

## RESEARCH ARTICLE OPEN ACCESS

# Do Risk Committee Attributes Enhance Climate Risk Disclosure? Evidence From the Listed Mining Firms in South Africa

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## ABSTRACT

This study examines the role of risk committee (RC) attributes in climate risk disclosure among 31 mining firms in South Africa. Focusing on annual data between 2016 and 2021, this study employs a feasible generalized least squares technique, a generalized method of moments, and a method of moment quantile regression to control for endogeneity, heterogeneity, and distributional effects between the target variables. The study revealed that RC characteristics such as RC size, RC independence, and RC gender diversity enhance climate risk disclosure, suggesting that these governance variables are crucial drivers of climate risk reporting among the listed mining firms in South Africa. On the other hand, the frequency of RC meetings impedes corporate climate risk disclosure. The results are consistent across different model specifications and robust to various methodologies. The study concludes that risk committee attributes are essential corporate governance mechanisms that drive corporate decisions on the climate risk disclosure of mining firms in South Africa.

## 1 | Introduction

Climate risk has become a major challenge facing the global economy in the twenty-first century, with major implications for the existence, continuity, and survival of living organisms (Matemane and Graca 2023; Simsek et al. 2024). This is because climate change has caused catastrophic and irreparable damage to the planet and its residents. To address this existential threat, several initiatives and policies have been implemented both in advanced and developing countries to achieve net-zero emissions that support human existence and minimize the adverse effects of climate change (Sun et al. 2020; Saha and Khan 2024). For example, the Security and Exchange Commission and the European Commission have implemented mandatory guidelines on the disclosure of climate risk for United States and European firms, respectively (Gatzert and Reichel 2022). Similarly, the Kyoto Protocol (1997), and, more recently, the 30th Committee of Parties (COP 30) are parts of the measures taken to address

climate-related risk. Similarly, at the micro level, many standards and principles have been introduced to encourage corporations to integrate the disclosure of climate change risk in their annual reports (Vestrelli et al. 2024). For example, in South Africa, the Johannesburg Stock Exchange (JSE) issued a standard and prescription in 2021 for listed companies on the reporting and disclosure of information on climate change.

One of the mechanisms identified in the literature as an avenue to reduce the environmental impact of climate risk is through adequate disclosure of climate-related activities (Bui et al. 2020; da Silva et al. 2022; Daradkeh et al. 2023). Climate risk disclosure (CRD) is a nonfinancial disclosure in which firms provide information on their efforts in managing or reducing the detrimental effects of their activities on the environment (Saha and Khan 2024). Potential investors and shareholders consider firms with greater information on environmental disclosure, such as climate change, as destinations

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of their investment because such disclosure enables them to identify a comprehensive and overall risk embedded in their investment portfolio (Matemane and Graca 2023). In addition, providing sufficient information on climate change risk is a sign of accountability and transparency on the part of firm managers, which can increase firm value in the eyes of investors (Jia et al. 2019). Owing to the pervasiveness and consequences of greenhouse gas emissions on the planet, there is increased demand from shareholders, international communities, and investors for proper and adequate disclosure of climate-related risks by corporate organisations (Hasan, Sufi, and Hussainey 2023). In terms of content, the CRD provides information on a firm's contribution to climate change, its exposure, and its mitigation efforts (Nowiski 2018). However, substantial evidence has been documented on the effects of board characteristics on general risk disclosure (see Al-Qahtani and Elgharbawy 2020; Gull et al. 2023), greenhouse gas (GHG) emissions (Tingbani et al. 2020; Chithambo et al. 2020; Barg et al. 2024) and environmental/ESG disclosure (Sharma et al. 2020; Chung et al. 2024; Nuhu and Alam 2024; Seow 2024).

In view of this, prior studies with a specific focus on CRD have considered only firm board attributes such as board size, board independence, gender diversity, CEO duality, and board meetings as significant predictors of corporate risk disclosure (Ooi et al. 2019; Daradkeh et al. 2023; Saha and Khan 2024; Simsek et al. 2024), whereas existing studies with emphasis on risk committee attributes have considered only their impact on general risk disclosure in sectors such as banking and other environmentally insensitive sectors (Al-Hadi et al. 2016; Jia et al. 2019; Hasan, Sufi, and Hussainey 2023; Malahim 2023). Hence, the connection between a separate risk committee (RC) and CRD is relatively unexplored, especially in the context of developing economies. This study makes some fundamental contributions to the risk disclosure literature by examining the impact of RC characteristics on CRD. In line with this, scholars have identified the importance of stand-alone risk committees for climate risk disclosure (Serag and Daoud (2022)). For example, it is argued that a separate RC strengthens risk management and improves risk disclosure (Hasan, Sufi, and Hussainey 2023; Malahim 2023), improves board effectiveness (Khemakhem et al. 2023) and increases investor and shareholder confidence (Serag and Daoud 2022). This implies that a separate RC plays a fundamental and pivotal role in influencing the quality and quantity of risk management and mitigation strategies to achieve better risk disclosure.

On the basis of the above background, the current study extends the frontier of knowledge in the environmental disclosure literature in the following ways. First, unlike prior studies that consider the existence of the RC, risk committee size and independence (Jia et al. 2016; Al-Hadi et al. 2016), this study examines the attributes of the RC from a broader perspective by including risk committee existence, risk committee size, risk committee independence, gender diversity in the committee and the frequency of risk committee meetings. Importantly, the existence of an RC alone might be insufficient to achieve better risk management. This study argues that the composition and demographic attributes and activity of an RC are important for providing a strong mechanism that strengthens climate

risk identification and mitigation. Second, unlike prior studies on climate risk disclosure (see Jia et al. 2019; Nahar et al. 2021; Hassan et al. 2023), this study provides fresh evidence on firms' attitudes toward climate risk disclosure from an emerging economy perspective. Owing to the peculiar nature of the institutional and regulatory environment in an emerging economy, our study focuses on a leading African economy, South Africa, on the basis of its distinct regulatory and institutional environment. It is mandatory for JSE firms to disclose climate risk in South Africa. As part of integrated reporting, climate risk disclosure is a component of ESG disclosure that is in line with the Task Force for Climate-related Financial Disclosure (TCFD) and the Global Reporting Initiative (GRI). Third, with respect to methodology, the study applies mean-based estimators and moment-based estimators using quantile regression to control for endogeneity, heterogeneity and distributional effects between the target variables. Finally, and more importantly, this study contributes to the importance of corporate governance in influencing climate risk disclosure through the lens of risk committee attributes. To our knowledge, scholarly works on the value relevance of stand-alone RC characteristics as corporate governance mechanisms in predicting CRD in the context of an emerging market such as South Africa are lacking and non-existent.

Following the introductory section, the rest of the paper is structured as follows. Section 2 discusses the theoretical foundations, literature review, and hypothesis development, and the model specification and methodology are presented in Section 3. The empirical results and a discussion of the findings are presented in Sections 4 and 5 concludes the study.

## 2 | Literature Review and Hypothesis Development

### 2.1 | Theoretical Foundation

Theoretically, several strands of thought have been advanced to support the significance of CRD as a major component of non-financial reporting. Owing to the importance of CRD to firm environmental performance, no single theory seems adequate and exhaustive in explaining the rationale for climate risk disclosure practices among business organisations. In addition, theories on disclosure complement rather than compete when discussing the corporate governance and climate risk disclosure nexus (Deegan and Unerman 2011). Hence, this study is premised on stakeholder-agency theory (SAT) and legitimacy theory (LMT) as a theoretical lens to analyze the role of corporate governance via risk committee attributes in firms' engagement in climate risk disclosure among mining firms in South Africa.

#### 2.1.1 | Stakeholder-Agency Theory (SAT)

The SAT integrates the propositions of the stakeholder and agency theories to explain the importance of voluntary disclosure (climate risk in particular) in addressing agency costs and satisfying the interests of multiple stakeholders that rely on a company's reports. However, as documented by Hill and Jones (1992), the SAT represents a new paradigm shift that takes into consideration the conflicts of interest between

managers and multiple expanded stakeholders. The theory proposes that managers are responsible not only to the firm shareholders but also to wider stakeholders who are directly or indirectly affected by the firm's operation. Stakeholder agency theory underscores firms' obligation in the discharge of their duties to all stakeholders (Nicolò et al. 2022, 2023). At the root of stakeholder agency theory is the "right to know" of stakeholders. In this context, stakeholders are interested in the firm's engagement and interactions with the natural environment, the consequences of its actions on the environment, and its efforts and actions towards maintaining and sustaining environmental quality, especially within host communities. According to this school of thought, a company can inform its stakeholders about its environmental stewardship by using social and environmental disclosure (Deegan 2002). Similarly, in the context of agency theory, managers act as agents and representatives of shareholders, and as such, when adequate and substantial information is disclosed by a firm, information asymmetry is reduced, and the principal-agent conflict associated with a corporate firm is mitigated (Jensen and Meckling 1976; Khairreddine et al. 2020). Thus, disclosure on climate risk activities can be used to bridge the information gap between management, shareholders and other stakeholders. However, Hossain et al. (2017) identify CRD as one way of providing evidence that increases shareholders' confidence. Hence, CRD can be employed as a strategic management mechanism to align stakeholders' interests to create value in an integrative and sustainable way (Freeman 1984).

