# Gender diversity and cost of equity capital: evidence from an emerging market

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Luiz Eduardo Gaio
*University of Campinas, Limeira, Brazil, and*
Nelson Oliveira Stefanelli
*University of Campinas, Limeira, Brazil and Fucape Business School, Vitória, Brazil*

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## Abstract

**Purpose** – This study examines the relationship between board gender diversity and the cost of equity among publicly traded Brazilian companies.

**Design/methodology/approach** – The sample includes Brazilian firms listed on B3 from 2010 to 2023. This study estimated linear and nonlinear regression models using the two-step generalized method of moments (GMM). It measured gender diversity through board composition metrics and diversity indices, while it calculated the cost of equity using the Fama–French five-factor model.

**Findings** – The results obtained suggest that increased board gender diversity is associated with a lower cost of equity, with a nonlinear effect indicating that progressive diversity improvements yield more significant reductions in capital costs.

**Originality/value** – This study better provides a comprehension of gender diversity and financial performance in a Latin American emerging market, addressing a gap in research predominantly focused on developed economies. It is the first to use the Fama–French five-factor model to explore this relationship in emerging markets.

**Keywords** Gender diversity, Cost of equity, Financial performance, Fama–French five-factor, Emerging market

**Paper type** Research paper

## 1. Introduction

In recent years, the increasing presence of women in the workforce has attracted considerable attention. Gender diversity in organizations is recognized not only as a matter of social justice but also as a strategy with economic and social benefits. According to the Organisation for Economic Co-operation and Development (OECD) data, female representation in executive positions is 33.7%, while on corporate boards, it is 29.6% (OECD, 2023). In Brazil, women occupy 38.7% of managerial roles. However, female participation in corporate boards remains limited, increasing from 5.8% in 2016 to 14.8% in 2021, which is still below the OECD average and broader social participation benchmarks. The promotion of gender equality is a Sustainable Development Goal (SDG 5) of the United Nations, which emphasizes equal opportunities, fair pay, and active leadership participation (UN, 2023). Companies that adopt gender diversity practices often experience competitive advantages, such as superior financial

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performance (Gong and Girma, 2020; Liu *et al.*, 2020; Sarhan *et al.*, 2018), greater innovation (Triana *et al.*, 2019), risk reduction (Nadeem *et al.*, 2019; Mastella *et al.*, 2021), improved financial reporting quality (Fan *et al.*, 2019), operational efficiency (Shabbir *et al.*, 2019), and reduced misconduct (Arnaboldi *et al.*, 2021). These outcomes are often attributed to the diverse perspectives women bring to leadership, fostering more effective decision-making and cautious risk management. Theoretical frameworks such as agency theory (Jensen and Meckling, 1976) and critical mass theory (Kanter, 1977) support these findings.

Although the link between gender diversity and financial performance has been extensively studied, its impact on the cost of equity (COE) remains underexplored. Existing research focuses on developed economies (Nguyên, 2020; Aljughaiman *et al.*, 2022; Sarang *et al.*, 2024b), with limited studies on emerging markets such as China (Jiang *et al.*, 2024) and India (Srivastava *et al.*, 2018). Latin America, with its distinct corporate governance practices and socioeconomic dynamics, provides a valuable context to address this gap (Aguinis *et al.*, 2020; Gaio *et al.*, 2024).

Empirical evidence suggests that gender diversity may have a non-linear relationship with COE, where benefits become significant only after reaching a critical mass (Aljughaiman *et al.*, 2022; Sarang *et al.*, 2024a). However, previous studies rarely used comprehensive diversity metrics, such as the Blau or Shannon indices, or advanced COE estimation methods, such as the Fama and French factor models (1993, 2015).

This study seeks to address these gaps by analysing the relationship between gender diversity and COE in Brazilian companies, focusing on three main contributions. First, this study is the first to investigate this relationship in a Latin American context, where corporate governance and regional policies may influence outcomes. Second, it employs the Fama-French Five-Factor Model (2015), advancing the methodological rigor of the COE estimation. Third, it explores the potential non-linear relationship between gender diversity and COE, providing deeper insights into this dynamic.

