1-1-2024

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Rashid Zaman
Edith Cowan University

Kaveh Asiaei

Muhammad Nadeem

Ihtisham Malik

Muhammad Arif

10.1111/corg.12545
Zaman, R., Asiaei, K., Nadeem, M., Malik, I., & Arif, M. (2024). Board demographic, structural diversity, and eco-innovation: International evidence. Corporate Governance: An International Review, 32(3), 374-390. https://doi.org/10.1111/corg.12545

Received: 21 October 2021 | Revised: 7 February 2023 | Accepted: 10 May 2023

DOI: 10.1111/corg.12545

ORIGINAL ARTICLE

WILEY

Board demographic, structural diversity, and eco-innovation: International evidence

Rashid Zaman[1] | Kaveh Asiaei[2] | Muhammad Nadeem[3] | Ihtisham Malik[3] | Muhammad Arif[4]

[1]School of Business & Law, Edith Cowan University, Perth, Western Australia, Australia

[2]School of Business, Monash University, Bandar Sunway, Malaysia

[3]UQ Business School, University of Queensland, Brisbane, Queensland, Australia

[4]Department of Business Administration, Shaheed Benazir Bhutto University, Karachi, Pakistan

Correspondence
Muhammad Nadeem, UQ Business School, University of Queensland, Brisbane, Queensland, Australia.
Email: nadeem@business.uq.edu.au

Abstract

Research question/issue: We examine whether and how board diversity, measured by demographics (i.e., board gender, cultural diversity, tenure, social capital, expertise, and age) and structural diversity (i.e., board independence, size, board seat accumulation-chair, board compensation, and board meeting frequency), influence corporate eco-innovation.

Research findings/insights: Utilizing a global sample of publicly listed companies for the period 2004–2019, we find that a one-standard deviation increase in demographic and structural diversity translates into 4.66% and 7.11% higher corporate eco-innovation, respectively. Furthermore, we discover that demographic and structural diversity promotes eco-innovation by offsetting the negative effects of political risk. In an additional analysis, we find evidence that, in the absence of greater external monitoring (institutional investors and analyst following), organizations benefit more from the monitoring role of board diversity.

Theoretical/academic implications: By adopting the concept of "bundling the governance mechanisms," our study adds to the ongoing discourse about the function of board diversity in addressing corporate climate footprints by offering original evidence that board diversity heterogeneity—demographic and structural diversity—matters for corporate eco-innovation.

Practitioner/policy implications: Given the increasing pressure on companies to manage their environmental impacts and carbon footprints, our paper has significant ramifications for those involved in promoting eco-innovative business practices, such as policymakers, regulators, and practitioners.

KEYWORDS

corporate governance, board demographic diversity, structural diversity, eco-innovation, political risk, stakeholder-agency theory

1 | INTRODUCTION

Catastrophic climate change-generated incidents around the world are now having serious consequences for man-made environmental degradation and pollution, leading to much outcry among citizens worldwide. Whether it is a worldwide revolt against the plastics industry (Buranyi, 2018) or the continued practice of burning huge swathes of the Amazon rainforests (AP, 2020), public pressure has pushed global leaders to show urgency in dealing with climate change issues (Arif et al., 2022; Benlemlih et al., 2022). Responding to public criticism, there have been significant global efforts to tackle climate change issues—from the Paris Climate Change 2016 Agreement to the global commitments of COP 26 and COP 27. These global efforts have given corporations added responsibility of controlling and containing their environmental footprints. Consequently, corporations are now under pressure to recognize climate change as a material business risk and devise policies and procedures accordingly. Against this backdrop, prior literature echoes environment-focused innovation (also called eco-innovation)[1] as an effective business strategy for corporations to reduce their environmental footprints (Zaman et al., 2022), gain a competitive advantage (Nadeem et al., 2021), and improve their long-term financial performance (Szutowski, 2020) and public credibility.

Despite the importance of eco-innovation, its effective implementation requires significant corporate resources, which is why managers, under the clientele effect of short-term profit maximization, restrain themselves from accepting eco-innovation. In such instances, the effective implementation of eco-innovation largely occurs at the corporate boards' discretion. Being positioned at the apex of the corporation, boards are generally responsible for monitoring management, providing advice and access to resources, and determining companies' long-term strategies, such as eco-innovation (Boivie et al., 2016; Sierra-Morán et al., 2021; Zaman et al., 2022). However, board actions are often constrained by their structure and diversity in the composition, such as independence, skills and expertise, gender, and cultural sensitivities, and age and tenure influence their decisions (Aguilera et al., 2015, 2018; Boivie et al., 2016; Jain & Jamali, 2016). To date, there is some disagreement in the academic literature about what diversity structures give boards an advantage in terms of navigating challenges related to eco-innovation adoption (Jain & Jamali, 2016; Zaman et al., 2022), with the empirical evidence being inconclusive in many cases (Sierra-Morán et al., 2021). This is because most governance studies employ single diversity characteristics (gender diversity, directors' independence, board meeting frequency, and directors' age (Jain & Jamali, 2016) in their estimations. However, recent studies criticize the standalone, single characteristics approach because the board of directors does not operate in isolation but rather reflects a group's judgement (Desender et al., 2016; Jain & Zaman, 2020; Schiehll et al., 2014). Presence and absence of certain indicators have the potential to influence strategic board decision-making, such as eco-innovation in the current study (Oh et al., 2018). Against this backdrop, the current study investigates whether and how board diversity, such as demographics (including board gender, cultural, tenure, social capital, expertise, and age) and structural features (board independence, size, board seat accumulation - chair, board compensation, and board meeting frequency), influence corporate eco-innovation.

We draw on multiple theoretical rationales to establish the relationship between board diversity and eco-innovation. First, the *stakeholder-agency theory* argues that differences in objectives between agents (managers) and multiple principals (stakeholders) create stakeholder-agency conflicts (Hill & Jones, 1992), and a diverse board protecting stakeholders' interests lowers these conflicts. For instance, on one hand, inherent characteristics of eco-innovation, such as higher capital cost, delayed payback period, and high failure-to-success ratio, may limit managers' efforts to implement such activities. On the other hand, pro-environmental stakeholders, interested in corporate eco-innovation activities, count on the board of directors to lower stakeholder-agency conflict by encouraging managers to embrace eco-innovation practices. Prior literature argues that diverse board structures, comprising several individual components related to demographic and structural diversity, are in a better position to protect stakeholders' rights (Hill & Jones, 1992; Jain & Jamali, 2016; Jain & Zaman, 2020) and may positively encourage an organization to show eco-innovation commitment.

Second, *resource dependence theory* contends that every corporation holds a unique set of tangible and intangible resources and capabilities. Such resources and capabilities, when companies effectively channel them, lead to better business outcomes, including general innovations (see Barney, 1991; Ferreira et al., 2020). Similarly, this theory asserts that organizations extract resources from the external environment, and outside pressures, such as a higher level of global environmental awareness, can influence resource-seeking ability (Wincent et al., 2010). In such cases, a highly diverse board (rich in demographic and structural diversity), when properly constituted, might benefit companies in accessing strategically important resources. Such diverse boards link organizations to the outside environment and provide resources for improving companies' eco-innovation capabilities.

Third, the *upper echelons perspective* provides theoretical support for the relationship between board diversity and eco-innovation. Upper echelons theory argues that board composition is vital in setting corporate strategy and strategic decisions (Hambrick & Mason, 1984). According to this theory, directors' thought processes and decisions are contingent on their personal attributes, including experiences, knowledge, expertise, and values (Hambrick, 2007). Consequently, a more diverse board (demographic or structural diversity) brings a variety of perspectives, including a broader knowledge base, and contributes to distinct decisions being made (Harjoto et al., 2018)—all of which remain instrumental in achieving higher organizational environmental commitment such as eco-innovation (Nadeem et al., 2020). Cosma et al. (2021) support this assertion and argue that a more diverse board (a large proportion of female directors, directors with financial expertise, and independent directors) positively relates to companies' being more in tune with environmental protection.

Despite the above three theoretical paradigms portraying a positive image of diversity in board structure, leading to more eco-innovation activities, there is still a debate in the literature where some studies contend that there is detrimental impact of diversity on board processes and outcomes (Phillips & O'Reilly, 1998). Contrary arguments are attributed to the similarity/attraction theory (e.g., Berscheid & Walster, 1978). *Similarity/attraction theory* postulates that similar groups of people are attracted to those they resemble (e.g., Berscheid & Walster, 1978; Byrne et al., 1966). Accordingly, diversity in the form of directors' characteristics (e.g., independence, gender, age, and culture) creates ingroup/outgroup bias and cognitive prejudices. It also hampers the board's deliberation, causing conflict among directors and ultimately affecting the organization's desired outcomes (e.g., Jehn, 1997; O'Reilly et al., 1993; Riordan & Shore, 1997; Nadeem, 2022). Since eco-innovation has a higher capital cost, delayed return on investment, and high failure-to-success ratio, greater diversity might exacerbate these ingroup/outgroup biases and cognitive biases. This scenario subsequently leads to a negative association between board diversity and eco-innovation.