### 2.1.2 | Legitimacy Theory (LMT)

LMT provides an adequate background to support a firm's existence and continuity, especially in the context of the society within which it operates (see Deegan and Unerman 2011; C. M. Deegan 2019; Simsek et al. 2024). In this context, C. M. Deegan (2019) identifies disclosure as a crucial way to foster legitimacy. The LMT opines that the activities and actions of a firm should align with the norms, values, and traditions, bonds, beliefs, and moral and ethical standards of the society within which it operates (Simsek et al. 2024). The tenets of legitimacy theory are construed on the grounds that corporate firms should aspire to meet the demands of various stakeholders, including the host community, to guarantee their continuous existence and operations and garner the necessary support from the business environment. This implies that firms can adopt voluntary disclosure, such as CRD, to garner community support and mitigate legitimacy threats (Nicolò and Cervilla-Bellido 2025). Furthermore, scholars such as C. M. Deegan (2019) assert that organisations embark on sustainability reporting, including CRD, to gain and retain their legitimacy as business entities. Deegan (2002) emphasises that legitimacy is derived from the concept of a "social contract" between the corporation and the society within which it operates. The authors contend that the failure of corporations to abide by social contracts may threaten their existence. Furthermore, the notion of a social contract is premised on the alignment of business objectives with accepted societal values. Hence, the failure of firms to provide sufficient disclosure of their activities on the environment, and most importantly on climate-related activities, could stymie their ongoing concern and may eventually lose legitimacy

(Matemane and Graca 2023; Simsek et al. 2024; Nicolò and Cervilla-Bellido 2025). The study is premised on legitimacy theory because for environmentally sensitive industries such as the mining sector, adequate and sufficient disclosure of climate-oriented information is expected to address societal and environmental concerns. By disclosing relevant information on the climate and environment, the image and reputation of firms can be increased while community trust can be earned. Hence, this study utilises stakeholder-agency theory and legitimacy theory as the theoretical basis for addressing the study's objective.

## 2.2 | Empirical Studies and Hypothesis Development

The issue of climate risk is at the forefront of global discussion and has attracted the attention of policymakers, governments, and international organisations across the globe. To underscore this, Papakonstantinou (2019) identifies climate risk as the leading global threat for companies that must be managed and mitigated to achieve better financial outcomes. Additionally, as documented by Karl et al. (2025), mental health and other social costs related to climate change are estimated to increase by \$47B and \$537B in 2030 and 2050, respectively. In the empirical literature, Honey et al. (2025) discovered a positive association between corporate governance quality and corporate climate risk disclosure. Similarly, the studies by Al-Hadi et al. 2016; Jia et al. (2019) and Nahar et al. (2021) contend that the presence of a standalone RC is beneficial to risk disclosure among the GCC, Australian, and Bangladesh firms. Focusing on Pakistani firms, Hassan et al. (2023) show that risk committee independence and female representation in the risk committee are negatively associated with corporate risk disclosure, whereas risk committee size significantly enhances risk disclosure. Thus, in this study, we argue that the composition and structure of the RC matter for greater disclosure of climate risk-oriented information. A summary of existing studies on corporate governance and (climate) risk disclosure is provided in Table A1 in the Appendix A.

Focusing on the proposition of stakeholder theory, a separate RC is presumed to enhance risk communication and thus reduce information asymmetry between management and other stakeholders. Having a distinct RC is linked to better risk management techniques (Daly and Bocchino 2006), which supports the necessity of having a separate RC. Similarly, the study of Al-Hadi et al. (2016) explores the interconnections among risk committees, the business life cycle, and market risk disclosure among financial firms in Gulf Cooperation Council (GCC) countries and establishes that the presence of RCs enhances market risk disclosures. Similarly, Jia et al. (2016), Jia et al. (2019) and Jia and Li (2022) opine that a standalone RC improves corporate governance and thus enhances the corporate risk disclosure of listed firms in Australia. These studies contend that the presence and effectiveness of a risk management committee stimulate risk disclosure. Nahar et al. (2021) analyze the association between risk governance and risk disclosure among listed banks in Bangladesh and find that the existence of RCs increases risk disclosure. In a recent study, Ardianto et al. (2024) find evidence of a positive association between RC existence and carbon emission disclosure among listed firms in Southeast Asia. Since the board of directors is occupied with many responsibilities, a risk

committee must be established to manage the board's risk monitoring division. In line with the aforementioned studies, we expect a positive relationship between RC existence and climate risk disclosure.

**Hypothesis 1.** *There is a positive relationship between RC existence and climate risk disclosure.*

Fundamentally, the link between board size and risk disclosure is unresolved in the empirical font. Theoretically, agency theory supports a large board size and concludes that risk disclosure increases with increasing board size (Jensen and Meckling 1976). From an empirical perspective, exponents of large board size contend that firms with large boards benefit from diverse skills, knowledge, and experience to increase board effectiveness and promote adequate disclosure (Raimo et al. 2022). Hence, previous studies (Salem et al. 2019; Saha and Khan 2024) have revealed a positive association between board size and risk disclosure. On the other hand, other scholars (e.g., Jensen 1993; Wintoki 2007; Ntim and Soobaroyen 2013) discourage large boards due to coordination problems. Following this argument, firms with large RCs enjoy diversified skills, which in turn could boost the committee monitoring effort and enhance risk disclosure. For example, Al-Hadi et al. (2016) find that for GCC listed financial firms, a larger RC size encourages market risk disclosure. Similarly, scholarly works such as Jia et al. (2019) and Hasan, Sufi, and Hussainey (2023) suggest that firms with large RCs experience greater risk disclosure among Australian and Pakistanis firms. This paper aligns with the conclusions of these studies and identifies RC size as a crucial determinant of climate risk disclosure. Hence, we expect a positive link between climate risk disclosure and RC size.

**Hypothesis 2.** *There is a positive association between RC size and climate risk disclosure.*

Another important governance mechanism that has received substantial attention in the nonfinancial disclosure literature is board independence. Independent directors are perceived as objective and impartial since they do not have financial interests in the company. To support this assertion, scholars such as Beasley (1996), Linsley and Shrivs (2006), and Salem et al. (2019) opine that the presence of independent directors provides a strong mechanism for superior risk disclosure. Since independent directors have no financial interest in the company, their presence on the board reduces agency costs and information asymmetry between the managers of the shareholders. Independent directors are appointed to represent and protect the interests of certain shareholders and stakeholders; hence, their presence on the corporate board guarantees better information dissemination and greater disclosure, including climate-related disclosure. Despite the perceived role of board independence, its value relevance to disclosure and risk disclosure, in particular, is inconclusive. For instance, Elshandidy and Neri (2015), Salem et al. (2019), and Raimo et al. (2022) reported a positive association between board independence and risk disclosure. On the other hand, scholars, including ElGammal et al. (2018), Abu Qa'dan and Suwaidan (2019), and Gull et al. (2023), find that board independence encourages less risk disclosure. However, empirical studies such as Allini et al. (2016) and Saha and Khan (2024) find no evidence of a significant

association between board independence and risk disclosure. Similarly, the scant evidence on the nexus between RC independence and risk disclosure has produced mixed outcomes. For instance, Jia et al. (2019) find no association between RC independence and risk disclosure for 100 listed firms in Australia. The outcome of Jia et al. (2019) reinforces the results of Al-Hadi et al. (2016), who discovered that RC independence is not a key determinant of the market risk disclosure of listed firms in GCC countries. Moreover, a recent study by Seth and Saxena (2025) revealed a positive association between audit committee independence and environmental disclosure among listed firms in India. Notwithstanding these contradictory findings, we anticipate that independent directors' participation in the RC inspires and promotes South African mining firms' disclosure of climate risk. This leads to the next hypothesis, as specified below:

**Hypothesis 3.** *RC independence and climate risk disclosure are positively related.*

There are increased agitations for adequate female representation at the upper level of leadership, which implies that an organisation can recruit more women directors to attract diverse resources and retain legitimacy (Lee and Thong 2023; Wang et al. 2024). This is based on the notion that women's representation at the board level facilitates better and enhanced communication between the organisation and society. To enhance board oversight tasks, female directors contribute a wide range of knowledge, abilities, experience, and human resources. (Salem et al. 2019). In addition, existing studies by García and Herrero (2021) and Guizani and Abdalkrim (2023) reveal that compared with their male counterparts, women directors are generally averse to risk and tend to support greater risk disclosure. Similarly, Raimo et al. (2022) noted that with a higher proportion of female directors on the board, transparency and accountability in reporting are enhanced. Focusing on different markets, Reguera-Alvarado et al. (2017), Tingbani et al. (2020) and Tunyi et al. (2023) contend that female directors are humorous, consider and encourage and support board decisions on nonfinancial disclosure, such as risk-related information. Despite the criticality of women directors as a crucial corporate governance mechanism, the importance of gender diversity in risk disclosure, especially in terms of climate risk, is underexplored. For instance, the studies by Salem et al. (2019) and Raimo et al. (2022) document a significant positive association between board gender diversity and the quality of risk disclosure for listed nonfinancial firms in Tunisia and 24 other countries, respectively. These studies find strong evidence to support the exigency and imperativeness of women directors in achieving greater risk disclosure. On the other hand, Hassan et al. (2023) and Saha and Khan (2024) focus on RC and observe a negative and significant association between RC gender diversity and climate change risk disclosure for listed firms in Pakistan and Bangladesh. Conversely, Al-Shammari and Al-Saidi (2014) revealed that board gender diversity is not a significant driver of voluntary disclosure in Kuwait. The results of Al-Shammari and Al-Saidi (2014) are reinforced by the study of Gull et al. (2022), who discovered that the presence of women in the boardroom has no significant effect on the risk disclosure of Pakistani firms. Regardless of these conflicting outcomes, we envisage a positive association between RC gender diversity and climate risk disclosure, as presented in the next hypothesis.

**Hypothesis 4.** *RC gender diversity has a positive association with climate risk disclosure.*

The frequency of board meetings is used in the literature as a measure of the board's activity, diligence, and effort. Following the stakeholders' agency, an increase in the number of RC meetings offers a good platform for the committee to discuss and deliberate on issues that affect all stakeholders, including risk-oriented activities. Hence, a higher frequency of board/committee meetings indicates board diligence, quality and effort, which are perceived to enhance board effectiveness and efficiency and consequently promote climate risk disclosure (Shahbaz et al. 2020; Nuhu and Alam 2024). However, in the empirical literature, findings on the board meetings and risk disclosure nexus are inconsistent and grossly inconclusive. For instance, Jizi et al. (2014) find that the quantity of CSR disclosure increases with the frequency of board meetings for US banks. Similarly, Nguyen et al. (2022) establish a positive and significant correlation between board meetings and environmental performance for environmentally sensitive enterprises in China. Recently, Nuhu and Alam (2024) confirmed the favourable and enhancing effects of board meetings on ESG disclosure for listed firms in BRICS countries. In contrast, Saha and Khan (2024) reported that the frequency of board meetings has no significant effect on climate change disclosure. The author noted that the number of board meetings is not a decisive governance mechanism in promoting climate change disclosure. Similarly, Al-Qahtani and Elgharbawy (2020) find an insignificant association between board meetings and GHG disclosure for UK firms. Relatedly, Tingbani et al. (2020) fail to discover any significant relationship between board meetings and voluntary GHG disclosure for UK firms. Following the argument in the literature, we argue that more frequent meetings of the RC will afford them sufficient time to deliberate on climate-related risk, which will in turn positively impact the level of disclosure. On this basis, we expect a positive association between RC meetings and climate risk disclosure among the selected mining firms in South Africa.

**Hypothesis 5.** *RC meetings positively influence climate risk disclosure.*

## 3 | Methodology

### 3.1 | Sampling Process

The study is sector-specific in that it focuses on environmentally sensitive firms with an emphasis on the mining sector. The selection of the mining sector is informed by vulnerability and susceptibility to climate risk and is thus responsible for climate degradation (Saha and Khan 2024). Because of its commercial operations, the mining industry has the greatest environmental impact, with greater exposure and vulnerability to climate change risk (Sun et al. 2020; Saha and Khan 2024). Mining activities are associated with air and water pollution, which consequently pollutes the environment (Matemane and Graca 2023). The study focuses on Africa and specifically on South Africa for the following reasons. First, South Africa is one of the highest mining countries in the world. Second, South Africa is among the top 15 GHG

polluters in the world (Hasan, Sufi, and Hussainey 2023). Notably, the mining sector plays a crucial role in the economic fabric of South Africa (Nkwadi and Matemane 2022; Lumadi and Nyasha 2024). For example, the mining sector generated approximately ZAR 202.05 billion in South African gross domestic product (GDP) in 2023 (Cowling 2024). This impressive performance, notwithstanding, is associated with environmental damage, which must be addressed to achieve a safer and cleaner environment. In view of the environmental impact of the mining sector on the ozone layer, it is imperative for the sector to promote adequate disclosure of its operations on climate risk via integrated reports. Similarly, Griffin and Jaffe (2022) and Matemane and Graca (2023) emphasize that the mining sector is more vulnerable to environmental risk and climate change than other sectors are; hence, the choice of this sector as the unit of analysis.

On the basis of this background, this study focuses on listed mining firms on the Johannesburg Stock Exchange (JSE) between 2016 and 2021. According to the IRESS database, 36 mining companies were listed on the JSE. However, five firms do not have complete data on the target variables and were excluded from the study. Hence, the study focuses on 31 firms with 186 yearly observations after excluding five companies<sup>1</sup> with missing data. Specifically, 86% of the JSE companies listed under the mining sector employed in the study are employed. Details of the firms employed in the study are provided in Table A2 of the Appendix A. The selection of 2016 as the commencement period was informed by the ratification of the International Treaty on Climate Change, which christened the "Paris Agreement" which was signed by 196 parties (including South Africa) on December 12, 2015, and enforced on November 4, 2016, at the UN Climate Change Conference (COP21) in Paris, France. One major focus of the Agreement is to limit global warming to below 20°C. On this basis, all listed firms in South Africa have been expected to disclose information on climate risk in their integrated reports since 2016.

### 3.2 | Dependent Variable

The secondary data were manually collected from the integrated reports of selected JSE-listed mining companies. Since 2016, climate risk disclosure (the outcome variable) has been mandatory as part of ESG reporting requirements. A disclosure checklist was developed in accordance with the JSE Sustainability Disclosure Guidelines (see Table B1 of the Appendix A). These guidelines draw on the Paris Agreement, the Task Force on Climate-related Financial Disclosures (TCFD), and the Global Reporting Initiative (GRI). The checklist was used to assess disclosure practices.

Climate risk disclosure was measured through a manual content analysis. This method is a widely applied qualitative approach in non-financial disclosure research (Manetti and Bellucci 2016; Gerged et al. 2018; Nicolò et al. 2021; Sun 2023; Nicolò and Cervilla-Bellido 2025). It enables reliable inferences from textual data (Michelon and Parbonetti 2012). Sentences served as the unit of analysis to enhance scoring reliability. Each sentence was matched to one of twelve items in the JSE sustainability grid. An unweighted

score was assigned, treating all the items equally (Kouloukoui et al. 2019; Matemane and Graca 2023).

To ensure validity and reliability, two trained master's students in financial management coded the disclosures under the supervision of two principal investigators. A pilot test was conducted with ten randomly selected firms to calibrate the scoring. Discrepancies were resolved through consensus. The research assistants then independently coded the remaining firms. The principal investigators verified all the scores. The final un-weighted scores were rescaled to percentages, with firms ranked from 0% (no disclosure) to 100% (full disclosure).

### 3.3 | Independent Variables

Risk committee attributes constitute the key independent variables. Data on risk committee characteristics are obtained from the integrated reports of the selected firms through their risk committees. Specifically, the study focuses on RC attributes such as RC existence, RC size, RC independence, gender diversity in RCs, and the frequency of RC meetings. These variables have been employed as proxies for risk committee attributes (see Jia et al. 2019; Jia and Li 2022; Hasan, Sufi, and Hussainey 2023).

### 3.4 | Control Variables

The selection of control variables is guided by the extant studies on risk disclosure. Following previous studies in the risk committee–risk disclosure literature (Salem et al. 2019; Jia and

Li 2022; Hasan, Sufi, and Hussainey 2023), we employ two sets of control variables. First, we utilize board size as a governance control variable. This is because the size of the board determines the size of the risk committee and is expected to influence a firm's decision on climate risk disclosure. Second, firm-specific variables such as profitability, leverage, and firm size are considered. These firm-specific variables have been widely employed in the corporate governance literature (Gerged 2021; Grassa et al. 2021; Saha and Khan 2024). While firm-specific variables come from yearly financial reports, board characteristic control variables are taken from companies' integrated reports. Table 1 provides a summary, description, and measurement of the variables.