The rest of the paper is organized into five sections. Section 2 reviews the literature on gender diversity and the cost of capital. Section 3 presents the data, sources, and methodology. Section 4 analyses the results. The paper concludes with Sections 5 and 6 by addressing the study's limitations and implications for future research.

## 2. Literature review

### *2.1 Corporate governance and firm value*

Corporate governance plays a fundamental role in maximizing firm value, primarily by reducing agency costs (Salehi *et al.*, 2021) and enhancing operational efficiency (Jo and Harjoto, 2011). Jensen and Meckling's (1976) agency theory posits that governance mechanisms align managerial and shareholder interests, mitigating conflicts and promoting transparency. This alignment directly influences capital structure decisions, optimizing the cost of capital and increasing firm value (Balachandran and Faff, 2015). Furthermore, effective governance practices are linked to greater investor confidence and reduced risk perceptions, resulting in lower capital and debt costs (Beiner *et al.*, 2006).

Empirical studies demonstrate that companies with better governance practices achieve higher market valuations and improved growth opportunities (Durnev and Kim, 2005; Black *et al.*, 2006). Governance directly impacts value through internal and external mechanisms, such as acquisition controls and shareholder activism, which complement each other synergistically (Cremers and Nair, 2005). Moreover, corporate governance enhances the quality of financial statements and internal controls, promoting greater transparency and reducing earnings manipulation (Agrawal and Chadha, 2005; Cornett *et al.*, 2008). In addition, it strengthens investor protection and monitoring systems, thus profoundly affecting firm value (Klapper and Love, 2004). These reductions in uncertainty are reflected in lower capital costs, as demonstrated by AlHares (2020), who identified a relationship between sound governance practices and reduced financing costs.

*2.2 Corporate governance and gender diversity*

Within the broader scope of Corporate Governance, board diversity—particularly gender diversity—has gained attention as a mechanism to improve governance quality (Zagorchev, 2024). Stakeholder theory suggests that boards with gender diversity are better equipped to balance the interests of diverse stakeholders, promoting fairness and reducing conflicts (Fernandez and Thams, 2019). Empirical studies show that having diverse voices on the board can help align the interests of managers with those of shareholders (Jurkus *et al.*, 2011; Amin *et al.*, 2022), reduce conflicts of interest (Yakubu and Oumarou, 2023), increase transparency (Benito-Esteban *et al.*, 2024; Seebeck and Vetter, 2022), reduce risk (Maxfield and Wang, 2024) and protect the rights of all stakeholders (Fernandez and Thams, 2019). This not only reduces direct costs associated with monitoring and control but also improves investor confidence, potentially increasing firm value.

The concept of critical mass further strengthens the argument for gender diversity. Research indicates that a minimum threshold of female directors is necessary to realize all the benefits of diversity. For example, Sarang *et al.* (2024a) found that French companies with at least four female directors had significantly better governance outcomes. Similarly, Aljughaiman *et al.* (2022) observed that a critical mass of 28% female representation on boards in North America was associated with better financial decisions and reduced financing costs. Although there is evidence that gender diversity on boards is assumed to increase effectiveness (Adams *et al.*, 2015) and can lead to more independent boards, its impact on financial performance remains inconclusive (Gaio *et al.*, 2024; Post and Byron, 2015).

*2.3 Board gender diversity and cost of equity*

Empirical studies are increasingly exploring the relationship between gender diversity on boards and the cost of capital, particularly equity capital. Diverse boards, through enhanced governance and reduced information asymmetry, can lower perceived risks, causing investors to demand lower returns. This reduction in required returns translates into a lower cost of equity (Nguyên, 2020; Sarang *et al.*, 2024b).