To test the above conflicting arguments, we employ a global dataset of publicly listed firms from 2004 to 2019 and find evidence that a one-standard deviation increase in demographic and structural diversity corresponds to a 4.66% and 7.11% increase in corporate eco-innovation, respectively. Furthermore, we discover that demographic and structural diversity promotes more eco-innovation by offsetting the negative effects of political risk. In an additional analysis, we find evidence that the documented positive association between board diversity, measured by demographics and structural diversity and corporate eco-innovation, is more pronounced in firms with poor external monitoring. This implies that in the absence of greater external monitoring (institutional investors and analyst following), companies benefit more from the monitoring role of board diversity.

This study contributes to the literature in several ways. First, it extends the growing body of research on board diversity in eco-innovation, by using two dimensions of diversity: first, demographic diversity, which includes board gender, culture, tenure, social capital, expertise, and age; and second, structural diversity, which includes board independence, size, board seat accumulation (chair), board compensation, and board meeting frequency. Prior literature has traditionally focused on single diversity characteristics such as gender diversity and/or board independence—resulting in divergent literature outcomes (Jain & Jamali, 2016; Sierra-Morán et al., 2021; Zaman et al., 2022). Second, we provide new perspectives on how demographics and structural diversity influence corporate eco-innovation. Prior research concentrated on the linear relationship between a single diversity metric and corporate innovation (see Nadeem et al., 2020) without addressing the underlying conditions. We expand on such literature by testing for political risk and monitoring channels in board diversity and eco-innovation relationship. Finally, our research has substantial policy and practice implications—as our results suggest that diversity heterogeneity matters in promoting eco-innovation. Their reliance on specific diversity traits, such as gender diversity or board independence, will not produce the desired results, particularly when it comes to promoting firms' 'green' committees that deal with issues such as eco-innovation.

The rest of this paper is structured as follows. In part two, it provides a literature review on the relevant studies and provides the hypotheses. The third section discusses the methodological approach, which includes the sample and data, variable measurements, and estimation model. Section four summarizes and examines the findings. Finally, section five concludes this paper with a summation of the main themes covered here.

2 | LITERATURE AND HYPOTHESES

2.1 | Eco-innovation

In recent decades, climate change, escalating environmental pollution, irremediable damage to the Earth's biodiversity, and intensified exploitation of finite natural resources have become major concerns for societies around the world (Carvajal et al., 2022; Talpur et al., 2023). Being major contributors to such problems, companies face enormous pressures from different stakeholders, communities, and policymakers/regulators to be innovative and remedial in their business practices; they now have to be environmentally friendly as well as economically profitable (He et al., 2018; Zaman et al., 2021). Eco-innovation, also referred to as green/environmental innovation, represents a type of innovation encompassing new or modified systems, products, practices, and processes, which bring sustainable benefits to the environment (Liao et al., 2018). Eco-innovation is mutually beneficial for its positive effects on the environment through diminishing waste, minimizing pollution, and augmenting corporate profitability through embedding innovativeness in the production or manufacturing process and efficient use of resources (Zaman et al., 2022).

Despite the fact that eco-innovation is increasingly desired by stakeholders, including customers and regulators, it has several idiosyncratic characteristics—restraining managers from adopting eco-innovative business operations. First, eco-innovation is a complex process including changes within the production process and the risk of product failure—making firms' managements wary of such risky investments (Christensen, 1997). Second, the diffusion of eco-innovation is a very slow process and returns on investment in such projects cannot be realized immediately (Kemp & Volpi, 2008). Since eco-innovation projects are long-term investments that can cast doubts on firms' short-term financial performance, businesses facing financial constraints and managers concerned about short-term performance are less likely to give eco-innovative projects the go-ahead. Finally, eco-innovation cannot happen in isolation at the firm level, rather is in fact a systemic process requiring changes in raw materials, waste management practices, and cooperation among industrial partners—making it an extremely interdependent process calling for different stakeholders to work together (Tang et al., 2015).

Nonetheless, eco-innovation is beneficial for a firm, in addition to its positive impacts on the environment. For instance, Liao (2018a) observes that firms' investments in eco-friendly products or goods/services significantly enhance their financial performance. More recently, Alos-Simo et al. (2020) report that eco-innovation is positively associated with the revenues of Spanish companies across different sectors. Similarly, Zaman et al. (2022) find that eco-innovative firms face significantly lower stock price crash risk compared with their less innovative counterparts. Prior literature highlights several factors that can affect an organization's willingness to invest in eco-innovation, including stakeholder pressures (Yu et al., 2017), institutional environment (Liao, 2018a; Pickman, 1998), resources (Cainelli et al., 2015; Li, 2014), and industry competition (Liao et al., 2018b). Along the same lines, the managerial interpretations, individual characteristics, and thought processes of a company's directors are considered as important drivers of environmental innovation (Sharma, 2000). Furthermore, Cuerva et al. (2014) argue that a firm's abilities can stimulate eco-innovation since companies require considerable financial and non-financial resources for such projects to be undertaken and successfully completed.

Corporate boards, being positioned at the apex of firms, are generally responsible for monitoring managerial actions, protecting stakeholders' interests, providing advice and access to resources, and determining companies' long-term strategies, such as eco-innovation (Boivie et al., 2016; Sierra-Morán et al., 2021; Zaman et al., 2022). Scholars in this stream of the literature have recently begun to investigate the impact of board characteristics on firms' willingness to adopt eco-innovative practices. For instance, García-Sánchez et al. (2021) find that independent directors are significantly and positively associated with implementing eco-innovation and eco-design projects. Similarly, Arena et al. (2018) document that CEO hubris facilitates firms' engagement in green innovation activities. In their work, Nadeem et al. (2020) find that the boards' gender composition is vital for eco-innovation, reporting that female directors significantly increase firms' willingness to implement eco-innovative projects. Nevertheless, a major concern with prior studies on the board-level determinants of eco-innovation is that these studies employ single diversity attributes. Some studies (e.g., Desender et al., 2016; Schiehll et al., 2014) have argued that boards of directors do not operate in isolation but rather reflect a group's logic—suggesting that the presence and absence of certain indicators have the potential to influence strategic board decision-making, that is, eco-innovation in our case. To fill this void in the literature, this study attempts to investigate whether and how boards' demographic diversity (gender, cultural, social, expertise, and age-related issues) and structural diversity (reflecting board independence, size, board seat accumulation, chair, compensation, and meeting frequency) affect corporate eco-innovation practices.

2.2 | Board demographic and structural diversity and eco-innovation

Corporate boards, being at the top of the firm, assume two key roles in a company: a monitoring role and a resource/advisory role (Jain & Zaman, 2020; Nadeem, 2020). The former involves a board's ability to monitor and influence managers' day-to-day decisions concerning business operations, and the latter implies that boards play a crucial role in connecting a firm to the external environment in order to procure necessary resources. However, boards' actions are often shaped by their structure and diversity in their composition, such as independence, skills and expertise, gender and cultural sensitivities, and age, and corporate strategic decisions often reflect such board attributes (Aguilera et al., 2015, 2018; Boivie et al., 2016; Jain & Jamali, 2016). Conceptualizing directors' role as advisors, Ben-Amar et al. (2013), for instance, argue that board effectiveness relies on diversity of cultures, experiences, and genders, referred to as board's demographic diversity. The literature on governance mechanisms has vastly explored the role of board characteristics in corporate strategic directions, including environmental orientation, yet the findings remain inconclusive (e.g., Nadeem, 2021; Sierra-Morán et al., 2021). For example, Ararat et al. (2015) find that a board's demographic diversity is positively associated with firm performance, indicating that demographically diverse boards bring diversity and new perspective to firms' strategic directions. Similarly, Hafsi and Turgut (2013) document a significant positive relationship between board diversity and firms' social performance. Conversely, Adams and Ferreira (2009) find that although board gender diversity improves corporate board dynamics, the average effect of gender diversity on firm performance is negative.

One of the primary reasons of inconclusive findings in the governance scholarship, according to Jain and Jamali (2016), is that most prior studies have focused on governance mechanisms as independent constructs (e.g., gender, race, expertise, ownership)—implicitly assuming that boards of directors operate in isolation. However, relatively recent research (e.g., Desender et al., 2016; Schiehll et al., 2014) contends that boards are workgroups with complex monitoring and advising tasks, and corporate strategic decisions reflect groups' logics. It has been argued by Aguilera et al. (2008) and Dalton et al. (2003) that corporate strategic orientation depends on the efficiency of a bundle of governance mechanisms since several governance mechanisms interactively influence organizational outcomes in complex ways. Therefore, the purpose of this study is to examine the impact of boards' demographic and structural diversity, measured by bundling different governance mechanisms, on corporate eco-innovation—a strategic decision corporate boards need to make against the backdrop of alarming changes in the world's climate.

A board's demographic diversity encompasses gender diversity, cultural diversity, tenure, social capital, directors' expertise, and age, and structural diversity encircles board independence, size, board seat accumulation, board chair, compensation, and board meeting frequency. In line with the "bundling the governance mechanisms" notion put forward by Ward et al. (2009) and García-Castro et al. (2013), we contend that different board attributes do not act in isolation. Instead, board characteristics interact with each other to have an aggregate effect on corporate decision-making. We draw on the following multiple theories to establish a link between boards' demographic and structural diversity and eco-innovation.

