceptable explanatory power (0.381).[31] The three latent variables' SMC, when measured in the context of the overall Fig. 2 model, also indicate good to excellent explanatory power for each latent construct (GOV: 0.528, BEE: 0.308, and BSE: 0.388).

Our approach tests the direct and indirect effects of our measures of governance quality (GOV), board environmental expertise (BEE), board social engagement (BSE), CSO appointment, and CSR Committee existence on firm environmental performance (EN). We begin our discussion of the results by focusing on the direct effects of each predictor (the SEM equivalent of an independent variable) on EN (our primary dependent variable) in Table 4. Table 5 provides the basis for computation of indirect effects by reporting the effects of the predictor variables on each other. All significance levels reported in Tables 4 and 5 are two-tailed. Table 6 presents the results for the direct, indirect, and total effects of each predictor variable in our model on environmental performance one year ahead.

Tests of hypotheses: direct effects of predictor variables on environmental performance (EN)

From the first column in Table 4, we see that GOV impacts environmental performance. The pooled raw estimate of 2.371 is positive and significant at the 0.01 level. Consistent with our H1a, and replicating prior research, we find that firms with higher traditional board governance quality have higher one year ahead firm environmental performance.

Table 4 Column 2 shows that BEE strongly affects one-year-ahead environmental performance. The pooled raw estimate of 0.165 is positive and significant at the 0.01 level, thus providing evidence consistent with H2. This finding suggests that firms with higher board environmental expertise will have higher firm environmental performance.

Table 4 Column 3 shows that BSE also positively affects one-year-ahead environmental performance, consistent with H4a. The pooled raw estimate of 0.110 is positive and significant at the 0.01 level. This finding suggests that firms with higher board social engagement have higher firm environmental performance.

Consistent with H5, Table 4 Column 4 shows that the appointment of a chief sustainability officer (CSO) strongly and positively affects one-year-ahead environmental performance. The pooled raw estimate of 0.156 is positive and significant at the 0.01 level. Table 4 Column 5 shows that, while the effects for the existence of a Board CSR committee are more modest compared to management's appointment of a CSO, the existence of a CSR committee also affects one-year-ahead environmental performance providing support for H3c. The pooled raw estimate of 0.037 is positive and significant at the 0.01 level.

Tests of hypotheses: effects of predictor variables on each other

Table 5 presents the effects of predictor variables on each other. Supporting H1b, GOV is significantly and positively related to BEE. The pooled raw estimate of 2.141 is positive and significant at the 0.01 level. Our GOV measure is also positive and significantly related to BSE, supporting H1c. The pooled raw estimate of 1.483 is positive and significant at the 0.01 level. This finding suggests that firms with better quality governance are associated with boards that have a higher social engagement. Supporting H3a, GOV relates to positively to appointment of a CSR committee. The pooled raw estimate of 1.848 is positive and significant at the 0.01 level. As noted in the hypotheses section, CSO is a management choice and supporting that position we find that there is no significant relationship between GOV and CSO appointment.

Column 6 of Table 5 presents the results for the direct effect of BEE on CSR committee. As hypothesized in H3b, BEE is positively related to the existence of a CSR committee. The pooled raw estimate of 0.186 is positive and significant at the 0.01 level. In Column 5 of Table 5, we also report that, while not the focus of a hypothesis, BEE is positively related to the appointment of a CSO.

Table 5 Column 7 shows that BSE is positively associated with BEE, providing support for H4b. The pooled raw estimate of 0.281 is positive and significant at the 0.01 level. This finding suggests that Boards with an overall set of socially embedded and empathetic directors are more likely to ensure that the required level of board environmental expertise is in place, pointing to complementarity between BSE and BEE.

Table 5 column 9 present the results for the direct effect of BSE on CSR committee. Inconsistent with our expectations in H4c, BSE is not related to the existence of a CSR committee. We also note that our control relationship between BSE and CSO, like our control relationship between GOV and CSO, is insignificant.

Overall, as can be seen in comparing Fig. 1 Panels A and B, we find a high degree of support for our hypothesized relationships among the predictor variables and with the dependent variable. Indeed, ten of our eleven theorized relationships are supported in our empirical tests.