### 3.5 | Model Specification

To address the study's objective, we follow the modeling style of previous studies on risk disclosure (see Salem et al. 2019; Jia and Li 2022; Daradkeh et al. 2023). In line with these studies, climate risk disclosure is expressed as a function of risk committee attributes, the board characteristic control variable, and firm-specific control variables, as presented in the following equation:

$$crd_{it} = \gamma_0 + \sum_1^5 \gamma_i rc_{it} + \gamma_6 bsz_{it} + \sum_7^9 \gamma_j fscv_{it} + \mu_{it} \quad (1)$$

In Equation (1),  $crd_{it}$  represents climate risk disclosure, and  $rc_{it}$  captures risk committee attributes, which include risk committee existence ( $rcx$ ), risk committee size ( $rcz$ ), risk committee independence ( $rci$ ), the gender diversity of the risk committee ( $rcg$ ), and risk committee meetings ( $rcm$ ). On the

TABLE 1 | Description and measurement of variables.

Variables	Symbol	Description/measurement
Dependent variable		
Climate risk disclosure	<i>crd</i>	Content analysis of the integrated report of sample firms (it ranges between 0% and 100%)
Independent variable		
Existence of risk committee	<i>rcx</i>	Dummy variable where 1 is assigned if a firm has a separate risk committee and zero (0) if otherwise
Risk committee size	<i>rcz</i>	Total number of risk committee members
Risk committee independence	<i>rci</i>	Proportion of independent nonexecutive directors to committee members (%)
Gender diversity of the risk committee	<i>rcg</i>	Proportion of female directors to board members (%)
Risk committee meetings	<i>rcm</i>	Number of committee meetings held in a year
Control variables: Corporate governance variables		
Board size	<i>bsz</i>	Total number of board members
Control variables: Firm specifics		
Profitability	<i>roa</i>	Ratio of profit before tax to total asset (%)
Firm size	<i>fsz</i>	Natural logarithm of total asset
Leverage	<i>lvr</i>	Ratio total debt to total asset

Source: Authors' compilation.

other hand,  $bsz_{it}$  is board size ( $bsz$ ), whereas  $fcv_{it}$  stands for firm-specific control variables such as firm size ( $fsz$ ), the leverage ratio ( $lvr$ ) and profitability ( $roa$ ). Finally, the residual term is represented by  $\mu_{it}$ . Equation (1) can be explicitly presented as

$$crd_{it} = \gamma_0 + \gamma_1 rcx_{it} + \gamma_2 rcz_{it} + \gamma_3 rci_{it} + \gamma_4 rcg_{it} + \gamma_5 rcm_{it} + \gamma_6 bsz_{it} + \gamma_7 fsz_{it} + \gamma_8 lvr_{it} + \gamma_9 roa_{it} + \mu_{it} \quad (2)$$

### 3.6 | Analytical Technique

The data utilized for the study consisted of time series (2016–2021) and cross-sectional data (31 firms). Given these attributes, this study applies panel regression techniques to uncover the intricate relationship between RC attributes and climate risk disclosure. However, the study uses the Breusch–Pagan LM test to determine whether a panel effect exists before choosing the best model or technique. The outcome from the B–PLM test confirms the existence of a panel effect in the estimated model. In the second stage, we perform the Hausman test (Hausman 1978) to select the preferred model between the fixed effect and the random effect models. The outcome from the Hausman test supports the fixed effect model over the random effect model. However, we subject the results from the fixed effect test to the assumptions of ordinary least squares, such as normality, heteroscedasticity, and autocorrelation tests, to ensure that the estimates from the study are reliable, consistent, and unbiased. The findings from these tests indicate that the residual from the fixed effect model suffers from heteroscedasticity and autocorrelation, which implies that the FE model produces suboptimal outcomes in the presence of these econometric pitfalls.

To address these challenges, this study employs the feasible generalized least squares (FGLS) method. As documented by Wahba (2015) and Tshipa et al. (2018), the FGLS controls for possible heteroscedasticity and serial correlation in the residual. These authors also argue that the FGLS technique controls for unobserved heterogeneity among the cross-sectional units in the panel. Hence, FGLS provides robust standard errors that account for the influence of serial correlation and heterogeneity in residual terms.

For robustness of the analysis, the study utilises the method of moments quantile regression (MMQR) as an alternative approach to analyse the nexus between RC attributes and climate risk disclosure. The MMQR controls for distributional and heterogeneous effects between the target variables across different quantiles. The MMQR was developed by Machado and Santos Silva (2019) and is considered superior to mean-based panel estimators (such as OLS, fixed and random effects) because it is robust and resilient to outliers, which could bias the research outcomes if not addressed (Aziz et al. 2021; Mvita and Du Toit 2024). Once again, the MMQR is robust with nonlinear and heterogeneous models with numerous endogenous variables and is a member of a unique class of the dynamic GMM estimator (Machado and Santos Silva 2019). This approach has also proven effective because it does not require the distribution assumption of a normal distribution of the residual term (Chu 2024). This implies that the approach is robust and consistent in the case of non-normality in the error distribution (Olaniyi and Odhiambo 2025). All these distinguishing features make the technique attractive over mean-based panel estimators, such as OLS and fixed and random effects, which rely on the least squares technique.

## 4 | Empirical Results and Discussion of Findings

### 4.1 | Descriptive Statistics

Before the actual analysis, it is imperative to examine the behavior of the variables in the study using descriptive statistics such as measures of central tendency and measures of dispersion. The results of the descriptive statistics are displayed in Table 2. Starting with the outcome variable, the average value of climate risk disclosure ( $crd$ ) is 33.58%. This implies that the level of climate risk disclosure among South African mining firms is low. However, the value of  $crd$  over the sample period ranges from 0.00 (minimum) to 83.33% (maximum). There is considerable variability in the value of  $crd$ , given the standard deviation of 21.444, which is clearly below the average value. According to the RC characteristics, 74.7% of the sample organizations had a risk committee with an average membership ( $rcz$ ) of approximately four members. The firms with the highest and lowest RC sizes have 10 and 2

TABLE 2 | Descriptive statistics.

Variable	Mean	Min	Max	Std. Dev.	Obsv
<i>Crd</i>	33.580	0.000	83.333	21.445	186
<i>Rcx</i>	0.747	0.000	1.000	0.436	186
<i>Rcz</i>	4.317	2.000	10.000	1.816	186
<i>Rci</i>	89.224	42.857	100.000	17.401	186
<i>Rcg</i>	25.835	0.000	100.000	25.835	186
<i>rcm</i>	4.000	0.000	14.000	2.343	186
<i>bsz</i>	9.409	4.000	18.000	3.300	186
<i>fsz</i>	47.673	0.002	554.725	91.061	186
<i>lvr</i>	0.274	0.000	0.800	0.197	186
<i>roa</i>	−14.902	−656.130	59.520	94.344	186

Source: Authors' compilation.

members, respectively. The evidence from Table 2 reveals that approximately 89% and 26% of the RCs are independent and female directors, respectively. On average, the RC meets 4 times a year. Concerning the control variables, the average board size (*bsz*) of approximately 9 members is recorded, with an average firm size of R47.673 million. For other firm-specific control variables, the selected firm recorded leverage ratios and profitability values of 0.274% and -14.902%, respectively, within the study period.

## 4.2 | Trend in Climate Risk Disclosure

Following the descriptive statistics of the variables, we present the trend in climate risk disclosure among the sample firms from 2016 to 2021. As presented in Figure 1, climate risk disclosure tends to increase over the study period. Specifically, the percentage of climate risk disclosure increased gradually from 26.98% in 2016 to 36.5% in 2019 and then to 39.42% in 2021. This implies that mining firms in South Africa have embraced the culture of mainstreaming information on climate risk-related activities in their integrated annual reports. The majority of the enterprises, however, accomplish less than 50% over the

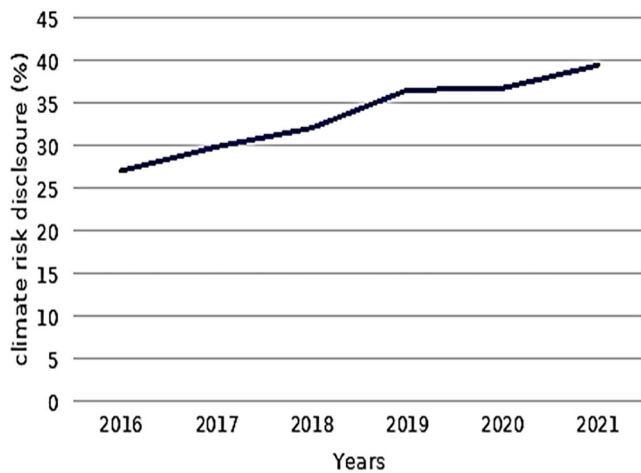


FIGURE 1 | Trend of climate risk disclosure (2016–2021).

TABLE 3 | Pairwise correlations.