First, the stakeholder-agency theory proposes that a typical firm is composed of different stakeholders (Freeman, 1999; Hill &

Jones, 1992), who have implicit contracts with each other concerning a wide range of interests which, at times, could be conflicting (Jain & Zaman, 2020). Motivated by their own interests, managers may opportunistically shun strategic projects beneficial for multiple stakeholders. Given that eco-innovation activities are costly, riskier, and may have adverse impacts on short-term performance, self-interested managers are less likely to invest in such projects—raising agency issues. In such circumstance, stakeholders expect boards of directors to lower stakeholder–agency conflicts by encouraging managers to undertake pro-environmental projects (Jain & Zaman, 2020; Nadeem, 2021). Prior literature maintains that diverse board structures encompassing demographic and structural diversities are in a better position to protect stakeholders' interests (Hill & Jones, 1992; Jain & Jamali, 2016) and thus may positively get the organization to commit to eco-innovation-related projects.

Second, resource dependence theory maintains that the corporate strategic orientation of a firm is linked to the opportunities that are available to access the necessary resources, upon which firms' survival is contingent (Pfeffer & Salancik, 1978). Boards of directors play a vital role in linking a business to the external environment in order to access necessary resources (Nadeem, 2020). Prior studies (e.g., Wincent et al., 2010) argue that diverse boards, rich in demographic and structural attributes, are more likely to benefit their firms in terms of providing access to vital resources and effective advising. Given that eco-innovation projects require strategic partnerships, changes throughout the supply chain, and cooperation from different stakeholders, demographically and structurally diverse boards are expected to link the organization to the external environment and provide resources for improving organizational eco-innovation capabilities.

Third, upper echelons theory argues that firms' outcomes reflect top managements' decisions and choices (Hambrick & Mason, 1984). Demographic attributes such as age, education, and background of upper echelons are deemed to be vital predictors of corporate policymaking. For example, Hambrick (2007) argues that executives perceive situations and alternatives through individualized lenses shaped by their personal attributes such as experience and demographic features or circumstances. Consequently, a more diverse board (demographically and structurally) is expected to introduce a variety of perspectives, including a broader knowledge base, and contribute to diverse decision-making—all of which is vital for policymaking concerning eco-innovation. In this regard, prior studies such as Cosma et al. (2021) provide empirical evidence that diverse boards (with female proportion, financial expertise, and independent directors) are positively associated with corporate environmental orientation. Consequently, to the extent that eco-innovation requires substantial resources and cooperation from different stakeholders, and a board's demographic and structural diversity represent diverse stakeholder interests, this helps firms access necessary resources and shape corporate strategic orientation. We expect a positive relationship to appear between a board's demographic and structural diversity and corporate eco-innovation. Based on this argument, we present the following hypotheses.

H1. Board demographic diversity is positively associated with eco-innovation.

H2. Board structural diversity is positively associated with eco-innovation.

3 | RESEARCH METHODOLOGY

3.1 | Sample

Our analyses require several databases to be searched. Refinitiv Eikon provides the eco-innovation score. Bloomberg provides corporate governance data, including board structure and demographic-diversity variables. The Compustat Global database serves to extract all company-level financial information data. World Governance Indicators are sourced from the World Bank. Hassan et al. (2019) provide firm-level political risk. We begin our sampling by collecting data for all publicly traded global firms covered by Refinitiv Eikon from 2004 to 2019. Our sample period dates to 2004, as this is the first year for which data on eco-innovation are available. Our initial sample consisted of 59,883 firm-year observations. We merged all databases and deleted firm years with missing data on our dependent, explanatory, and financial variables. Our final sample amounted to 22,528 firm-year observations from 36 countries.

3.2 | Dependent variable: eco-innovation

Prior literature relies on survey/questionnaire methods to measure eco-innovation (e.g., Eiadat et al., 2008; Peng & Liu, 2016). However, this method may lack verifiability and objectivity, as respondents' views on the questions being asked may be influenced by their personal beliefs and assumptions (Arena et al., 2018). Arena et al. (2018) and Nadeem et al. (2020) developed a self-created environmental innovation index through specific indicators. More specifically, they use total sum scores for a focal firm that would range from 0 (no disclosure made on any indicator) to a maximum of 6 (disclosure made on all indicators). However, self-developed index effectiveness induces selection noise and has been criticized in the extant literature (see Zaman et al., 2021). The Refinitiv Eikon score was recently employed by Zaman et al. (2021) to assess the extent of eco-innovation among businesses. The eco-innovation score from Refinitiv Eikon measures a company's ability to reduce environmental costs and burdens for its consumers, opening up new market opportunities by developing new or improved environmental technology, processes, or eco-designed goods or procedures (See, Refinitiv Eikon). The eco-innovation score from Refinitiv Eikon is a weighted average industry-adjusted composite score on a scale of 0–100 that considers 20 criteria pertaining to organizational eco-products and eco-processes. A score of 100 indicates a high level of commitment to eco-innovation (see Zaman et al., 2021 for details).

3.3 | Independent variables

Scholars have noted the inconclusive literature findings on board diversity and environmental responsibility because a single diversity characteristic was deployed (gender diversity, directors' independence, board meeting frequency, and directors' age; see Jain & Jamali, 2016; Zaman et al., 2022) in their estimations. Because the board of directors does not operate in isolation but rather reflects the logic of a group, recent literature favors the categorization/bundle approach (Desender et al., 2016; Jain & Zaman, 2020; Schiehll et al., 2014). For instance, Harjoto et al. (2018) examined the relationship between board diversity and corporate investment oversight by measuring diversity in two ways: relation oriented (gender, race, and age) and task oriented (tenure and expertise). Similar to this, Sierra-Morán et al. (2021) did a meta-analysis to investigate the impact of board diversity—grouped by demographic and structural diversity—on businesses' overall innovation. We used two dimensions: first, demographic diversity, which includes board gender, culture, tenure, social capital, expertise, and age; and second, structural diversity, which incorporates board independence, size, board seat accumulation - chair, board compensation, and board meeting frequency. We did this in accordance with the recent literature on board diversity bundles, particularly Harjoto et al. (2018) and Sierra-Morán et al. (2021). We assess board diversity using the BLAU index, a popular demographic study measure (Blau, 2000). We calculated the BLAU index using the below equation.

$$BLAU\ index = 1 - \sum P_i^2 \tag{1}$$

where P is the proportion of individual categories, and i is the number of categories. An index value of 1 indicates perfect heterogeneity, while a zero value reflects perfect homogeneity. We employed a two-step process to measure both *Demographic diversity* and *Structural diversity*. First, we created an individual BLAU index for each indicator of demographic diversity (structural diversity), namely board gender-BLAU, board cultural diversity-BLAU, board tenure-BLAU, board social capital-BLAU, board expertise-BLAU, and board age-BLAU (board independence-BLAU, board size-BLAU, board chair-BLAU, board compensation-BLAU, and board meeting frequency-BLAU). Finally, our final measure, demographic diversity (structural diversity) is defined as the sum of all relevant BLAU indices of the respective category.

3.4 | Control variables

We also control for several firm-specific characteristics that may guide eco-innovation (Liao et al., 2015; Nadeem et al., 2020). First of all, these include overall environmental, social, and governance (ESG) performance because companies with higher ESG may undertake more environmentally innovative projects (Zaman et al., 2022). We also control for firm-specific financial variables: firm size (*Firm SIZE*) is measured as the natural logarithm of total assets; financial performance (*ROA*) is measured as income before extraordinary items divided by total assets; LOSS takes the value of one if the company suffered a loss in year *t*, zero otherwise; market performance – market value divided by book value; leverage (*Leverage*) is total debt to total equity ratio; capital intensity (*CAPX_TA*) is net property, plant, and equipment divided by total assets; research and development (*R&D_TA*) is total research and development expense divided by total assets; foreign income (*Ln_Foreign Income*) is the natural logarithm of companies total income operations outside the country of origin. Finally, we also take into account the institutional infrastructure at the national level using the global governance indicator (*W.G index*). This is because businesses operating in strong institutional environments may have easier access to resources that make eco-innovation possible.

To empirically examine the impact of board diversity, grouped by demographic diversity and structural diversity, on eco-innovation, we developed the following estimation model:

$$\begin{aligned} Eco-innovation_{it+1} = {} & \alpha_0 + \alpha_1 Demographic\ diversity_{it} \\ & + \alpha_2 Structural\ diversity_{it} + \alpha_z Controls_{it} \\ & + Year\ Fixed\ Effect + Industry\ Fixed\ Effect \\ & + Country\ Fixed\ Effect + \varepsilon_{it} \end{aligned} \tag{2}$$

where, *Eco-innovation* reflects the Refinitiv Eikon environmental innovation score of company *i* at year $t+1$. *Demographic diversity* includes the sum of all *BLAU* indices related to individual indicators including board gender, culture, tenure, social capital, expertise, and age. *Structural diversity* comprises the sum of the *BLAU* indices related to board independence, size, board seat accumulation - chair, board compensation, and board meeting frequency. *Controls* represent a vector of all control variables defined in Section 3.4. Fixed effects for the year, industry, and country account for time-invariant, sectoral and country variation that may be related to the dependent and independent variables. The Appendix contains detailed explanations of the variables.