[30] As noted in Table 3 the only exception is the χ^2 goodness of fit test which is problematic in many studies using SEM to examine large scale samples of archival data.

[31] SMC is interpreted analogously to R^2 in OLS regressions; see Arbuckle, (2012).

Table 3
SEM measurement model fit.

Panel A: Model Fit statistics (see Note 1)	
Goodness of fit (greater than 0.95 is excellent)	0.960
Adjusted Goodness of Fit Index (greater than 0.90 good)	0.937
Normed Fit Index (greater than 0.95 is excellent)	0.956
Incremental Fit index (greater than 0.95 is excellent)	0.960
Tucker Lewis Index (greater than 0.90 is good)	0.942
CFI (greater than 0.95 Excellent)	0.960
Residual Mean Squared Error (RMSEA), (0.05 or less is excellent fit)	0.048
Test for non-significant (p > 0.05) difference from RMSEA = 0.05	0.966
χ^2 goodness of fit (df = 206)	1900.241
Test of non-significance for improvement in model fit	0.0001

Panel B: Model Explanatory Power (see Note 2)

	Environment performance (EN)	Board Governance quality (GOV)	Board Environmental Expertise (BEE)	Board Social Engagement (BSE)
Squared Multiple Correlations:	0.381	0.528	0.308	0.388

Note 1: Fit indices statistics.
[1]The GFI (goodness of fit index) for SEMs developed by Jöreskog and Sörbom (1984) suggests that fit approaching 1 is excellent. The GFI modified AGFI (adjusted goodness of fit index) adjust for the number of degrees of freedom with good fit is indicated by models that approach 1. The normed fit index is yet another refinement to deal with sample size leading to assumptions of good fit when it is lacking.
[2]CFI (comparative fit index) with 0.95 and above excellent fit (Chau 1997). Thompson (2000) advocates for constructed scales a norm of 0.95 and above. (Bollen 1989a) developed an earlier fit index called the IFI (incremental fit index) where values approaching 1 (greater than 0.95) are considered excellent fits. The Tucker Lewis Index is another such adaption with the same thresholds (see (Bollen 1989b).
[3]RMSEA (root mean square error of approximation) with 0.05 being a very good fit and above 0.05 to 0.08 representing an acceptable fit (Thompson 2000, Chau 1997). The associated p-values is a test of the null hypotheses RMSEA is<0.05 and is based on a simulated distribution of RMSEA values.
[4]The goal of the chi-square test in SEM is to test the null hypothesis that no improvement in the model fit (in this case the latent variable fit) is possible, hence the test result should be non-significant to indicate no room for model improvement (e.g., Brannick 1995). The $\chi 2$ goodness of fit test is highly sensitive to sample size when fitting overall models. Brannick (1995: 205) states that "with large samples, it is extremely rare to find a nonsignificant chi-square". Our sample falls into the category of large (N = 3600) compared to samples typically employed using SEM. Hence, the significant value for the $\chi 2$ test is acceptable (see Lu, Richardson and Salterio 2011 for similar analysis).
Note 2: Squared multiple correlations (SMC) are a measure of explanatory power of the predictor variables on the dependent variable in an SEM model and are similar in interpretation to R2. As the latent variables are constructed from multiple indicators, the SMC are also provided for the three latent variables GOV, BEE, and BSE. In all cases the explanatory power which ranges from 0.31 to 0.53 is acceptable.

Table 4
Direct effects of predictor variables on environmental performance (EN).

	Environmental Performance (EN)				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Predictor variables	**GOV (+)**	**BEE (+)**	**BSE (+)**	**CSO (+)**	**CSRCOM (+)**
2010–2015 Pooled Raw Estimate	2.371	0.165	0.110	0.156	0.037
S.E.	0.374	0.022	0.030	0.014	0.014
C.R.	6.334	7.409	3.665	10.770	2.700
P	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0070**
Pooled Standardized Coefficient	0.212	0.173	0.081	0.153	0.040

Note: See Appendix A for model variable descriptions. See Fig. 1 Panel B for graphical representation of the results. Bolded items indicate significance at the p < 0.01 two tailed level.