Var	<i>crd</i>	<i>rcx</i>	<i>rcz</i>	<i>rci</i>	<i>rcg</i>	<i>rcm</i>	<i>bsz</i>	<i>fsz</i>	<i>lvr</i>	<i>roa</i>
<i>crd</i>	1.000									
<i>rcx</i>	0.154**	1.000								
<i>rcsize</i>	0.243***	0.273***	1.000							
<i>rcind2</i>	0.113	-0.071	-0.607***	1.000						
<i>rcgend</i>	0.379***	0.244***	-0.047*	0.160**	1.000					
<i>rcmeet</i>	0.035	0.254***	-0.074	0.335***	0.435***	1.000				
<i>bsize</i>	0.493***	0.380***	0.520***	-0.109	0.359***	0.280***	1.000			
<i>fsz</i>	0.399***	0.173**	0.231***	-0.094	0.177**	-0.048	0.342***	1.000		
<i>lvr</i>	0.006***	0.165**	-0.005	-0.026	0.353***	0.184**	0.210***	-0.142*	1.000	
<i>roa</i>	0.244***	0.323***	0.169**	-0.082	0.282***	0.220***	0.309***	-0.032	0.189*	1.000

Note: \*\*\*, \*\*, and \* indicate 1%, 5%, and 10% significant level.

reporting period, given the average value of climate risk disclosure (33.58%) shown in Table 3.

## 4.3 | Correlation Analysis and Variance Inflation Factor (VIF)

Correlation analysis is employed to examine the degree of association among the series in the study. From Table 3, the outcome from the Pearson correlation coefficient indicates that the outcome variable (*crd*) is positively and significantly associated with all the indicators of RC except risk committee independence (*rci*) and RC meeting (*rcm*), suggesting that these RC attributes enhance the effect of firm disclosure on climate risk. Similarly, there is a positive and substantial correlation between *crd* and all of the control variables. Considering the magnitudes of the correlation coefficients among the independent variables, the highest correlation (0.607) is observed between RC independence (*rci*) and RC size (*rsz*). This suggests that the degree of association among the explanatory variables is moderate and that there is no evidence of multicollinearity in the estimated models. To validate the outcome from the correlation analysis, the variance inflation factor (VIF) is used to rule out the possibility of multicollinearity in the model. Focusing on the results in Table 4, the VIFs of the explanatory variables vary between 1.26 (*roa*) and 2.56 (*rcz*), with an average VIF of 1.66. The results reiterate the finding from the Pearson correlation coefficient that multicollinearity does not constitute a threat in the estimated model.

## 4.4 | Risk Committee Attributes and Climate Risk Disclosure: Prior Analysis

We first use the B-P LM test to determine whether a panel effect is present in the model. The outcome is reported in the lower panel of Model 2 in Table 5. The value of the B-P LM test (Breusch and Pagan 1980) is statistically significant at the 1% level, which indicates the rejection of pooled OLS in favor of panel effect models (FE or RE). On this basis, the Hausman test (Hausman 1978) is conducted to choose the preferred model between RE and FE. The result of the Hausman test in Model 3 (Table 5) buttresses the

**TABLE 4** | Variance inflation factors.

Variable	VIF	1/VIF
<i>rcz</i>	2.56	0.391
<i>bsz</i>	2.15	0.465
<i>rci</i>	1.96	0.509
<i>rcg</i>	1.62	0.618
<i>rcm</i>	1.52	0.659
<i>fsz</i>	1.32	0.758
<i>rcx</i>	1.31	0.762
<i>lvr</i>	1.28	0.783
<i>roa</i>	1.26	0.792
Mean VIF	1.66	

Source: Authors' compilation.

rejection of the null hypothesis that the random effect model is the suitable model. Hence, in this study, the FE model was chosen as the preferred model over the random model. To ensure the reliability and consistency of the estimates, the residual term from the FE model is further subjected to heteroscedasticity, autocorrelation, and normality tests using the modified Wald test (Greene 2002), Wooldridge test (Wooldridge 2002), and Jarque–Bera statistic, respectively. Model 2 in Table 5 contains the results from these diagnostic tests. The outcome from the modified Wald test attests to the presence of heteroscedasticity at the 1% significance level. Similarly, the study confirms the presence of autocorrelation in the residual term at the 5% significance level. The Jarque–Bera statistic, however, is not significant, indicating that the normal distribution null hypothesis cannot be disproved. Owing to the presence of autocorrelation and heteroscedasticity in the residual term, the fixed effect model cannot be used as the best model. Hence, it is important to consider an estimation technique that is robust for the two identified econometric pitfalls.

To control for heteroscedasticity and autocorrelation in the residual, this study employs the feasible generalised least squares (FGLS) approach as the main technique. Following the studies of Hausman (1978) and Wahba (2015), the FGLS method delivers superior and better results in the case of heteroscedasticity and serial correlation in the residual. However, with respect to the efficiency of the FGLS approach, the study by Tshipa et al. (2018) contends that the technique controls for heterogeneity and unobserved heterogeneity among the cross-sectional units in the panel. Finally, the FGLS provides robust standard errors that account for the influence of serial correlation and heterogeneity in residual terms. On the basis of these advantages, this study applied the FGLS method to achieve the study's objectives. The outcomes from the FGLS are presented in Table 6.

#### 4.5 | Risk Committee Attributes and Climate Risk Disclosure—FGLS Results

The stepwise results in Table 6 are presented below. In Model 1, we regress the outcome variable (*crd*) on RC committee attributes, excluding the control variables. For Model 2, the study

**TABLE 5** | POLS, FE and RE results.

Variables	POLS	RE	FE
	(1)	(3)	(2)
	<i>crd</i>	<i>crd</i>	<i>crd</i>
<i>Rcx</i>	-3.124 (4.691)	-3.124 (4.691)	-4.308 (6.460)
<i>Rcz</i>	0.0322 (0.981)	0.0322 (0.981)	-1.111 (1.099)
<i>Rci</i>	0.0850 (0.108)	0.0850 (0.108)	-0.0366 (0.134)
<i>Rcg</i>	0.325*** (0.0879)	0.325*** (0.0879)	0.384*** (0.109)
<i>Rcm</i>	-1.069 (0.692)	-1.069 (0.692)	-0.690 (0.809)
<i>Bsz</i>	1.404** (0.658)	1.404** (0.658)	0.195 (0.873)
<i>lvr</i>	-13.60 (8.858)	-13.60 (8.858)	-15.25 (11.23)
<i>roa</i>	0.0205* (0.0120)	0.0205* (0.0120)	0.0178 (0.0124)
<i>fsz</i>	2.309*** (0.858)	2.309*** (0.858)	3.455** (1.629)
Constant	10.87 (13.05)	10.87 (13.05)	34.29* (17.43)
firm FE	yes	yes	yes
Year FE	yes	yes	yes
Observations	186	186	186
B-P LM	119.82***		
Hausman test		19.6**	
Panel Heteroscedasticity test			40570***
Autocorrelation test			5.881**
Normality test (Jarque Bera)			0.214

Note: Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

incorporates board size (*bsz*) as the only control variable. Model 3 contains all the control variables, including firm-specific variables such as firm size (*fsz*), the leverage ratio (*lvr*) and profitability (*roa*). Additionally, firm and year effects are included in all the estimated models. Overall, the value of the Wald test is significant at the 1% level for all the regressions. This suggests that the fitness of the estimated models suggests that the identified predictors significantly explain the dynamics and behaviors of climate risk disclosure among the sample mining firms on the JSE. The findings in Table 6 imply that the establishment of

**TABLE 6** | Risk committee characteristics and climate risk disclosure.

Variables	(2)	(3)	(4)
	<i>crd</i>	<i>crd</i>	<i>crd</i>
<i>rcx</i>	0.255 (3.236)	-2.061 (3.103)	-4.021 (3.013)
<i>rcz</i>	6.035*** (0.933)	3.323*** (1.058)	2.951*** (1.009)
<i>rci</i>	0.545*** (0.0996)	0.455*** (0.0962)	0.448*** (0.0923)
<i>rcg</i>	0.440*** (0.0659)	0.340*** (0.0660)	0.310*** (0.0665)
<i>rcm</i>	-2.497*** (0.656)	-2.849*** (0.625)	-2.534*** (0.603)
<i>bsz</i>		2.378*** (0.511)	1.918*** (0.509)
<i>lvr</i>			-10.17 (6.575)
<i>roa</i>			0.0370*** (0.0137)
<i>fsz</i>			1.626*** (0.472)
Constant	-42.68*** (11.23)	-39.54*** (10.65)	-31.55*** (10.36)
firm FE	yes	yes	yes
Year FE	yes	yes	yes
Wald test	93.95***	126.49***	164.12***
Observations	186	186	186

Note: Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

an RC does not significantly influence the disclosure of climate risk by South African mining companies. The results are consistent across the three regressions. However, other RC committee attributes, such as RC size (*rsz*), RC independence (*rci*) and the proportion of female directors on the RC committee (*rcg*), have a positive and significant effect on *crd* at the 1% level of significance. Focusing on the full model (Model 3), a unit rise in *rsz*, *rci*, and *rcg* enhances *crd* by 2.951 units, 0.448 units, and 0.310 units, respectively. This implies that RC size, RC independence, and gender diversity are major determinants of climate risk disclosure. Conversely, the impact of the RC meeting (*rcm*) on *crd* is negative and statistically significant at the 1% level. This finding indicates that a unit increase in the frequency of RC meetings hurts *crd* by 2.534 units (Model 3). The outcome is robust and the same under the three model specifications.