4 | RESULTS

4.1 | Descriptive statistics

The descriptive statistics for the dependent, independent, and control variables are shown in Table 1. The Eco-innovation average score (23.5) continues to be low, meaning that businesses throughout the world are performing badly in terms of adopting environmentally innovative processes and practices. Similarly, in terms of our explanatory factors, the mean score indicates that organizations are more committed to demographic than structural diversity. This disparity might be attributable to stakeholder pressure on corporations to increase diversity at the upper echelon levels. Regarding control variables, the ESG average score of 27.9 suggests that global firms have less favorable preferences for overall ESG performance. All other financial characteristic controls are consistent with the literature (see Liao et al., 2015; Zaman et al., 2022).

TABLE 1 Descriptive statistics.

	N	Mean	Std. dev.	p25	Median	p75
Dependent variable						
Eco-innovation	22,528	23.541	31.245	0.000	0.000	50.000
Independent variables						
Demographic diversity	22,528	0.476	1.434	0.279	0.892	1.282
Structural diversity	22,528	0.289	0.224	0.025	0.309	0.512
Control variables						
ESG score	22,528	27.944	23.867	0.000	29.300	43.273
Firm SIZE	22,528	16.395	2.260	14.808	15.966	17.542
ROA	22,528	5.775	7.575	2.060	5.350	9.160
LOSS	22,528	0.134	0.341	0.000	0.000	0.000
MTB	22,528	2.857	3.824	1.230	2.040	3.280
Leverage	22,528	0.257	0.184	0.110	0.241	0.370
CAPX_TA	22,528	0.047	0.050	0.013	0.033	0.062
R&D_TA	22,528	0.016	0.040	0.000	0.000	0.009
Ln_Foreign income	22,528	0.895	1.654	0.000	0.000	0.806
W.G index	22,528	83.798	12.461	84.281	84.948	89.380

Table 2 presents the correlation matrix that reveals a significant positive association between demographic and structural diversity with eco-innovation; it provides initial support for our hypothesis. Furthermore, the reported results indicate that the Pearson correlation coefficient of all explanatory factors is less than 0.80. (Wooldridge, 2010). Therefore, multicollinearity does not appear to be a problem in this investigation.

4.2 | Baseline results

The regression results for Equation 2 are shown in Table 3. Models (1) to (3) provide regression findings for the influence of demographic and structural diversity on eco-innovation in the absence of control factors. Models (4) through (6) investigated the same but with control variables, along with country, industry, and year fixed effects.

The findings of our models (1) to (6) demonstrate that the coefficient estimates on demographic and structural diversity are positive and substantial, confirming that board diversity considerably enhances eco-innovation. In particular, the coefficient estimates on the demographic and structural diversity in column (6) are 0.766 (*p*-value .01) and 7.474 (*p*-value .01), with a statistical significance of 1%. These findings are economically significant. A one-standard deviation increase in demographic and structural diversity, for example, corresponds to 4.66% and 7.11% increases in eco-innovation, respectively.

At the onset of control variables, we find that large firms (*Firm Size*) with better financial performance (*ROA*) and higher research and development expenses (*R&D_TA*) are associated with eco-innovation. Companies with foreign operations (*Ln Foreign Income*), particularly operating in nations where there is a lot of government oversight (*W.G Index*), are in a better position to accept eco-innovation. Conversely, companies focusing on market performance (*MTB*) and heavy capital investment (*CAPX_TA*) are negatively associated with eco-innovation.

4.3 | Board demographic and structural diversity and eco-innovation: does firm-level political risk matter?

Strong environmental commitment actually worsens productivity because it forces a company to devote a large portion of its resources to putting environmentally friendly practices in place, which is time-consuming and expensive to do (Palmer et al., 1995; Rassier & Earnhart, 2010). This reallocation of funds to the acquisition of environmentally friendly practices will to some extent undermine managerial and financial objectives, including profitability (Sarkis & Cordeiro, 2001; Walley & Whitehead, 1994). Such activities rely on the outside environment and may be restricted or stopped in response to various political demands. Literature mapping on the negative effect of eco-innovation maintains that development and implementation are costly and heavily dependent on state and/or government incentives (Walley & Whitehead, 1994) that may be curtailed or withdrawn in response to fluctuating political imperatives. Further, higher capital costs, a longer payback period, and a high failure-to-success ratio of eco-innovation make an ideal case for political risk. Consequently, companies that are exposed to political risk invariably face higher uncertainties that are counter to market demand, harm to their reputations, high operating costs due to additional statutory compliance requirements, future litigation, and enforcement activities. All of these can result in some companies going out of business—which may limit or simply stop any general trend toward eco-innovation.

TABLE 2 Pearson correlation.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *Eco-innovation*	1.000												
(2) *Demographic diversity*	0.064***	1.000											
(3) *Structural diversity*	0.136***	−0.094***	1.000										
(4) *ESG score*	0.135***	0.018***	0.697***	1.000									
(5) *Firm SIZE*	0.333***	0.042***	0.014**	0.051***	1.000								
(6) *ROA*	−0.020***	0.007	−0.033***	−0.056***	−0.084***	1.000							
(7) *LOSS*	−0.055***	−0.001	0.009	0.012*	−0.118***	−0.570***	1.000						
(8) *MTB*	−0.062***	−0.006	−0.010	−0.012*	−0.169***	0.225***	−0.044***	1.000					
(9) *Leverage*	−0.029***	−0.011*	−0.007	0.007	−0.038***	−0.087***	0.114***	−0.025***	1.000				
(10) *CAPX_TA*	−0.048***	−0.011*	−0.031***	−0.024***	−0.029***	0.075***	0.029***	0.016**	0.116***	1.000			
(11) *R&D_TA*	−0.004	−0.023***	−0.029***	−0.041***	−0.256***	−0.041***	0.128***	0.200***	−0.163***	−0.086***	1.000		
(12) *Ln_Foreign income*	0.033***	−0.027***	−0.086***	−0.114***	0.022***	0.079***	−0.050***	0.023***	−0.084***	−0.022***	0.065***	1.000	
(13) *W. G index*	0.016**	0.006	−0.054***	−0.083***	−0.315***	−0.045***	0.033***	−0.010	−0.042***	−0.043***	0.071***	0.072***	1.000

$^{***}p < .01$. $^{**}p < .05$. $^{*}p < .1$.

Since organizations draw their resources from the outside world, external pressures like a higher level of political risk can make it difficult for organizations to find resources (Wincent et al., 2010). Supporting this, Hassan et al. (2019) advocate that businesses cut back on investment when political risk increases. However, we believe that board diversity, when properly structured in terms of demographics and structural features, may help businesses gain access to strategically important resources and get around political risk-related obstacles. We anticipate that businesses with greater demographic and structural diversity may experience more eco-innovation due to reducing the negative effects of political risk.

We employ an interaction variable approach to examine the role of political risk in demographic and structural diversity and eco-innovation by employing Equation 3 as follows.

$$\begin{aligned} Eco-innovation_{it+1} = {} & \alpha_0 + \alpha_1 Demographic\ diversity * Political\ Risk_{it} \\ & + \alpha_2 Structural\ diversity * Political\ Risk_{it} \\ & + \alpha_3 Demographic\ diversity_{it} \\ & + \alpha_4 Structural\ diversity_{it} + \alpha_5\ Political\ Risk_{it} \\ & + \alpha_z Controls_{it} + Year\ Fixed\ Effect \\ & + Industry\ Fixed\ Effect + Country\ Fixed\ Effect + \varepsilon_{it} \end{aligned} \tag{3}$$

where *Political Risk* is a textual measure that indicates how much time is spent discussing political risks during a company's quarterly earnings conference calls. We present our results in Table 4.

Despite the fact that the results of models (1) through (3) show that political risk significantly lowers eco-innovation, the coefficient estimates of the interaction between Political Risk and Diversity, both demographic and structural diversity, remain significant and positive at a level of 1%. These findings support the resources-based theory's view that a board of directors from diverse backgrounds enhances a company's capacity to increase resources, particularly in the face of high political risk.

4.4 | Board demographic and structural diversity and eco-innovation: does external corporate governance matter?

In this section, we explore whether the positive association between board demographic and structural diversity and eco-innovation varies across external monitoring. Due to the nature of eco-innovation operations, in particular their emphasis on reducing corporate environmental impact, such businesses may attract more institutional investors and equity analyst support. Due to a notable increase in responsible/sustainable investment that considers businesses' environmental elements, the existence of major institutions and analyst followings may improve companies' eco-innovation strategies. Eccles and Klimenko (2019), for instance, conducted interviews with 70 executives from 43 international investing institutions. Their data reveal that when deciding where to invest their capital, major global financial institutions take the environmental impact of potential investors into account. In addition, having well-developed external corporate

TABLE 3 Board diversity and eco-innovation.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Demographic diversity	0.787***		0.957***	0.633***		0.766***
	(6.07)		(7.33)	(5.22)		(6.26)
Structural diversity		8.209***	9.102***		6.396***	7.474***
		(8.58)	(9.45)		(5.76)	(6.66)
ESG score				0.057***	0.019*	0.014
				(6.75)	(1.82)	(1.29)
Firm size				5.293***	5.316***	5.305***
				(58.08)	(58.32)	(58.26)
ROA				0.119***	0.120***	0.116***
				(4.46)	(4.50)	(4.37)
LOSS				−2.095***	−2.063***	−2.087***
				(−3.55)	(−3.49)	(−3.54)
MTB				−0.116***	−0.116***	−0.117***
				(−2.73)	(−2.72)	(−2.75)
Leverage				0.717	0.806	0.755
				(0.77)	(0.87)	(0.81)
CAPX_TA				−8.479***	−8.652***	−7.872**
				(−2.58)	(−2.64)	(−2.40)
R&D_TA				84.473***	84.688***	84.207***
				(18.38)	(18.50)	(18.40)
Ln_Foreign income				0.971***	0.960***	0.972***
				(8.56)	(8.47)	(8.57)
W.G index				0.357***	0.357***	0.357***
				(22.84)	(22.81)	(22.81)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,528	22,528	22,528	22,528	22,528	22,528
Adjusted R^2	0.160	0.161	0.163	0.278	0.278	0.279

Note: This table reports results for the impact of board demographic and structural diversity on eco-innovation. All variables are defined in the Appendix. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

governance mechanisms, such as institutional investors and analyst monitoring, enhances managerial oversight and motivates businesses to pursue eco-innovation. On the other hand, businesses with weak external corporate governance mechanisms might adopt a staggered strategy for eco-innovation.