Table 5
Path effects among model predictor variables.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Predictor variable	**BEE GOV (+)**	**BSE**	**CSO***	**CSRCOM**	**CSO* BEE (+)**	**CSRCOM**	**BEE BSE (+)**	**CSO***	**CSRCOM**
2010–2015 Pooled Estimate	2.141	1.483	0.210	1.848	0.074	0.186	0.281	−0.024	0.001
S.E.	0.314	0.482	0.383	0.435	0.024	0.027	0.042	0.037	0.034
C.R.	6.811	3.076	0.548	4.247	3.034	6.842	6.634	−0.651	0.038
P	**0.0001**	**0.0020**	0.5830	**0.0001**	**0.0020**	**0.0001**	**0.0001**	0.5150	0.9700
Pooled Standardized Coefficient	0.258	0.126	n.s.	0.154	0.078	0.181	0.198	n.s	n.s.

Note: See Appendix A for model variable descriptions. See Fig. 1 Panel B for graphical representation of results. The direction of hypothesized effects for the relationship would be positive for GOV, BEE, and BSE on the predictor variables, except that we do not hypothesize effects for board governance measures on CSO appointment as it is a management decision (marked with * above). Bolded items indicate significance at the p < 0.01 two tailed level.

Table 6
Standardized direct, indirect, and total effects of variables on environmental performance.

Panel A: Indirect effects as a percentage of total effects

Indirect Effects (see Fig. 1 Panel A for structural model indirect paths tested and Panel B for results)

Effect on EN	**Direct** (Table 4)	Via BEE	Via BSE	Via CSR COM	Via BEE* CSR COM	Via BSE* BEE	Via BSE* BEE* CSR COM	Via CSO	Via BEE* CSO	Via BSE* BEE* CSO	**Total Indirect Effect**	**Total Stand. Effect**	Indirect Effects as % of Total Effect
GOV	0.212	0.045	0.010	0.006	0.002	0.004	0.0002	n.s.	0.003	0.0003	0.071	0.283	25.1%
BEE	0.173	n/a	n/a	0.007	n/a	n/a	n/a	0.012	n/a	n/a	0.019	0.192	9.9%
BSE	0.081	0.034	n/a	n.s.	0.001	n/a	n/a	n.s.	0.002	n/a	0.037	0.118	31.4%
CSR COM	0.040	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.040	n/a
CSO	0.153	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.153	n/a

Panel B: Illustrative computations of indirect effects

	Source	Standardized Co-efficient
A. GOV indirect effects on EN via BEE		
(1) Effect on GOV on BEE	Table 5 Column 1	0.258
(2) Effect of BEE on EN	Table 4 Column 2	0.173
Indirect effect of GOV on EN via BEE	(1)*(2)	0.045
B. GOV indirect effect on EN via BEE*CSRCOM		
(1) Effect on GOV on BEE	Table 5 Column 1	0.258
(2) Effect of BEE on CSRCOM	Table 5 Column 6	0.181
(3) Effect of CSRCOM on EN	Table 4 Column 5	0.040
Indirect effect of GOV on EN via BEE* CSRCOM	(1)*(2)*(3)	0.002

Notes: See Appendix A for model variable descriptions. All direct effects reported are significant at $p < 0.01$ two tailed as reported in Table 4. All indirect effects that are neither reported as n.s. or n/a above are tested via bootstrapping with 200 iterations and such effects are significant at the $p < 0.05$ or lower level. n.s. denotes non-significant indirect paths as reported in Table 5, in which case we assign a value of 0 above. n/a – path does not exist – See Fig. 1.

Computation of total effects for predictor variables

An important advantage of our SEM model (over most linear models such as OLS) is that it allows for the ready computation of the indirect effects of our predictor variables on EN. An indirect effect is the product of two or more significant effects as reported in Tables 4 and 5. Following our SEM structural model in Fig. 1, there are multiple indirect effects which our hypotheses imply should exist. For example, in H2 and in H3c we predict that both BEE and the existence of a CSR committee directly impact EN. We also predict in H3b that BEE impacts the existence of a CSR committee. Hence, the combination of H3b and H3c would lead us to expect that BEE provides an additional indirect boost to one year ahead EN through its effects on the CSR Committee.