With respect to the control variables, evidence from models 2 and 3 reveals that an increase in board size (*bsz*) is significantly

and positively associated with an increase in corporate climate risk disclosure. The estimate of *bsz* espouses that for a unit increase in board size, *crd* increases by 2.378 units and 1.918 units in models 2 and 3, respectively. Similarly, company characteristics such as firm size (*fsz*) and profitability (*roa*) are recognized as important factors that influence climate risk disclosure. This suggests that larger and more profitable firms provide more information on climate risk than do smaller and less profitable firms. Moreover, the impact of the leverage ratio on climate risk disclosure is immaterial, suggesting that a firm's attitude toward climate risk disclosure is not affected by the leverage ratio.

#### 4.6 | Robustness Test

To further check for the consistency and credibility of the FGLS results, we re-estimate Equation (2) using the method of moment quantile regression (MMQR). The approach controls for heterogeneity and the distributional effect of RC attributes on climate risk disclosure across different quantiles. However, in line with the studies of Mvita and Du Toit (2024), we examine the nexus between RC characteristics and climate risk disclosure over three quantile ranges, such as the lower quantile (25%), middle quantile (50%) and upper quantile (75%), and the outcomes are displayed in Table 7. Consistent with the prior results, the effect of RC existence on climate risk disclosure is inconsequential except for the upper quantile range in Model 5, where RC existence is discovered to depress climate risk disclosure at the 5% significance level. The MMQR findings indicate that the chosen enterprises' disclosure of climate-related risk activities is greatly facilitated by the RC's size, independence, and gender diversity. However, an increase in RC meetings undermines the disclosure of climate risk. The results are consistent across the three quantiles examined. An increase in board size, profitability, and firm size enhances climate risk disclosure, suggesting that the three control variables are established as fundamental drivers of climate risk disclosure. Moreover, an increase in the leverage ratio is associated with a decline in climate risk disclosure.

#### 4.7 | Endogeneity

We also subject the outcomes from the main analysis to another robustness check using the instrumental variable technique. Specifically, we apply the generalised method of moments (GMM) approach to control for potential endogeneity bias and reverse causality in the analysis. Previous studies on corporate governance have identified endogeneity concerns as a major econometric pitfall that must be addressed to achieve consistent and reliable estimates (Nguyen et al. 2022; Zaman et al. 2021; Carvajal et al. 2022). This is based on the notion that risk committee attributes can influence corporate decisions on climate risk disclosure and vice versa. To achieve this, we incorporate the lag value (L.crd) of the outcome variable (climate risk disclosure) into Equation 2 and re-estimate the model using the GMM approach. The outcomes from the GMM approach are presented in Table 8. Again, we estimate three separate models, as discussed in the main results. However, prior to the discussion of the GMM results, it is important to evaluate the efficacy and efficiency of the instruments employed. We

TABLE 7 | MMQR results.

Variables	(1)	(2)	(3)	(4)	(5)
	Location	Scale	Q (0.25)	Q (0.50)	Q (0.75)
<i>rcx</i>	-4.021 (3.931)	-7.754*** (2.445)	3.182 (4.026)	-3.278 (3.872)	-10.26** (4.979)
<i>rcz</i>	2.951*** (0.938)	-0.742 (0.584)	3.641*** (0.929)	3.022*** (0.923)	2.355** (1.175)
<i>rci</i>	0.448*** (0.0973)	0.0295 (0.0605)	0.421*** (0.0960)	0.445*** (0.0957)	0.472*** (0.122)
<i>rcg</i>	0.310*** (0.0668)	-0.0556 (0.0416)	0.361*** (0.0663)	0.315*** (0.0657)	0.265*** (0.0838)
<i>rcm</i>	-2.534*** (0.565)	0.0841 (0.351)	-2.612*** (0.557)	-2.542*** (0.555)	-2.467*** (0.707)
<i>bsz</i>	1.918*** (0.517)	0.713** (0.322)	1.256** (0.518)	1.850*** (0.509)	2.492*** (0.651)
<i>lvr</i>	-10.17 (7.464)	8.480* (4.642)	-18.05** (7.449)	-10.99 (7.341)	-3.355 (9.373)
<i>roa</i>	0.0370*** (0.0105)	0.0164** (0.00654)	0.0217** (0.0106)	0.0354*** (0.0103)	0.0502*** (0.0132)
<i>fsz</i>	1.626*** (0.489)	0.203 (0.304)	1.437*** (0.482)	1.606*** (0.480)	1.789*** (0.611)
Constant	-31.55*** (10.95)	10.64*** (6.813)	-41.44*** (10.85)	-32.57*** (10.78)	-22.99* (13.73)
Observations	186	186	186	186	186
firm FE	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes

Note: Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

Source: Authors' computation.

apply the Hansen test for overidentifying restrictions to assess the validity of the instrument. Focusing on the results in Table 8, the probability value of the Hansen test is not significant across the three models estimated, confirming the validity of the instruments utilised. Similarly, we subject the residual term from the GMM model to serial correlation using the AR (1) and AR (2). As presented in Table 2, the value of AR (1) is significant, whereas the value of AR (2) is not significant. This consequently implies that the residuals from the three models are free from second-order serial correlation. Thus, the GMM models pass all the preliminary tests conducted. The results in Table 8 indicate that the magnitude of the lag value of CRD is positive and significant, indicating persistence in CRD. With respect to the outcome from the main analysis, the existence of a standalone risk committee has no impact on climate risk disclosure across the three specifications. Similarly, risk committee size (*rcz*), risk committee independence (*rci*) and risk committee gender diversity (*rcg*) significantly promote climate risk disclosure, whereas a higher frequency of risk committee meetings (*rcm*) leads to less disclosure of climate information in

annual reports. With respect to the control variables, board size (*bsz*) and firm size (*fsz*) are strong predictors of corporate climate risk disclosure among the selected mining firms. In summary, after controlling for the endogeneity problem, the outcomes remain the sample, buttressing the consistency and reliability of the study's outcomes across different estimation approaches.

#### 4.8 | Discussion of Results

This study reveals the key drivers of climate risk disclosure from the perspective of risk committee attributes. In the first stage, we analyze the performance of the sample firms in the disclosure of climate risk over the study period (2016–2021). Figure 1 shows that there is a consistent rise in the amount of climate risk activities disclosed in the annual reports of the selected firms over the study period. This suggests that mining firms in South Africa are gradually embracing the practice of climate risk disclosure as part of their stewardship in their integrated reports. The

**TABLE 8** | Robustness test using GMM technique.

<b>Dependent variable: Climate risk disclosure</b>			
<b>Variables</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>
	<i>crd</i>	<i>crd</i>	<i>crd</i>
L.crd	0.322** (0.131)	0.230** (0.0995)	0.270*** (0.0750)
<i>rcx</i>	0.138 (4.398)	-0.957 (5.085)	-2.370 (6.433)
<i>rcz</i>	3.060** (1.192)	0.713 (1.042)	0.710 (1.126)
<i>rci</i>	0.527*** (0.163)	0.389*** (0.137)	0.546** (0.202)
<i>rcg</i>	10.45*** (2.789)	8.963*** (2.736)	8.177** (3.000)
<i>rcm</i>	-2.511** (0.950)	-2.809** (1.067)	-2.748*** (0.769)
<i>bsz</i>		2.207*** (0.667)	1.712*** (0.578)
<i>lvr</i>			-3.592 (8.260)
<i>roa</i>			0.0205 (0.0281)
<i>fsz</i>			1.652** (0.659)
Constant	-38.36** (16.21)	-29.84** (13.80)	-40.08** (16.25)
Hansen test	1.55 [0.817]	1.27 [0.867]	0.49 [0.483]
AR(1)	-2.87*** [0.004]	-3.37*** [0.001]	-3.55*** [0.000]
AR(2)	0.64 [0.521]	1.30 [0.195]	0.93 [0.351]
Observations	186	186	186

Note: () indicates standard errors, [] represents probability value. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

results, which focus on the study's hypothesis, consistently support the claim that RC alone is insufficient to encourage climate risk disclosure. On this basis, the study rejects the first hypothesis that RC existence promotes corporate climate risk disclosure. This finding resonates with the outcomes of Dilling et al. (2024), who discovered that the presence of a sustainability committee has no material impact on climate governance disclosure. Ooi et al. (2019) fail to document any significant connection between audit committees and climate change disclosure among listed firms in Malaysia. The outcome, however, contrasts with the findings of prior studies, such as Al-Hadi et al. (2016), Jia et al. (2016, 2019), Nahar et al. (2021), and Jia and Li (2022), who disclosed that the existence of a separate RC significantly enhances risk disclosure. However, unlike the current study,

which concentrates on climate risk disclosure, the aforementioned papers focus on risk disclosure in general. In addition, none of these studies concentrated on the South African economy or the mining industry. This finding highlights the need to explore the nexus between RC characteristics and climate disclosure in a highly environmentally sensitive sector from the perspective of an emerging economy such as South Africa. The outcome implies that the establishment of a standalone RC is not sufficient to encourage adequate disclosure of climate risk-oriented activities.