Prior literature on board monitoring suggests that board diversity, demographic and structural diversity, improves board monitoring by lowering stakeholder interest (Zaman et al., 2021; Zaman et al., 2022), leading to more eco-innovation. This is important because managers may opportunistically avoid strategic projects that benefit many stakeholders. They are motivated by their own interests and are less likely to invest in such projects because they are more expensive, riskier, and may harm short-term performance—all of such discouraging them from committing to eco-innovation. We empirically anticipate that our arguments related to monitoring the role of demographic and structural diversity hold, then the positive relationship between board diversity and eco-innovation should be more (less) pronounced in companies with poor (good) external monitoring. To test our conjecture, we employed two proxies for external monitoring: (i) the proportion of institutional investors and (ii) the analyst following and used a subsampling approach. More specifically, we rerun Equation (2) on two subsamples. High institutional investors (high analyst coverage) comprise firm-year observations where the proportion of institutional investors (high analyst coverage) is higher than the industry median. Contrarily, low institutional investors (low analyst coverage) comprise firm-year observations where the proportion of institutional investors (high analyst coverage) is lower than the industry median. We present our results in Table 5.

TABLE 4 Board diversity and eco-innovation: does political risk matter?

	Eco-innovation $_{t+1}$		
	Model (1)	Model (2)	Model (3)
*Demographic diversity * political risk*	0.113***		0.141***
	(4.61)		(5.72)
*Structural diversity *political risk*		1.445***	1.628***
		(6.77)	(7.55)
Demographic diversity	0.523**		0.423**
	(4.22)		(2.22)
Structural diversity		1.396***	1.201**
		(4.76)	(2.26)
Political risk	−0.373*	−0.853***	−1.002***
	(−1.74)	(−3.77)	(−4.40)
ESG score	0.069***	0.020	0.014
	(7.08)	(1.62)	(1.19)
Firm size	5.670***	5.717***	5.706***
	(53.29)	(53.72)	(53.67)
ROA	0.115***	0.114***	0.110***
	(3.78)	(3.72)	(3.60)
LOSS	−2.130***	−2.136***	−2.180***
	(−3.17)	(−3.18)	(−3.25)
MTB	−0.110**	−0.106**	−0.108**
	(−2.19)	(−2.13)	(−2.18)
Leverage	0.611	0.670	0.613
	(0.57)	(0.62)	(0.57)
CAPX_TA	−10.423***	−10.394***	−9.663***
	(−2.78)	(−2.78)	(−2.59)
R&D_TA	93.114***	93.229***	92.648***
	(17.37)	(17.47)	(17.38)
Ln_Foreign income	0.887***	0.867***	0.877***
	(7.12)	(6.98)	(7.05)
W.G index	0.384***	0.385***	0.386***
	(21.45)	(21.49)	(21.52)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	22,528	22,528	22,528
Adjusted R^2	0.292	0.293	0.294

Note: This table reports results for the role of political risk in board demographic and structural diversity and eco-innovation relationship. All variables are defined in the Appendix. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

According to the findings in Panels A and B of Table 5, a positive relationship between board diversity and eco-innovation is more pronounced in companies with weak external monitoring systems, that is, lower institutional ownership and analysis following. This implies that in the absence of strong external corporate governance procedures, companies benefit more from the monitoring role of a board of directors that is diverse.

4.5 | Sensitivity tests

4.5.1 | Robustness test

To confirm our baseline results, we run additional robustness tests. We examine whether our major findings are robust when we employ alternative measures of eco-innovation (industry-adjusted values of

TABLE 5 Board diversity and eco-innovation: role of external monitoring.

Panel A: Role of institutional investors		
	Eco-innovation $_{t+1}$	
	High IOW Model (1)	Low IOW Model (2)
Demographic diversity	0.355**	1.362***
	(2.00)	(5.57)
Structural diversity	7.769***	10.380***
	(4.58)	(4.50)
All controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes
Observations	6,780	6,780
Adjusted R^2	0.291	0.343
Panel B: Role of analyst coverage		
	Eco-innovation $_{t+1}$	
	High analyst coverage Model (1)	*Low analyst coverage* Model (2)
Demographic diversity	0.449*	1.032***
	(1.95)	(5.51)
Structural diversity	7.604***	9.174***
	(3.63)	(5.30)
All controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes
Observations	9592	9592
Adjusted R^2	0.318	0.328

Note: This table reports results for the role of external monitoring in board demographic and structural diversity and eco-innovation relationship. All variables are defined in the Appendix. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

TABLE 6 Robustness tests.

Panel A: Alternative dependent variable – industry adjusted eco-innovation			
	Industry adjusted eco-innovation		
	Model (1)	Model (2)	Model (3)
Demographic diversity	0.613***		0.763***
	(4.60)		(5.67)
Structural diversity		7.136***	8.259***
		(5.90)	(6.75)
All controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	22,528	22,528	22,528
Adjusted R^2	0.135	0.136	0.137
Panel B: Global financial crisis – 2008–2009			
	GFC Excluded 2008 and 2009 Eco-innovation $_{t+1}$		
	Model (1)	Model (2)	Model (3)
Demographic diversity	0.697***		0.850***
	(4.79)		(5.79)
Structural diversity		7.450***	8.699***
		(5.53)	(6.39)
All controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	20,051	20,051	20,051
Adjusted R^2	0.289	0.290	0.291

Note: This table reports results for the robustness checks using an industry-adjusted eco-innovation measure and by excluding GFC years. All variables are defined in the Appendix. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

eco-innovation) and ensure our results are not driven by the Global Financial Crisis (GFC). This is important because prior studies indicate that eco-innovation might vary from industry to industry (Zaman et al., 2021). Likewise, the GFC significantly hampers companies' balance sheets and subsequently their ability to follow environmentally friendly practices (Zaman et al., 2022). To rule out these possible noises in our main results, we re-run our main model by employing an industry adjusted measure for eco-innovation and by excluding the years 2008 and 2009 (for GFC). We present robustness results in Table 6.

Notably, our robustness tests include all control variables, including country-fixed, industry, and year fixed effects. We obtain qualitatively consistent results in both instances, indicating that our baseline results still persist regardless of the eco-innovation proxy used and even when accounting for the GFC.

4.5.2 | Identification tests

Endogeneity biases may exist in the link among board diversity, demographic and structural diversity, and eco-innovation for two reasons. First, the consequences of eco-innovation may continue over time, resulting in dynamic bias in our findings. Second, despite the fact that we include a large number of control variables in our analysis, there is still a chance that we overlook certain unobserved firm-specific characteristics that may affect board diversity, demographic and structural diversity, and eco-innovation. To rule out such endogeneity biases, we use two well-known endogeneity estimating approaches,

TABLE 7 Entropy balancing estimation.

	Before Entropy balancing		After Entropy balancing		Before Entropy balancing		After Entropy balancing	
	Treat	Control	Treat	Control	Treat	Control	Treat	Control
	High vs low demographic diversity				High vs low structural diversity			
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Panel A: Demographic and structural diversity univariate comparison								
ESG score	31.540	27.790	31.540	31.540	42.710	16.620	42.710	42.700
Firm SIZE	16.470	16.290	16.470	16.470	16.440	16.320	16.440	16.440
ROA	5.630	5.499	5.630	5.629	5.443	5.686	5.443	5.443
LOSS	0.139	0.144	0.139	0.139	0.141	0.143	0.141	0.141
MTB	2.820	2.871	2.820	2.820	2.840	2.851	2.840	2.840
Leverage	0.255	0.262	0.255	0.255	0.256	0.261	0.256	0.256
CAPX_TA	0.045	0.048	0.045	0.045	0.045	0.048	0.045	0.045
R&D_TA	0.014	0.017	0.014	0.014	0.014	0.017	0.014	0.014
Ln_Foreign income	0.792	0.855	0.792	0.793	0.726	0.921	0.726	0.727
W.G index	78.350	79.710	78.350	78.350	77.660	80.400	77.660	77.660

Panel A1: Entropy regression

	Eco-innovation $_{t+1}$ Model (1)	Eco-innovation $_{t+1}$ Model (2)
Demographic diversity	0.766***	
	(5.08)	
Structural diversity		12.812***
		(7.51)
All controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes
Observations	22,528	22,528
Adjusted R^2	0.197	0.181

Panel B: System GMM regression

	Eco-innovation $_{t+1}$ Model (1)	Eco-innovation $_{t+1}$ Model (2)
Demographic diversity	0.362**	
	(2.10)	
Structural diversity		13.755**
		(2.11)
Eco innovation $_{t-1}$	0.923***	0.914***
	(42.00)	(40.18)
All controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes
Observations	22,528	22,528
AR (1) *p*-value	.000	.000
AR (3) *p*-value	.468	.485
Hansen J test *p*-value	.311	.285

Note: This table reports results for the endogeneity checks using the entropy balancing method and system generalized method of moments. All variables are defined in the Appendix. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

namely System GMM and entropy balance estimation (Flannery & Hankins, 2013; Hainmueller, 2012; Wintoki et al., 2012). The results are presented in Table 7.