Table 6 Panel A presents the breakdown of direct, indirect, and total effects for each predictor variable in our model as well as the percentage of the total effect obtained from the indirect effects (final column Panel A). If an effect reported in Table 5 is not statistically significant (i.e., p-value < 0.01), we assign the corresponding effect in Table 6 to be zero, as indicated by "n.s.". We present in Panel B illustrative computations for how the indirect effects are developed from the effects reported in Tables 4 and 5. From Panel A we can see that the indirect effects of GOV, BEE, and BSE on EN represent a substantial portion (25.1%, 9.9% and 31.4%, respectively) of the total effects of these predictor variables on EN. Hence, ignoring these indirect effects would result in substantial understatement of the effects of improvements to governance on environmental performance.

From Panel A, we can see that the total effect of GOV on EN is substantial with a total standardized effect of 0.283. Importantly, we view this result as validation of prior research, whereby firms with higher traditional board governance quality have higher firm environmental performance.[32]

We also see that the total effect of BEE on environmental performance is also substantial with its effects being over 67% (0.192/0.283 from Table 6 Panel A) of the size of the governance quality measure on EN. Such effects (as captured by 0.192) are incremental to the total effects attributable to GOV (as captured by 0.283). Hence, while environmental expertise acquisition at the board level can co-occur with traditional governance quality enhancements (e.g., recruiting a woman who also has an environmental background), a substantial incremental effect occurs because of having board expertise and would not be enjoyed regardless of the quality of traditional governance quality in place.

Turning to BSE, we can see that the total standardized effect of BSE on EN is 0.118, which is also substantial. Such effects are incremental to the total effects attributable to GOV and would not be enjoyed regardless of the quality of traditional governance quality in place. Finally, in addition to the direct effects we report for BSE on EN, we observe a substantial indirect

[32] A standardized effect of 0.283 means that a one standard deviation increase in GOV results in 0.283 increase in the standard deviation of EN.

effect of BSE on EN via BEE (over 30% of total effect for BSE reported in Table 6 Panel A). The latter is clear evidence of the boost that a socially engaged board provides both directly and indirectly through environmental expertise to overall firm level environmental performance.

Finally, consistent with recent research (e.g., Miller and Serafeim 2014) and the practitioner literature we report that management's appointment of a CSO has as significant standardized effect (0.153 standardized coefficient) on environmental performance.[33] We also find, consistent with the findings of Dixon-Fowler et al. (2017), Baraibar-Diez and Odriozola (2019), and Orazalin (2020), a significant but weak effect for the Board's establishment of a CSR Committee (0.040 standardized coefficient) on future environmental performance.

Economic significance

While we have discussed the average total effect for each of our predictor variables above, Table 7 provides evidence about their economic significance. We assert that these measures effect economic significance as prior research shows that enhancing firm environmental performance is associated with firm valuation (see, for example, Clarkson et al., 2011).

As illustrated in Table 7 Panel B, a one standard deviation increase in GOV would result in an improvement in the ASSET4 EN score by (0.2827 $\times$ 0.3180) 8.99 points (out of 100). Put in perspective, based on the average EN score of 54.70 in our sample (See Table 1), a one standard deviation increase in GOV would result in a (8.99/54.70) 16.44% increase in the average EN score. Similarly, Table 7 Panel B indicates that a one standard deviation increase in BEE would result in an improvement in the ASSET4 EN score by (0.1922 $\times$ 0.3180) 6.11 points (out of 100). Once again, given the average EN score of 54.70 in our sample, a one standard deviation in BEE would result in a (6.11/54.70) 11.17% increase in the average EN score. This enhancement in the average EN score is economically significant and almost as large as the corresponding enhancement (16.44%) arising from GOV. As reported in Table 7 Panel B similar calculations would imply that a one standard deviation increase in BSE would increase the average EN score in our sample by 6.86%. Finally, Table 7 Panel C, which focuses on the effects of the presence of a CSO and a board CSR Committee, reports a percentage improvement in the average EN score of 27.97% and 7.31% when CSO is appointed, or a board CSR Committee is established.

Robustness tests

OLS regression results

To further corroborate our SEM results, we run OLS regressions based on the linear version of the direct effects in the SEM model, as follows.