Nguyên (2020) found that French companies with higher proportions of female directors experienced a significant reduction in equity costs, particularly after gender diversity laws, such as the Copé–Zimmermann quota, were implemented. Aljughaiman *et al.* (2022) and Sarang *et al.* (2024b) corroborated these findings in North American markets, emphasizing the role of critical mass in amplifying the impact of diversity on capital costs. In emerging markets, Srivastava *et al.* (2018) showed that regulatory reforms requiring at least one woman on the board in India led to a 5.5% reduction in the cost of capital. Saleh *et al.* (2022) highlighted the moderating role of gender diversity in improving earnings quality and its subsequent impact on capital costs.

On a global scale, Jun *et al.* (2023) analysed gender diversity reforms in 43 markets and found that the benefits of board diversity in reducing the cost of capital were most pronounced in companies that were already transparent and conservative in their accounting practices. For the Chinese market, Jiang *et al.* (2024) demonstrated that female chairpersons were associated with significantly lower capital costs, with stronger effects observed in companies with influential chairpersons.

Despite the growing body of evidence supporting the positive impact of gender diversity on the cost of capital, the literature does not present a consensus on the relationship between gender diversity and firm value. Sarang *et al.* (2024b) argue that the impact of board diversity on firm value is indirect, mainly operating through mechanisms such as reduced capital costs. These findings highlight the need for further exploration, particularly in regions such as Latin America, where evidence remains limited. For Latin American countries, while there is still no research investigating the cost of equity, Gonzalez-Ruiz *et al.* (2024) examined board gender diversity and debt financing costs in companies in Latin America and the Caribbean. The results suggest that board diversity policies consistently demonstrated effects in reducing both short-term and long-term debt costs.

An important aspect of the effect of including women on the board is the non-linear relationship with corporate performance. Studies show that the inclusion of women improves performance up to a certain point, described as an inverted U-shape (Campos-García and Zúñiga-Vicente, 2023), when what theorists call the critical mass is reached (Lefley and Janeček, 2024). After surpassing this threshold, company performance tended to decrease again. Some research even estimates the optimal percentage to be around 30% women on the board (Joecks *et al.*, 2013). These dynamics further emphasize the complex interplay between gender diversity, governance, and corporate outcomes, underscoring the need for region-specific studies to unravel these nuances.

Table 1 provides a summary of the most relevant recent studies investigating the relationship between gender diversity on boards of directors and the cost of equity capital (COE).

### *2.4 Hypotheses*

Several studies suggest a negative relationship between women's presence on boards and the cost of equity (COE). Nguyên (2020) found that higher female representation in French companies reduces COE by improving monitoring and investor confidence. Similarly, Saleh *et al.* (2022) observed a significant reduction in COE in Jordan, especially with strong governance practices. Sarang *et al.* (2024a, 2024b) confirmed these findings in both the U.S. and France, noting that female representation promotes transparency and reduces informational asymmetries, lowering investor risk perceptions. Based on the above, the following hypothesis is proposed:

*H1*. Increased female participation on corporate boards is negatively associated with the cost of equity for Brazilian companies.

Recent studies also suggest a non-linear relationship between gender diversity and COE. Aljughaiman *et al.* (2022) found that in the U.S., diversity impacts COE only when women represent at least 28% of the board. Similarly, Sarang *et al.* (2024b) showed COE reduction only with at least two women on a board, and Sarang *et al.* (2024a) found a larger effect with four or more women in French companies. These findings support Kanter's (1977) critical mass theory, indicating a threshold for significant diversity effects. Therefore, the following hypothesis is proposed:

*H2*. Female board representation has a non-linear effect on the cost of equity for Brazilian companies.

## 3. Methodology

### *3.1 Research design/model*

This study is structured around a theoretical model that integrates the Agency Theory (Jensen and Meckling, 1976), the Stakeholder Theory (Freeman, 1984), and the Critical Mass Theory (Kanter, 1977). These theories provide the foundation for analysing how gender diversity on corporate boards can influence the cost of equity in Brazilian companies.