Panels A and A1 report the entropy balancing results, while Panel B shows results for the system GMM. Panel A presents a univariate mean comparison of our covariates before and after entropy matching. The control and treatment groups are based on indicator variables with a higher and lower cross-sectional industrial mean for demographic and structural diversity, respectively. A firm-year observation is included in the treatment group if the cross-section mean of demographic diversity (structural diversity) is greater than the industrial average. Firm-year observations with a lower cross-sectional mean are included in the control group. Panel A1 presents univariate results before and after the application of the entropy procedure, with identical mean values of the post-entropy sample, suggesting there is no observed difference between the treatment and control groups. Panel A1 shows the regression on the post-entropy matched sample. We observe consistent findings in Panel A1, validating our baseline findings and demonstrating a considerably beneficial association among board diversity, demographic and structural diversity, and eco-innovation. Panel B reports system GMM results and qualitative similar that are findings to our baseline results. These findings strongly suggest that our baseline results are not vulnerable to endogeneity concerns.

5 | CONCLUSION

Despite substantial stakeholder pressure on firms to undertake environmentally friendly activities, such as eco-innovation, progress in putting such practices in place remains astonishingly low. This is due to the inherent qualities of eco-innovation, which necessitate substitutional expenditures with a delayed return on investment, hence impeding or changing management financial aims (Sarkis & Cordeiro, 2001; Walley & Whitehead, 1994). As a result, managers, despite knowing that eco-innovation provides a competitive advantage by lowering a company's environmental footprint and risk profile, either avoid engaging in expensive eco-innovation initiatives (eco-innovation) or do so only to advance their own agenda (i.e., reputation building or "PR"-related kudos), resulting in lower eco-innovation diffusion in a company. Our paper sheds light on the role of board diversity, demographics (including board gender, cultural, tenure, social capital, expertise, and age), and structural features (encompassing board independence, size, board seat accumulation - chair, board compensation, and board meeting frequency) in promoting corporate eco-innovation. We show that a one-standard deviation increase in demographic and structural diversity translates, respectively, into 4.66% and 7.11% amplified corporate eco-innovation. Furthermore, we discover that demographic and structural diversity promotes more eco-innovation by offsetting the negative effects of political risk. Additionally, we find that in the absence of good external monitoring (institutional investors and analyst following), organizations benefit more from the monitoring role of a diverse board. Our findings have substantial literature, policy, and practical implications, which we explain below.

First, we make a novel contribution to the board of directors group dynamics literature, which has largely remained focused on individual diversity (gender diversity) characteristics, by demonstrating that demographic (including board gender, culture, tenure, social capital, expertise, and age) and structural (encompassing board independence, size, board seat accumulation (chair), board compensation, and board meeting frequency) diversity influence corporate eco-innovation.

Second, we offer a new insight into how demographics and structural diversity influence corporate eco-innovation. Prior research concentrated on the linear relationship between a single diversity measure and corporate innovation (see Nadeem et al., 2020) but without commenting on the underlying conditions. We expand this literature concept by testing for political risk and monitoring channels in board diversity and eco-innovation relationships.

Third, our study has important implications for policymakers and regulatory practices. Policymakers and practitioners must be aware that relying on specific diversity traits, such as gender diversity or board independence, will not produce the desired results, particularly when it comes to promoting firms' green committees that deal with eco-innovation-related issues or opportunities. Instead, we recommend strengthening demographic and structural aspects of diversity, as they are beneficial to companies' commitment to "green" causes.

Fourth and finally, by basing our empirical examination on worldwide data sets, we demonstrate the applicability of our results to a world ravaged by global warming, huge amounts of pollution, and approaching dystopian problems. In elucidating the public discussion on the costs and advantages of board diversity, our analysis clearly indicates that corporate eco-innovation may be accelerated by putting in place a well-designed board that is rich in demographic and structural diversity.

Although the methodology of our study was meticulously planned, the work contains significant limitations that serve as a springboard for new avenues of enquiry for future scholars to undertake. First, our study is limited to understanding the role of board diversity, namely demographic and structural diversity and eco-innovation. However, our analysis remains silent on whether eco-innovation, a consequence of demographic and structural diversity, has an impact on firms' financial performance and needs further investigation. Second, similarly, we conducted various robustness and identification tests and presented data compatible with a causal interpretation; nevertheless, the lack of stringent exogenous instruments restricts the current study's capacity to reduce endogeneity issues.

ACKNOWLEDGEMENTS

The authors would like to thank the associate editor and two anonymous reviewers for their constructive feedback on the earlier version of this article. Any errors are our own. Open access publishing facilitated by The University of Queensland, as part of the Wiley - The University of Queensland agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

There is no conflict of interest with third party or with any other author or publisher.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Rashid Zaman https://orcid.org/0000-0003-3111-9437
Kaveh Asiaei https://orcid.org/0000-0001-7713-4697
Muhammad Nadeem https://orcid.org/0000-0002-8877-4400

NOTE

[1] Eco-innovation is defined as: 'the production, assimilation or exploitation of a product, product process, service or management or business method that is novel to the organisation and which results, through its lifecycle, in a reduction of environmental risk, pollution and other negative impacts of resources use compared to relevant alternatives' (Kemp & Pearson, 2008, p. 7).

REFERENCES

Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics*, *94*(2), 291–309. https://doi.org/10.1016/j.jfineco.2008.10.007

Aguilera, R. V., Desender, K., Bednar, M. K., & Lee, J. H. (2015). Connecting the dots: Bringing external corporate governance into the corporate governance puzzle. *Academy of Management Annals*, *9*(1), 483–573. https://doi.org/10.5465/19416520.2015.1024503

Aguilera, R. V., Filatotchev, I., Gospel, H., & Jackson, G. (2008). An organizational approach to comparative corporate governance: Costs, contingencies, and complementarities. *Organization Science*, *19*(3), 475–492. https://doi.org/10.1287/orsc.1070.0322

Aguilera, R. V., Judge, W. Q., & Terjesen, S. A. (2018). Corporate governance deviance. *Academy of Management Review*, *43*(1), 87–109. https://doi.org/10.5465/amr.2014.0394

Alos-Simo, L., Verdu-Jover, A. J., & Gomez-Gras, J. M. (2020). Does activity sector matter for the relationship between eco-innovation and performance? Implications for cleaner production. *Journal of Cleaner Production*, *263*, 121544. https://doi.org/10.1016/j.jclepro.2020.121544

AP. (2020). *Outcry from environmentalists as Brazil fires official monitoring deforestation*. The Guardian. https://www.theguardian.com/world/2020/jul/13/brazil-firing-amazon-deforestation-data

Ararat, M., Aksu, M., & Tansel Cetin, A. (2015). How board diversity affects firm performance in emerging markets: Evidence on channels in controlled firms. *Corporate Governance: an International Review*, *23*(2), 83–103. https://doi.org/10.1111/corg.12103

Arena, C., Michelon, G., & Trojanowski, G. (2018). Big egos can be green: A study of CEO hubris and environmental innovation. *British Journal of Management*, *29*(2), 316–336. https://doi.org/10.1111/1467-8551.12250

Arif, M., Gan, C., & Nadeem, M. (2022). Regulating non-financial reporting: Evidence from European firms' environmental, social and governance disclosures and earnings risk. *Meditari Accountancy Research*, *30*(3), 495–523. https://doi.org/10.1108/MEDAR-11-2020-1086

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Ben-Amar, W., Francoeur, C., Hafsi, T., & Labelle, R. (2013). What makes better boards? A closer look at diversity and ownership. *British Journal of Management*, *24*(1), 85–101. https://doi.org/10.1111/j.1467-8551.2011.00789.x

Benlemlih, M., Arif, M., & Nadeem, M. (2022). Institutional ownership and greenhouse gas emissions: A comparative study of the UK and the USA. *British Journal of Management*, *34*(2), 623–647. https://doi.org/10.1111/1467-8551.12613

Berscheid, E., & Walster, E. H. (1978). *Interpersonal attraction* (2nd ed.). Reading, MA: Addison-Wesley.