$EN = \beta_0 + \beta_1 GOV + \beta_2 BEE + \beta_3 BSE + \beta_4 CSRCOM + \beta_5 CSO + \beta_5 FIRMSIZE + \beta_6 ROA + \beta_7 FIRMAGE +$ Industry fixed Effects + Year fixed Effects + ε.

To follow our SEM specifications as closely as possible, we run a pooled cross-sectional OLS analysis with added industry and year fixed effects. Putting the traditional elements of board governance quality (e.g., female board member) in the OLS regression in place of GOV (as would normally be done in the OLS approach) does not change the inferences about the other independent variables effects on EN.

We report the OLS regression results in Table 8 in the first column. Overall, the results of the OLS analyses are qualitatively similar with our SEM results. All independent variables have signs similar to their predictors in the SEM analyses and are strongly significant.

Vuong tests

We additionally validate the SEM results by estimating how each variable contributes to the OLS model's explanatory power using the Vuong test (Vuong, 1989), as seen in Table 8 Panel B. We start the test with a base model that regresses only the control variables with industry and year fixed effects on EN. Then we add GOV to the base model and test whether GOV adds any incremental explanatory power to the OLS model. We subsequently repeat this process by further adding BEE, BSE, CSR Committee, and CSO (in that order).[34] The Vuong test results are consistent with our results. We find that the addition of all these variables are statistically significant in improving the model's explanatory power (R^2) with Vuong Z-statistics above 2.76 or greater (equivalent to p-values 0.0057 or less).

The OLS regression and the Vuong test results suggest that the inferences we derive from the SEM results are not research-design specific. While this substantiates our SEM model, we note that the OLS regression design does not allow one to readily explore the theoretical linkages portrayed in our path diagram (Fig. 1). Therefore, OLS results do not permit

[33] Peters et al. (2019) do not find that CSO appointments are associated with increases in sustainability performance for firms with poor prior sustainability performance. On the contrary, they find a positive association between CSO appointments and subsequent sustainability performance for firms with good prior sustainability performance. They further show that CSOs' prior sustainability expertise matters in the relation between CSO and sustainability performance. They study CSO appointments between 2002 and 2008. Our more recent sample time period may explain the strength of the association which we observe between the existence of a CSO and firm environmental performance.

[34] We also conduct the Vuong test (untabulated) by adding BSE before BEE. When BSE is added to the model, right after GOV, the incremental R-square of the model is 0.7%. The corresponding Vuong Statistic is 3.39 (p-value of 0.0007). In comparison, Table 8 indicates that when BEE is added to the model, right after GOV, the incremental R-square of the model is 1.3% with a Vuong Statistic is 4.63 (p-value of 0.0000). Thus, our OLS Vuong tests confirm the impression obtained from our SEM Model: Both BSE and BEE matter but the incremental effects for BSE are more modest, compared to those for BEE.

Table 7
Economic significance.

Panel A: Increase in EN Score due to 1 Standard Deviation Increase in Predictor Variable				
		GOV	BEE	BSE
Total Standardized Effect	Table 6	0.283	0.192	0.118
x EN Std. Deviation in percentiles	Table 1	31.80	31.80	31.80
Increase in EN score in percentiles		**8.99**	**6.11**	**3.75**

Panel B: % Increase in Average EN Score Due to Increase in EN score				
		GOV	BEE	BSE
Increase in EN Score in percentiles	Panel A	**8.99**	**6.11**	**3.75**
÷ Average EN Score in percentiles	Table 1	54.70	54.70	54.70
Avg. % Score Improvement		**16.44%**	**11.17%**	**6.86%**

Panel C: Effects on EN of establishing a CSR Comm or appointing a CSO

Establishment or Appointment	Total Standardized Effect (Table 6) when CSRCOM or CSO is present	Effect on EN When CSR Comm or CSO is present (in percentiles)	(÷) Average EN Score in percentiles (Table 1)	**% Increase In EN Score**
CSO	0.153 * 100 =	15.3	54.7	27.97%
CSR Committee	0.040 * 100 =	4.0	54.7	7.31%

Note 1: Panel A and B portrays the economic significance of GOV, BEE, and BSE for a one standard deviation increase in that variable on the average EN score. Variables are described in Appendix A.
Note 2: Panel C shows the economic significance of creating a Board CSR Committee or management appointment of a CSO on average EN score.