In alignment with this theoretical grounding, the research employs a Generalized Method of Moments (GMM) regression model, in accordance with Nguyên (2020), to empirically test the proposed hypotheses. This model was specifically chosen to address potential endogeneity concerns, thereby ensuring the robustness of the estimated relationships between the variables of interest. The analysis encompasses both linear and non-linear effects of gender diversity on the cost of equity capital, utilizing multiple metrics such as the number and percentage of women on the board, the Blau index, the Shannon index, and four dummies, following Sarang

**Table 1.** Summary of empirical studies

| Year | Source | Countries | Gender variables | Cost of equity variables | Main result | Effect |
|---|---|---|---|---|---|---|
| 2018 | Srivastava *et al.* (2018) | India | Number of women on the board; Dummy indicating the presence of women in board committees; Dummy indicating the presence of women as independent directors on the board | Ex-post COE obtained using the Sharpe (1964) CAPM | Female board members have a negative impact on the cost of equity | Negative |
| 2020 | Nguyên (2020) | France | Proportion of women on the board | Ex-ante COE obtained using the Pastor *et al.* (2008) model | Female directors are associated with lower COE due to higher diligence and monitoring, increasing investor confidence | Negative |
| 2022 | Saleh *et al.* (2022) | Jordan | Dummy indicating the presence of women on the board | Ex-ante COE obtained using the Easton (2004) model | Gender diversity significantly reduces the COE. The interaction between earnings management (EM) practices and gender diversity positively moderates this relationship | Negative |
| 2022 | Aljughaiman *et al.* (2022) | U.S. | Proportion of women on the board | Ex-ante COE obtained using the Claus and Thomas (2001), Easton (2004), Gebhardt *et al.* (2001), and Ohlson and Juettner-Nauroth (2005) models | Companies with higher proportions of women tend to adopt less risky capital structures, reducing the COE. The effect is significant only when female participation reaches a critical level (28%) | Negative |
| 2023 | Jun *et al.* (2023) | 43 countries | Dummy for firms with mandatory female representation | Ex-ante COE obtained using the Claus and Thomas (2001), Easton (2004), Gebhardt *et al.* (2001), and Ohlson and Juettner-Nauroth (2005) models | Legislative reforms for greater gender diversity reduced the COE | Negative |

(*continued*)

**Table 1.** Continued

| Year | Source | Countries | Gender variables | Cost of equity variables | Main result | Effect |
|---|---|---|---|---|---|---|
| 2024 | Sarang *et al.* (2024b) | U.S. | Proportion of women on the board | Ex-ante COE obtained using the Claus and Thomas (2001), Easton (2004), Gebhardt *et al.* (2001), and Ohlson and Juettner-Nauroth (2005) models | Women on boards reduce the COE, but only with a critical mass of two or more women. The effect is mediated by the reduction of information asymmetry (IA) | Negative |
| 2024 | Sarang *et al.* (2024a) | France | Proportion of women on the board and 4 dummies indicating the number of women | Ex-post COE adapted from the Sharpe (1964) CAPM | Gender diversity decreases the COE, especially after the implementation of quota legislation (Copé–Zimmermann). The relationship is significant for boards with four or more women | Negative |
| 2024 | Jiang *et al.* (2024) | China | Dummy indicating a woman as board chair | Ex-ante COE obtained using the Easton (2004) model | The presence of women as board chairs reduces the COE. The effect is stronger in firms with weak governance, located in low-trust environments, and with higher retail investor participation | Negative |

**Source(s):** Authors’ own work

*et al.* (2024a), to capture various dimensions of diversity. Figure 1 shows the conceptual framework.

*3.2 Data and variables*

For data analysis, this study gathered annual information from publicly traded Brazilian companies listed on the B3 stock exchange spanning the period from 2010 to 2023. The selection of this timeframe was motivated by the need to align financial statements with the provisions of Law 11.638/07, which became effective in 2010. Furthermore, the conclusion of the analysis at the end of 2023 was determined by the availability of data on the composition of companies’ boards of directors. The data for this study were obtained from the Refinitiv Eikon® database, which is commonly used in empirical research.