On the other hand, consistent with the second hypothesis (Hypothesis 2), RC size is identified as a crucial determinant of climate risk disclosure. This result implies that firms with large

RCs provide greater disclosure of climate risk. The outcome aligns with the prediction of stakeholder agency theory and legitimacy theory and resonates with the results of existing studies on risk disclosure (see Al-Hadi et al. 2016; Jia et al. 2019; Hassan et al. 2023), which establish a positive association between RC size and risk disclosure. At the board level, the studies of Salem et al. (2019) and Saha and Khan (2024) revealed a favorable effect of board size on risk disclosure. The theoretical implication of this finding is that firm RC size can be used as a governance tool to increase firm performance in the reporting of climate risk-related activities to increase firm image and garner public acceptance (legitimacy) from society. This is based on the argument that a large RC exposes firms to a wide array of human and intellectual resources, which can enhance committee effectiveness in disseminating greater information that addresses the environmental concerns of various stakeholders. Similarly, a larger RC size can strengthen better monitoring and promote the committee risk oversight function (Grassa et al. 2021).

Accordingly, RC independence has been identified as a critical determinant of climate risk disclosure. This outcome supports Hypothesis 3, revealing a positive and significant association between RC independence and climate risk disclosure. This finding implies that independent directors on the RC strengthen the committee's decisions toward climate risk-oriented reporting. Since independent directors do not have financial interests in the company, they tend to be impartial and objective in their oversight functions. Hence, their inclusion in the RC would enhance the committee's decision on issues that address different stakeholders' concerns, especially climate-related reporting. The outcome is in tandem with the findings of Salem et al. (2019) and Wang et al. (2024), who argue that the presence of independent directors forces corporate firms to be more socially inclined and environmentally sensitive. A greater proportion of independent directors in the RC engenders greater climate risk disclosure. However, the results contradict the conclusions of Abu Qa'dan and Suwaidan (2019) and Gull et al. (2022), who document a negative association between board independence and risk disclosure. According to Al-Hadi et al. (2016), independent directors promote accountability and openness in corporate disclosure because they are objective and neutral. The positive impact of RC size and independence on climate risk disclosure is generally in line with resource dependency theory, which is consistent with the fact that the RCs of the sample firms are dominated by independent directors. This confirms the economic importance of RC size and independence in encouraging greater dissemination of information about climate risk.

Furthermore, the study documents a positive and significant association between RC gender diversity and climate disclosure. This confirms the prediction of Hypothesis 4, suggesting that higher female representation in RCs is associated with more climate risk disclosure. Owing to the innate attributes of women, their inclusion in the RC is expected to positively influence committee decisions on matters that promote societal and environmental objectives such as climate-induced activities. Thus, the present study highlights the economic benefits of RC gender diversity in stimulating greater disclosure of climate risk. As documented by Chatterjee and Nag (2022), the presence of women on the board committee is associated with unique resources that can shape and reshape the committee's decision towards achieving stakeholders'

objectives. Similarly, increasing the number of women in the RC provides a governance mechanism to gain social legitimacy and promote more comprehensive climate risk reporting. These findings support the findings of prior studies, including Salem et al. (2019), and Raimo et al. (2022), but negate the findings of Saha and Khan (2024) for listed firms in Bangladesh. Therefore, we find evidence that increasing the presence of women in the RC is essential to improving climate risk disclosure. In contrast, the estimate of RC meetings is negative and significant. Hypothesis 5 is therefore not supported. However, this contradicts the expectation that more frequent committee meetings will encourage the disclosure of climate risk. Thus, our results disagree with the findings of Shahbaz et al. (2020) and Nuhu and Alam (2024). Moreover, evidence of an insignificant association has been confirmed in the literature by Al-Qahtani and Elgharbawy (2020), Tingbani et al. (2020) and Saha and Khan (2024). These studies affirm that the frequency of board meetings is not a significant determinant of GHG emissions and climate change disclosures for listed firms in the UK. Importantly, all the studies mentioned above focus on board meetings rather than the RC meetings considered in the present study. Additionally, none of the studies focused on sector-specific analysis, such as the mining enterprises used in this study, and none of them were carried out in an emerging market such as South Africa. Overall, the study refutes Hypothesis 5 and reveals that a higher frequency of RC meetings is associated with less climate risk disclosure in the South African mining sector. However, the outcome aligns with the study of Frias-Aceituno et al. (2013), who conclude that more frequent board meetings result in inactive and futile boards. In other words, our finding implies that fewer RC meetings are associated with greater climate risk disclosure and thus reinforces the outcomes of Hemrit (2018) for listed firms in Tunisia. Again, as noted by Malahim (2023), a higher frequency of RC meetings may not indicate a committee's effectiveness. Similarly, Saha and Khan (2024) find that a higher frequency of board meetings reduces climate change disclosure among environmentally sensitive firms in Bangladesh.

Regarding the firm-specific control variables, the outcome from the analysis reveals that profitability and firm size enhance climate risk disclosure, whereas an increase in the leverage ratio is detrimental to climate risk reporting. The outcome conforms to expectations since large firms are associated with diverse stakeholders. Disclosing greater information on climate risk will increase public and social confidence in large firms to gain legitimacy and acceptance. Thus, large firms may disclose greater climate risk information to enhance their reputation and satisfy the demand from their multiple stakeholders. Similar evidence is documented by Kouloukoui et al. (2019), Hasan, Sufi, and Hussainey (2023) and Grassa et al. (2021), who confirm that large firms respond more strongly to climate risk disclosure. The outcome also supports the assertion of Deegan and Gordon (1996) and Kılıç and Kuzey (2019), who opine that large companies engage in environmental disclosure to legitimize their operations. Profitable businesses can also allocate their financial resources to mandatory disclosure, particularly actions related to climate risk. Hence, to sustain their environmental performance, profitable firms can engage in climate risk-related activities. The outcome is in tandem with that of Kılıç and Kuzey (2019). Grassa et al. (2021) find that an increase in profitability increases climate risk disclosure.

## 5 | Conclusion and Implications

In this study, we investigate the role of risk committee characteristics in climate risk disclosure among listed mining firms in South Africa. Drawing from stakeholders and agency and legitimacy theories, this study employs 186 yearly observations between 2016 and 2021 using the feasible generalized least squares technique, the generalized method of moments, and the method of moment quantile regression. The study documents a persistent increase in the climate risk disclosure of the sample firms over the study period. After controlling for heteroscedasticity and autocorrelation in the error term, the findings from the study reveal that risk committee attributes such as risk committee size, independence, and gender diversity have favorable and enhancing effects on climate risk disclosure, whereas risk committee meetings are found to discourage firms' attitudes toward climate risk reporting. The findings from the study support the propositions of stakeholder-agency and legitimacy theories, which argue for the importance of RC as an important governance structure to enhance greater disclosure. The outcomes also resonate with the findings of Al-Hadi et al. (2016), Grassa et al. (2021), Raimo et al. (2022) and Saha and Khan (2024), who identify RC size, RC independence, and gender diversity as crucial predictors of climate risk disclosure. Hence, the findings suggest that firms with large RCs and a greater proportion of independent and female directors provide greater and richer information on climate risk in their integrated reports than do firms with smaller RCs and homogenous RCs. The study also demonstrated that the presence of a risk committee had no effect on the selected firms' disclosure of climate risk-related actions. This finding implies that South African mining firms should move beyond the establishment of the RC committee and be more concerned with the structure and composition of the RC committee to achieve better disclosure of climate risk-related information. A firm can establish an RC to fulfill demand from the regulator, especially in South Africa, where such a committee is mandatory, as contained in the King IV governance code. However, companies must ensure that the committee is large enough and structured to promote gender diversity and director independence to achieve better disclosure of climate-oriented activities. Regarding the control variables, the study reveals that board size, firm size, and profitability are the main determinants of corporate climate risk disclosure in the South African mining sector. Overall, our study finds substantial evidence of the criticality of risk committees as governance mechanisms to support adequate disclosure of climate risk among JSE mining companies. Our study has both theoretical and practical implications, which are clearly discussed below:

### 5.1 | Theoretical Contribution

With respect to the theoretical contribution, the study supports the propositions of stakeholders—agency theory and legitimacy theory. Risk committees with large, independent, and gender-balanced members serve as strong governance mechanisms to influence corporate decisions on climate risk-related activities. A large risk committee size is associated with diverse skills, expertise, knowledge, and experience that can shape organisational decisions on matters that affect the needs of all stakeholders, which encourages better disclosure of climate risk-oriented activities.