Table 8
OLS regression results for effects of independent variables on EN.

	OLS results	Vuong Results					
Variable		(1)	(2)	(3)	(4)	(5)	(6)
FIRMSIZE	0.0757***	0.114***	0.0988***	0.0926***	0.0843***	0.0829***	0.0757***
	(18.31)	(32.62)	(25.92)	(24.12)	(20.51)	(20.22)	(18.31)
ROA	0.266***	0.274***	0.288***	0.302***	0.288***	0.295***	0.266***
	(4.61)	(4.57)	(4.87)	(5.16)	(4.92)	(5.06)	(4.61)
FIRMAGE	0.000906***	0.00200***	0.00151***	0.00129***	0.00110***	0.00101***	0.000906***
	(3.33)	(7.28)	(5.45)	(4.68)	(4.00)	(3.69)	(3.33)
GOV	0.0381***		0.0476***	0.0420***	0.0403***	0.0383***	0.0381***
	(7.62)		(9.35)	(8.26)	(7.96)	(7.56)	(7.62)
BEE	0.0333***			0.0405***	0.0363***	0.0340***	0.0333***
	(7.10)			(8.63)	(7.66)	(7.19)	(7.10)
BSE	0.0272***				0.0279***	0.0275***	0.0272***
	(5.42)				(5.47)	(5.41)	(5.42)
CSRCOM	0.0647***					0.0706***	0.0647***
	(5.09)					(5.50)	(5.09)
CSO	0.126***						0.126***
	(9.06)						(9.06)
_cons	−0.158***	−0.529***	−0.363***	−0.314***	−0.225***	−0.222***	−0.158***
	(-3.76)	(-15.09)	(-9.31)	(-8.06)	(-5.33)	(-5.29)	(-3.76)
Ind. FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
N	3600	3600	3600	3600	3600	3600	3600
R-sq.	0.442	0.393	0.407	0.420	0.424	0.429	0.442
adj. R-sq	0.437	0.389	0.403	0.415	0.420	0.424	0.437
			(2) vs. (1)	(3) vs. (2)	(4) vs. (3)	(5) vs. (4)	(6) vs. (5)
	Vuong test		Add GOV	Add BEE	Add BSE	Add CSRCOM	Add CSO
Difference in R-sq.			0.014	0.013	0.004	0.005	0.013
Vuong Z-Statistic			4.6592	4.6281	2.7633	3.0821	5.3593
p-value			0.0000	0.0000	0.0057	0.0021	0.0000

T-statistics are presented in parentheses. ***, **, * denote two-tailed significance at 1%, 5%, and 10% levels, respectively. Detailed variable definitions are presented in Appendix A.

the much more granular interpretation SEM provides; nor can we ignore the endogeneity problems that are inherent in a single-stage OLS regression and the potential for correlation among the variables which SEM based approaches attenuate.

Reconciling our results with the findings of insignificant BEE effects in previous studies

We reconcile our results with the findings of insignificant board environmental expertise effects in two previous studies. We replace our BEE measure with the environmental expertise measure included in Rodrigue et al. (2013) and Dixon-Fowler et al. (2017), respectively.

Rodrigue et al. (2013) define environmentally aware directors as board members with prior experience in environmental organizations, or a peer industry company (i.e., same first two digits SIC code). They aggregate to the board level by measuring the proportion of so defined environmentally aware directors. In untabulated analyses, when the Rodrigue et al. (2013) measure is used as a replacement for BEE in our pooled SEM and OLS models, we find no significant effects for their measure. This result suggests that their measure is too coarse to represent board environmental expertise.