Blau, J. R. (2000). Group enmity and accord: The commercial press in three American cities. *Social Science History*, *24*(2), 395–413. https://doi.org/10.1017/S0145553200010208

Boivie, S., Bednar, M. K., Aguilera, R. V., & Andrus, J. L. (2016). Are boards designed to fail? The implausibility of effective board monitoring. *Academy of Management Annals*, *10*(1), 319–407. https://doi.org/10.5465/19416520.2016.1120957

Buranyi, S. (2018). *The plastic backlash: what's behind our sudden rage—And will it make a difference?* The Guardian. https://www.theguardian.com/environment/2018/nov/13/the-plastic-backlash-whats-behind-our-sudden-rage-and-will-it-make-a-difference

Byrne, D., Clore, G. L. Jr., & Worchel, P. (1966). Effect of economic similarity-dissimilarity on interpersonal attraction. *Journal of Personality and Social Psychology*, *4*(2), 220–224. https://doi.org/10.1037/h0023559

Cainelli, G., De Marchi, V., & Grandinetti, R. (2015). Does the development of environmental innovation require different resources? Evidence from Spanish manufacturing firms. *Journal of Cleaner Production*, *94*, 211–220. https://doi.org/10.1016/j.jclepro.2015.02.008

Carvajal, M., Nadeem, M., & Zaman, R. (2022). Biodiversity disclosure, sustainable development and environmental initiatives: Does board gender diversity matter? *Business Strategy and the Environment*, *31*(3), 969–987. https://doi.org/10.1002/bse.2929

Christensen, C. M. (1997). Marketing strategy: Learning by doing. *Harvard Business Review*, *75*(6), 141–151.

Cosma, S., Schwizer, P., Nobile, L., & Leopizzi, R. (2021). Environmental attitude in the board. Who are the "green directors"? Evidences from Italy. *Business Strategy and the Environment*, *30*(7), 3360–3375. https://doi.org/10.1002/bse.2807

Cuerva, M. C., Triguero-Cano, Á., & Córcoles, D. (2014). Drivers of green and non-green innovation: Empirical evidence in low-tech SMEs. *Journal of Cleaner Production*, *68*, 104–113. https://doi.org/10.1016/j.jclepro.2013.10.049

Dalton, D. R., Daily, C. M., Certo, S. T., & Roengpitya, R. (2003). Meta-analyses of financial performance and equity: Fusion or confusion? *Academy of Management Journal*, *46*(1), 13–26. https://doi.org/10.2307/30040673

Desender, K. A., Aguilera, R. V., Lópezpuertas-Lamy, M., & Crespi, R. (2016). A clash of governance logics: Foreign ownership and board monitoring. *Strategic Management Journal*, *37*(2), 349–369. https://doi.org/10.1002/smj.2344

Eccles, R. G., & Klimenko, S. (2019). The investor revolution. *Harvard Business Review*, *97*(3), 106–116.

Eiadat, Y., Kelly, A., Roche, F., & Eyadat, H. (2008). Green and competitive? An empirical test of the mediating role of environmental innovation strategy. *Journal of World Business*, *43*(2), 131–145. https://doi.org/10.1016/j.jwb.2007.11.012

Ferreira, J., Coelho, A., & Moutinho, L. (2020). Dynamic capabilities, creativity and innovation capability and their impact on competitive advantage and firm performance: The moderating role of entrepreneurial orientation. *Technovation*, *92*, 102061. https://doi.org/10.1016/j.technovation.2018.11.004

Flannery, M. J., & Hankins, K. W. (2013). Estimating dynamic panel models in corporate finance. *Journal of Corporate Finance*, *19*, 1–19. https://doi.org/10.1016/j.jcorpfin.2012.09.004

Freeman, R. E. (1999). Divergent stakeholder theory. *Academy of Management Review*, *24*(2), 233–236. https://doi.org/10.5465/amr.1999.1893932

García-Castro, R., Aguilera, R. V., & Ariño, M. A. (2013). Bundles of firm corporate governance practices: A fuzzy set analysis. *Corporate*

Governance: an International Review, *21*(4), 390–407. https://doi.org/10.1111/corg.12024

García-Sánchez, I. M., Gallego-Álvarez, I., & Zafra-Gómez, J. L. (2021). Do independent, female and specialist directors promote eco-innovation and eco-design in agri-food firms? *Business Strategy and the Environment*, *30*(2), 1136–1152. https://doi.org/10.1002/bse.2676

Hafsi, T., & Turgut, G. (2013). Boardroom diversity and its effect on social performance: Conceptualization and empirical evidence. *Journal of Business Ethics*, *112*, 463–479. https://doi.org/10.1007/s10551-012-1272-z

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, *20*(1), 25–46. https://doi.org/10.1093/pan/mpr025

Hambrick, D. C. (2007). Upper echelons theory: An update. *Academy of Management Review*, *32*(2), 334–343. https://doi.org/10.5465/amr.2007.24345254

Hambrick, D. C., & Mason, P. A. (1984). Upper echelons: The organization as a reflection of its top managers. *Academy of Management Review*, *9*(2), 193–206. https://doi.org/10.2307/258434

Harjoto, M. A., Laksmana, I., & Yang, Y. W. (2018). Board diversity and corporate investment oversight. *Journal of Business Research*, *90*, 40–47. https://doi.org/10.1016/j.jbusres.2018.04.033

Hassan, T. A., Hollander, S., van Lent, L., & Tahoun, A. (2019). Firm-level political risk: Measurement and effects. *Quarterly Journal of Economics*, *134*(4), 2135–2202. https://doi.org/10.1093/qje/qjz021

He, F., Miao, X., Wong, C. W., & Lee, S. (2018). Contemporary corporate eco-innovation research: A systematic review. *Journal of Cleaner Production*, *174*, 502–526. https://doi.org/10.1016/j.jclepro.2017.10.314

Hill, C. W., & Jones, T. M. (1992). Stakeholder-agency theory. *Journal of Management Studies*, *29*(2), 131–154. https://doi.org/10.1111/j.1467-6486.1992.tb00657.x

Jain, T., & Jamali, D. (2016). Looking inside the black box: The effect of corporate governance on corporate social responsibility. *Corporate Governance: an International Review*, *24*(3), 253–273. https://doi.org/10.1111/corg.12154

Jain, T., & Zaman, R. (2020). When boards matter: The case of corporate social irresponsibility. *British Journal of Management*, *31*(2), 365–386. https://doi.org/10.1111/1467-8551.12376

Jehn, K. A. (1997). A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative Science Quarterly*, *42*, 530–557. https://doi.org/10.2307/2393737

Kemp, R., & Pearson, P. (2008). *MEI project about measuring eco-innovation*. Final report.

Kemp, R., & Volpi, M. (2008). The diffusion of clean technologies: A review with suggestions for future diffusion analysis. *Journal of Cleaner Production*, *16*(1), S14–S21. https://doi.org/10.1016/j.jclepro.2007.10.019

Li, Y. (2014). Environmental innovation practices and performance: Moderating effect of resource commitment. *Journal of Cleaner Production*, *66*, 450–458. https://doi.org/10.1016/j.jclepro.2013.11.044

Liao, L., Luo, L., & Tang, Q. (2015). Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *The British Accounting Review*, *47*(4), 409–424. https://doi.org/10.1016/j.bar.2014.01.002

Liao, X. (2018a). Public appeal, environmental regulation and green investment: Evidence from China. *Energy Policy*, *119*, 554–562. https://doi.org/10.1016/j.enpol.2018.05.020

Liao, Z. (2018b). Environmental policy instruments, environmental innovation and the reputation of enterprises. *Journal of Cleaner Production*, *171*, 1111–1117.

Liao, Z., Xu, C. K., Cheng, H., & Dong, J. (2018). What drives environmental innovation? A content analysis of listed companies in China. *Journal of Cleaner Production*, *198*, 1567–1573.

Nadeem, M. (2020). Does board gender diversity influence voluntary disclosure of intellectual capital in initial public offering prospectuses? Evidence from China. *Corporate Governance: an International Review*, *28*(2), 100–118. https://doi.org/10.1111/corg.12304

Nadeem, M. (2021). Corporate governance and supplemental environmental projects: A restorative justice approach. *Journal of Business Ethics*, *173*(2), 261–280. https://doi.org/10.1007/s10551-020-04561-x

Nadeem, M. (2022). Board gender diversity and managerial obfuscation: Evidence from the readability of narrative disclosure in 10-K reports. *Journal of Business Ethics*, *179*(1), 153–177. https://doi.org/10.1007/s10551-021-04830-3

Nadeem, M., Bahadar, S., Gull, A. A., & Iqbal, U. (2020). Are women eco-friendly? Board gender diversity and environmental innovation. *Business Strategy and the Environment*, *29*(8), 3146–3161. https://doi.org/10.1002/bse.2563

Nadeem, M., Bahadar, S., Zaman, R., & Farooq, M. B. (2021). Does organisational capital influence environmental strategies? Evidence from environmental innovation. *Business Strategy and the Environment*, *30*(8), 4121–4135.

Oh, W. Y., Chang, Y. K., & Kim, T. Y. (2018). Complementary or substitutive effects? Corporate governance mechanisms and corporate social responsibility. *Journal of Management*, *44*(7), 2716–2739. https://doi.org/10.1177/0149206316653804

O'Reilly, C., Snyder, R., & Boothe, J. (1993). Effects of executive team demography on organizational change. *Organizational Change and Redesign*, 147–175.

Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening environmental standards: The benefit-cost or the no-cost paradigm? *Journal of Economic Perspectives*, *9*(4), 119–132. https://doi.org/10.1257/jep.9.4.119

Peng, X., & Liu, Y. (2016). Behind eco-innovation: Managerial environmental awareness and external resource acquisition. *Journal of Cleaner Production*, *139*, 347–360. https://doi.org/10.1016/j.jclepro.2016.08.051

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. Stanford University Press.

Phillips, K. W., & O'Reilly, C. A. III (1998). Demography and diversity in organizations: A review of 40 years of research. *Research in Organizational Behavior*, *20*, 77–140.

Pickman, H. A. (1998). The effect of environmental regulation on environmental innovation. *Business Strategy and the Environment*, *7*(4), 223–233. https://doi.org/10.1002/(SICI)1099-0836(199809)7:4<223::AID-BSE164>3.0.CO;2-S

Rassier, D. G., & Earnhart, D. (2010). Does the porter hypothesis explain expected future financial performance? The effect of clean water regulation on chemical manufacturing firms. *Environmental and Resource Economics*, *45*, 353–377. https://doi.org/10.1007/s10640-009-9318-0

Riordan, C. M., & Shore, L. M. (1997). Demographic diversity and employee attitudes: An empirical examination of relational demography within work units. *Journal of Applied Psychology*, *82*(3), 342–358. https://doi.org/10.1037/0021-9010.82.3.342

Sarkis, J., & Cordeiro, J. J. (2001). An empirical evaluation of environmental efficiencies and firm performance: Pollution prevention versus end-of-pipe practice. *European Journal of Operational Research*, *135*(1), 102–113. https://doi.org/10.1016/S0377-2217(00)00306-4

Schiehll, E., Ahmadjian, C., & Filatotchev, I. (2014). National governance bundles perspective: Understanding the diversity of corporate governance practices at the firm and country levels. *Corporate Governance: An International Review*, *22*(3), 179–184. https://doi.org/10.1111/corg.12067

Sharma, S. (2000). Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy. *Academy of Management Journal*, *43*(4), 681–697. https://doi.org/10.2307/1556361

Sierra-Morán, J., Cabeza-García, L., González-Álvarez, N., & Botella, J. (2021). The board of directors and firm innovation: A meta-analytical review. *BRQ Business Research Quarterly*, 23409444211039856. https://doi.org/10.1177/23409444211039856

Szutowski, D. (2020). The impact of eco-innovation on the stock returns of technology-based KIBS: Role of eco-innovation type and its degree of novelty. *Sustainability Accounting, Management and Policy Journal*, *12*(1), 130–155. https://doi.org/10.1108/SAMPJ-10-2019-0375

Talpur, S., Nadeem, M., & Roberts, H. (2023). Corporate social responsibility decoupling: A systematic literature review and future research agenda. *Journal of Applied Accounting Research*, (ahead-of-print). https://doi.org/10.1108/JAAR-08-2022-0223

Tang, Y., Qian, C., Chen, G., & Shen, R. (2015). How CEO hubris affects corporate social (ir)responsibility. *Strategic Management Journal*, *36*(9), 1338–1357. https://doi.org/10.1002/smj.2286

Walley, N., & Whitehead, B. (1994). It's not easy being green. *Harvard Business Review*, *72*, 46–52.

Ward, A. J., Brown, J. A., & Rodriguez, D. (2009). Governance bundles, firm performance, and the substitutability and complementarity of governance mechanisms. *Corporate Governance: An International Review*, *17*(5), 646–660. https://doi.org/10.1111/j.1467-8683.2009.00766.x

Wincent, J., Anokhin, S., & Örtqvist, D. (2010). Does network board capital matter? A study of innovative performance in strategic SME networks. *Journal of Business Research*, *63*(3), 265–275. https://doi.org/10.1016/j.jbusres.2009.03.012

Wintoki, M. B., Linck, J. S., & Netter, J. M. (2012). Endogeneity and the dynamics of internal corporate governance. *Journal of Financial Economics*, *105*(3), 581–606. https://doi.org/10.1016/j.jfineco.2012.03.005

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Yu, W., Ramanathan, R., & Nath, P. (2017). Environmental pressures and performance: An analysis of the roles of environmental innovation strategy and marketing capability. *Technological Forecasting and Social Change*, *117*, 160–169. https://doi.org/10.1016/j.techfore.2016.12.005

Zaman, R., Atawnah, N., Haseeb, M., Nadeem, M., & Irfan, S. (2021). Does corporate eco-innovation affect stock price crash risk? *The British Accounting Review*, *53*(5), 101031. https://doi.org/10.1016/j.bar.2021.101031

Zaman, R., Jain, T., Samara, G., & Jamali, D. (2022). Corporate governance meets corporate social responsibility: Mapping the interface. *Business & Society*, *61*(3), 690–752. https://doi.org/10.1177/0007650320973415

Zaman, R., Nadeem, M., & Carvajal, M. (2021). Corporate governance and corporate social responsibility synergies: Evidence from New Zealand. *Meditari Accountancy Research*, *29*(1), 135–160. https://doi.org/10.1108/MEDAR-12-2019-0649

How to cite this article: Zaman, R., Asiaei, K., Nadeem, M., Malik, I., & Arif, M. (2023). Board demographic, structural diversity, and eco-innovation: International evidence. *Corporate Governance: An International Review*, 1–17. https://doi.org/10.1111/corg.12545

APPENDIX A: DEFINITIONS OF VARIABLES

Dependent variable	
Eco-innovation	Eco-innovation score takes values ranging from 0 to 100 with the lowest values corresponding to less eco-innovation activities in a firm (taken from ASSET4).
Independent variables	
Demographic diversity	Demographic diversity is defined as the sum of BLAU indices (Blau, 2000) corresponding to board gender diversity, culture, tenure, social capital, expertise, and age.
Structural diversity	Structural diversity is defined as the sum of BLAU indices (Blau, 2000) corresponding to board independence, size, board seat accumulation - chair, board compensation, and board meeting frequency.
Control variables	
ESG score	Companies' corporate governance, social, and environmental score (ESG score).
Firm SIZE	Natural log of total assets.
ROA	Return on assets is the ratio of income before extraordinary items to total assets.
LOSS	Takes the value of 1 if the firm suffers loss otherwise zero.
MTB	Market-to-book ratio.
Leverage	Leverage is the ratio of total debt to total assets.
CAPX_TA	Proportion of fixed asset, that is, plants, property and equipment to total assets.
R&D_TA	Research and development expenses divided by total assets.
Ln_Foreign income	Natural log of firm's income from foreign operations.
W.G index	Worldwide governance indicators (WGI) – aggregate for six dimensions of governance: Voice and accountability; political stability and absence of violence/terrorism; government effectiveness; regulatory quality; rule of law and control of corruption.

AUTHOR BIOGRAPHIES

Rashid Zaman is a Senior Lecturer and co-leader of the Corporate Governance and Sustainability Research Cluster at the School of Business and Law, Edith Cowan University in Australia. His research interests encompass a range of topics, including corporate governance, corporate fraud and violations, climate accounting and reporting, corporate social and environmental responsibility, water accounting and reporting, sustainability assurance, and business ethics. He has published his research in top-ranked journals such as *The British Accounting Review*, *Journal of Business Finance & Accounting*, *Journal of Corporate Finance, and Journal of Management*. Additionally, Rashid serves as a member of the editorial boards for *Meditari Accountancy Research* and *Business Ethics, the Environment & Responsibility*.

Kaveh Asiaei is a Senior Lecturer and Research Coordinator in the Department of Accounting at the School of Business, Monash University (Malaysia Campus). His research interests are sustainability accounting, intellectual capital, management control, and performance measurement systems. Kaveh has extensively published articles in various outlets in the field, such as the *International Journal of Accounting Information Systems*, *Business Strategy and the Environment*, *Journal of Management Control*, *Corporate Governance: An International Review*, *Journal of Intellectual Capital*, *Journal of Knowledge Management*, *Management Decision*, and *Meditari Accountancy Research*.

Muhammad Nadeem is an Associate Professor of Accounting at The University of Queensland, Australia. His research interests include corporate governance, corporate social and environmental responsibility, climate reporting and assurance, corporate misconduct, and intellectual capital. Nadeem has extensively published in various journals, including *the British Accounting Review*, *British Journal of Management*, *Corporate Governance: An International Review*, *Journal of Business Finance & Accounting*, and *Journal of Business Ethics*. Nadeem is an associate editor of *Meditari Accountancy Research* and an ad-hoc reviewer for various journals.

Ihtisham Malik is a Lecturer in Finance at The University of Queensland (UQ), also having earned his PhD in finance from UQ in 2020. He is actively involved in finance research and has published scholarly work, in the field of climate finance and asset pricing, in a number of highly ranked academic journals and has also been cited by different media outlets.

Muhammad Arif is currently serving as an Assistant Professor of Accounting and Finance at the Department of Business Administration, Shaheed Benazir Bhutto University, Shaheed Benazirabad. He earned his PhD from Lincoln University, New Zealand. His areas of research interest include sustainability disclosures, corporate governance, applied financial econometrics, corporate finance, and connectedness across financial markets. Dr. Arif has published in leading accounting and finance journals including *British Journal of Management*, *Global Finance Journal*, *Energy Economics*, *Meditari Accountancy Research*, and *Energy Policy*.