Similarly, having a risk committee with a substantial number of independent directors and female directors helps a firm act in accordance with societal expectations and thus secures its concern. Therefore, this study reveals that heterogeneous risk committee characteristics serve as vital governance mechanisms to reduce information asymmetry between management and stakeholders and protect a firm's legitimacy. Thus, the findings of this study support the tenets of stakeholders—agency theory and legitimacy theory.

### 5.2 | Practical Implications

From a practical view, the outcomes of the study offer valuable recommendations to regulators, policymakers, and the management of mining firms. First, regulatory bodies such as the JSE and policymakers should monitor mining firms to ensure strict adherence to climate risk disclosure guidelines, as outlined in the South African sustainability framework. Second, it is important to mandate that the board directors of JSE firms constitute a separate risk committee that must be sufficiently large to provide risk oversight and monitoring functions and thus promote greater climate risk disclosure. This is because when the size of the RC is large, it cannot be easily manipulated by executive directors. However, in constituting the committee, adequate consideration must be given to the independent and gender diversity of the members to perform its expected role in addressing stakeholders' concerns about climate risk disclosure. More importantly, the management of mining firms should emphasize the inclusion of more female and nonexecutive independent directors on the risk committee to achieve greater accountability in climate-oriented activities in integrated reports.

### 5.3 | Study Limitations and Suggestions for Future Research

This study contributes to the corporate governance literature in general and the risk committee–climate risk disclosure nexus in particular, and we identify several limitations that could serve as a roadmap for future studies. First, the sample size is limited to the mining sector. Therefore, the results might not apply to other ecologically sensitive industries or all JSE companies. Future studies might consider a large sample size that will incorporate other environmentally sensitive firms, such as those in the energy, basic materials, and industrial sectors, to obtain a holistic view of the performance of these sectors on the metric of climate risk disclosure performance. Second, the study considers only the structure and demographic attributes of RC members; further studies might consider other aspects of risk committee members, such as age, education, skills, and experience, and determine how climate risk disclosure is influenced by these attributes. Nevertheless, this study has advanced the frontier of knowledge by exploring the value relevance of risk committee attributes in achieving better and enhanced climate risk disclosure in the context of environmentally sensitive industries in South Africa.

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#### Endnotes

<sup>1</sup>Alphamin Resources corporation, Bauba Resources Limited, Royal Bafokeng Platinum, Sable Exploration and Union Atlantic Minerals.

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## Appendix A

**TABLE A1** | Summary of previous studies.

Study/Author	Focus	Technique	Findings
Amran et al. (2014)	Determinants of climate change disclosure (VVD) among countries in Asia Pacific	Ordinary Least Square (OLS)	Board independence increases CCD while board size is not a predictor of CCD in the region.
Al-Hadi et al. (2016)	Risk committee, firm life cycle and market risk disclosure among financial firms in Golf Corporation Council (GCC) countries	Ordinary Least Square (OLS)	Separate risk committee, risk committee's qualification and size have a positive and significant impact on market risk disclosure.
Jia et al. (2016)	Determinants of quality, quantity and richness of risk management disclosure (RMD) among top 100 listed companies in Australia.	Ordinary Least Square (OLS)	Firm size and firm risk are positively associated with total RMD while leverage ratio is not a significant driver of RMD
Kouloukoui et al. (2019)	Relationship between firm specific characteristics and climate risk disclosure among 67 listed firms in Brazil	Random/fixed effect	Firm size and firm performance positively influence climate risk disclosure.
Jia et al. (2019)	Risk management committee and risk management disclosure (RMD) among to 100 listed firms in Australia.	Ordinary Least Square (OLS)	Existence of a standalone risk committee and human capital of risk committee enhance RMD while risk committee independence and frequency of risk committee meetings have no significant effect on RMD quality.
Al-Qahtani and Elgharbawy (2020)	Board gender diversity and management/disclosure of GHG information among the UK firms	Ordinal logistic regression	Women directors enhance GHG disclosure while board size, board skill, board meetings, CEO duality fail to influence the dependent variable.
Ooi et al. (2019)	Board attributes and climate change disclosure (CCD) among listed firms in Malaysia.	Partial Least Square.	The presence of female and independent directors in the board significantly promotes CCD while board size and audit committee size fail to influence the extent of CCD.
Salem et al. (2019)	Corporate governance and risk disclosure in Tunisia	Ordinary least Square	Board independence, presence of female directors and audit committee independence stimulate risk disclosure quality.
Tingbani et al. (2020)	Board gender diversity, environmental committee and GHG voluntary disclosures among listed corporations in UK.	Ordinary Least Square and Two Stage Least Square.	Board gender diversity has a significant positive impact on the extent of GHG disclosure while audit and environmental committee do not affect GHG disclosure.
Hasan, Sufi, and Hussainey (2023)	Nexus between risk committee attributes and risk disclosure among banks in Pakistan.	Generalised Least Square (GLS)	Risk committee size increase risk disclosure while risk committee independence and gender diversity are negatively associated with risk disclosure.
Daradkeh et al. (2023)	Managerial ability and climate change disclosure among US firms	Fixed effect and Two Stage Least Square	Managerial ability improves firm' climate change disclosure.
Nuhu and Alam (2023)	Board characteristics and ESG disclosure in energy sector among BRICS countries.		Board gender diversity, board composition and board diligence are positively correlated with ESG disclosure while board size has no impact on the outcome variable.
Saha and Khan (2024)	Board characteristics and climate change disclosure (CCD) among environmentally sensitive firms in Bangladesh	Ordinary Least Square (OLS)	Board size, presence of foreign directors and existence of audit committee promote CCD but higher frequency of board meetings is associated with lower CCD.
Dilling et al. (2024)	Corporate characteristics and climate governance disclosure (CGD) among 100 world's largest firms.	Ordinary Least Square and Heckman Two Stage Regression.	Board gender diversity and the presence of sustainability committee have no effect on CGD. However, the appointment of chief sustainability officer leads to higher CGD.

**TABLE A2** | List of sample firms.

<b>S/N</b>	<b>Company name</b>
1	African Rainbow Min Ltd
2	Anglo American Plat Ltd
3	Anglo American Plc
4	Anglogold Ashanti Ltd
5	Arcelormittal SA Limited
6	BHP Group Limited
7	Chrometco Ltd
8	DRD Gold Ltd
9	Eastern Platinum Ltd
10	Europa Metals Limited
11	Gemfields Group Limited
12	Glencore Plc
13	Gold Fields Ltd
14	Harmony Gm Co. Ltd.
15	Hulamin Ltd
16	Impala Platinum Hlgs Ltd
17	Insimbi Ind Hldgs Ltd.
18	Jubilee Metals Group Plc
19	Kibo Energy Plc
20	Kore Potash Plc
21	Kumba Iron Ore Ltd
22	Master Drilling Grp Ltd
23	Merafe Resources Ltd
24	Northam Platinum Hldgs L
25	Orion Minerals Limited
26	Pan African Resource Plc
27	Randgold & Expl Co. Ltd
28	Sibanye Stillwater Ltd
29	South32 Limited
30	Tharisa Plc
31	Wesizwe Platinum Ltd

**TABLE B1** | Checklist based on JSE climate change disclosure requirements.

1. Does the organisation define and classify climate-related terms?	No	Yes	
2. How will climate risks affect strategies?	No disclosure	Partly disclose	And fully disclose
3. How is the significance of climate-related risks determined?	No disclosure	Partly disclose	Fully disclose
4. How does the risk management of the organisation incorporate climate-related risks?	No incorporation	Partly incorporates	In-depth incorporation
5. Is there a climate risk committee?	No	Yes	
6. How do managers receive information about climate-related risks?	Do not receive information	Receive little information	Receive in-depth information
7. How are climate-related risks observed by the board and managers?	No observation	Partial observation	In-depth observation
8. Are the board and committees aware of the climate-related risks within the organisation?	Not aware	Partly aware	Fully aware
a. Is climate change considered an applicable risk or opportunity for the business?	Not considered	Partly considered	Fully considered
b. Is there a board member or committee who should supervise the climate change policy?	No	Yes	
9. Are climate-related issues considered climate-related issues when the board or committees are reviewing and guiding			
a. Substantial plans of action	No	Yes	
b. Risk management policies	No	Yes	
c. Business plans	No	Yes	
d. Annual budgets	No	Yes	
e. Strategy	No	Yes	
f. Performance goals, observing implementation and performance and	No	Yes	
g. Supervising substantial capital expenditures, acquisitions and divestitures	No	Yes	
10. Are risks considered by sector or geography?	Sector	Geography	
11. Are risks related to greenhouse gas emissions being disclosed?	No	Yes	
12. What are the historic greenhouse gas emissions and trends?			