Dixon-Fowler et al. (2017) define a director to be an environmental stakeholder if the director is currently or previously employed in an environmentally related government agency, if the director holds directorships on the board of such organizations or is an academic/scientist working in environmentally related disciplines. Dixon-Fowler et al. (2017) aggregate to the environmental committee level by measuring the proportion of total committee members who are environmental stakeholders. As all of our measures are at the board level, we differ from their approach by computing the proportion of the total board who are "stakeholder directors".[35] We find that when our modified Dixon-Fowler et al. (2017) measure (i.e., aggregated to the board as a whole) is used as a replacement for BEE in our pooled SEM and OLS models, their measure has positive incremental effects on future environmental performance. Hence, it appears that the Dixon-Fowler et al. (2017) measure, although a narrower construct than ours (i.e. focused only on the environmental committee and based on a dichotomous approach), would have detected some of the expertise effects we document. Indeed, given the conceptual similarity in Dixon-Fowler et al., (2017) measure and the Homroy and Slechten (2019) measure, we suggest that the difference in results between those papers is due to Homroy and Slechten (2019) focusing on the board as a whole whereas Dixon-Fowler et al. (2017) only considered members of the environmental committee.

Conclusion

Using traditional governance quality drivers, researchers have shown that better firm governance enhances firm environmental performance ("G enhances E"). Using a structural equation model, we replicate the finding that traditional governance quality drivers, as captured by our overall measure of the latent construct termed governance quality (GOV), considerably enhance the average ASSET4 environmental performance score. In terms of total effects, we find that a one standard deviation increase in GOV would result in a 16.4% increase in the average ASSET4 environmental performance score.

Our second key finding contributes to the extant CSR academic literature, whose findings have been mixed regarding the importance of board environmental expertise (BEE) for firm environmental performance. We find that a one standard deviation increase in BEE would result in a 11.2% increase in the average ASSET4 environmental performance score. This effect is impressive being nearly 70% as large as the effects arising from traditional governance quality drivers explored in the literature. Such effects are incremental to the total effects attributable to GOV. Hence, while environmental expertise acquisition at the board level can co-occur with traditional governance quality enhancements, a substantial incremental effect exists because of having board expertise and would not be enjoyed regardless of the quality of traditional governance quality in place.

We also develop a construct that we believe is new to the literature: a comprehensive measure of social engagement. We conceptualize it as a key enabling factor that ensures that the board's environmental expertise and formal mechanisms to impose responsibility (CSR committee existence and CSO appointments) have the desired positive effects on environmental performance. Our third key finding is that a one standard deviation increase in BSE leads to an increase of 6.9% in the average ASSET4 environmental performance score. Such effects are incremental to the total effects attributable to GOV and would not be enjoyed regardless of the quality of traditional governance quality in place. Supporting the existence of complementarity between BSE and BEE, we find that the BSE indirect effects via BEE represent over 30% of the total BSE effects. This suggests that boards with an overall set of socially embedded and emphatic directors reinforce the positive effects of having board-level environmental expertise.

Finally, we reconcile the diverse findings in the extant CSR literature about the relationship between board environmental expertise and environmental performance. We find two reasons for this diversity of results: under specification in operationalizing board environmental expertise (i.e., overly simplistic proxy measures) and inappropriate focus on the board's environmental committee rather than the board as a whole. Hence, we provide the basis for future research in this area by documenting the necessity of more complete construct measurement and focusing on the board as a whole rather than sub-committees of the board.

Data availability

Data will be made available on request.

[35] Dixon-Fowler et al. (2017) measure environmental expertise at the level of the firm's CSR Committee but not at the overall board level. We attribute their null result for environmental expertise to this narrowness in scope.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Variable definitions

Variable	Definition
BEE	Board level environmental expertise
BSE	Board level social engagement composite
CSO	Firm has a Chief Sustainability officer
CSRCOM	Board has an environmental or CSR committee
EN	Firm environmental performance measure
FirmAge	Firm age
FirmSize	Firm size
GOV	Board level governance quality
ROA	Return-on-assets

Note: For our latent constructs, GOV, BEE, and BSE (see our path diagram) definitions are provided above only for data items that load significantly in the construction of each latent construct (see Table 2). See Appendices B, C, D and E for detailed descriptions of the three latent variables and EN.

Appendix B. Six potential data items used in constructing board governance quality (GOV) latent variable

Variable Description	Data Source(s)
1. Board independence	BoardEx
2. Board size	BoardEx
3. Female director on the board	BoardEx
4. Majority voting standards	ISS RiskMetrics
5. Board Chair/CEO duality	BoardEx
6. Institutional ownership %	WRDS Thomson Reuters Institutional (13-F) Holdings

Appendix C. Fourteen potential data items used in constructing board environmental expertise (BEE) latent variable

Raw Data Scoring Item (*excluding focal firm)	Data Source(s)
1. Total number of board-level CSR committees served*	BoardEx
2. Number of directors with CSR committee experience*	BoardEx
3. Total cumulative years of experience on all board-level CSR committees*	BoardEx; KLD
4. Total number of environmental non-profit affiliations	BoardEx/IRS
5. Number of directors with environmental non-profit affiliations	BoardEx/IRS

Fourteen potential data items used in constructing board environmental expertise (BEE) latent variable (*continued*)

Raw Data Scoring Item (*excluding focal firm)	**Data Source(s)**
6. Total number of boards served in environmentally sensitive industry firms*	BoardEx; KLD
7. Number of directors with board experience in environmentally sensitive industry firms*	BoardEx; KLD
8. Total cumulative years of board experience at environmentally sensitive industry firms*	SEC EDGAR proxy statements; Various regulatory agency websites
9. Total number of regulatory appointments	SEC EDGAR proxy statements; Various regulatory agency websites
10. Number of directors with regulatory appointments	SEC EDGAR proxy statements; Various regulatory agency websites
11. Total number of CEO appointments in environmentally sensitive industry firms*	SEC EDGAR proxy statements
12. Number of directors with CEO experience in environmentally sensitive industry firms*	SEC EDGAR proxy statements
13. Number of directors with a PhD	SEC EDGAR proxy statements
14. Number of directors with law degree	SEC EDGAR proxy statements

Note: The nine raw data items that are candidates for entry into BEE latent construct are further transformed into proportion of the focal board who possessed the attribute (number of board members with attribute/board size) and average amount of such attribute (total number of attribute/board size) of focal board members.

Appendix D. Fourteen potential data items used in constructing board social engagement (BSE) latent variable

Raw Data Scoring Item	**Data Source(s)**
1. Total number of government affiliations	BoardEx
2. Number of directors with government affiliations	BoardEx
3. Total number of military affiliations	BoardEx
4. Number of directors with military affiliations	BoardEx
5. Total number of university affiliations	BoardEx
6. Number of directors with university affiliations	BoardEx
7. Total number of religious non-profit organization affiliations	BoardEx
8. Number of directors with religious non-profit organization affiliations	BoardEx
9. Total number of medical organization affiliations	BoardEx
10. Number of directors with medical organization affiliations	BoardEx
11. Total number of other non-profit organization affiliations	BoardEx/IRS
12. Number of directors with other non-profit organization affiliations	BoardEx/IRS
13. Total number of director awards	BoardEx
14. Number of directors with awards	BoardEx

Note: The seven raw data items that are candidates for entry into BSE latent construct are further transformed into proportion of the focal board who possessed the attribute (number of board members with attribute/board size) and average amount of such attribute (total number of attribute/board size).

Appendix E. ASSET4 environmental performance (EN) measure

The environmental performance measure (EN) is composed of a linear combination of three subcategories as follows:

Category 1 - Resource Reduction (RR): This category measures a company's management commitment and effectiveness towards achieving an efficient use of natural resources in the production process. It reflects a company's capacity to reduce the use of materials, energy, or water, and to find more eco-efficient solutions by improving supply chain management.

(*continued on next page*)

ASSET4 environmental performance (EN) measure (*continued*)

The environmental performance measure (EN) is composed of a linear combination of three subcategories as follows:

Category 2 - Emission Reduction (ER): This category measures a company's management commitment and effectiveness towards reducing environmental emission in the production and operational processes. It reflects a company's capacity to reduce air emissions (greenhouse gases, F-gases, ozone-depleting substances, NOx, and SOx, etc.), waste, hazardous waste, water discharges, spills, or its impacts on biodiversity and to partner with environmental organizations to reduce the environmental impact of the company in the local or broader community.

Category 3 - Product Innovation (PI) This category measures a company's management commitment and effectiveness towards supporting the research and development of eco-efficient products or services. It reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed, dematerialized products with extended durability.

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