*3.2.1 Dependent variable.* This study estimated the cost of capital using the five-factor model by Fama and French (2015), which extends the three-factor model by Fama and French (1993). In addition to size (SMB) and value (HML) factors, the five-factor model incorporates profitability (RMW) and investment (CMA) factors. The choice of the Fama-French Five-Factor Model for the Brazilian market was guided by the findings of Foye (2018), who compared the CAPM, Fama-French three-factor, and five-factor models across emerging markets, including Brazil. His results demonstrated the superior explanatory power of the five-

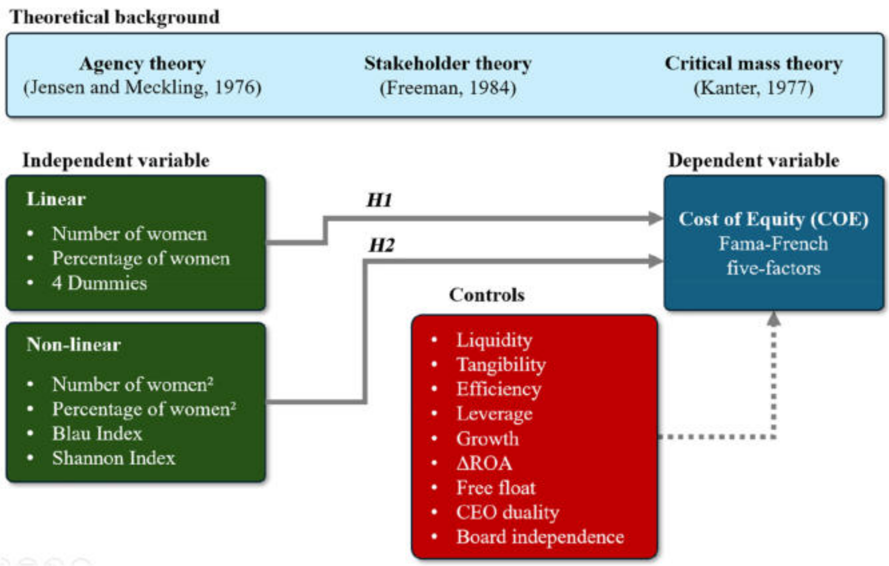


**Figure 1.** Theoretical model. Source(s): Authors' own work

factor model. This evidence was further corroborated by Carvalho *et al.* (2021), who conducted a Brazil-specific study that also included testing the Carhart (1997) four-factor model. The model is expressed as follows:

$$k_i = r_f + \beta_{1i}(r_m - r_f) + \beta_{2i}SMB + \beta_{3i}HML + \beta_{4i}RMW + \beta_{5i}CMA \quad (1)$$

where $r_f$ is the risk-free rate of return (based on Brazil's annual interest rate, known as the SELIC rate), $r_m$ is the market return (calculated as the annual variation of the Brazilian stock exchange index, Ibovespa), and $\beta_{ji}$ are the parameters of the model, and $(r_m - r_f)$ is the Market Risk Premium (MRP), SMB (Small Minus Big) is the size factor, HML (High Minus Low) is the value factor, RMW (Robust Minus Weak) is the profitability factor, and CMA (Conservative Minus Aggressive) is the investment factor.

The SMB factor, representing company size, is calculated as the return difference between small-cap and large-cap firms, following Foye (2018) and Carvalho *et al.* (2021). Firms are classified as "large" or "small" based on market capitalization relative to the median. The HML factor captures value by comparing the returns of firms with high and low book-to-market (BP) ratios, categorized using the 70th and 30th percentiles. Combining size and BP groups resulted in six portfolios: SH, SN, SL, BH, BN, and BL.

Profitability, measured by the RMW factor, uses Return on Equity (ROE) as a proxy. Firms are grouped into Robust (R), Neutral (N), and Weak (W), creating six portfolios: SR, SN, SW, BR, BN, and BW. The CMA factor reflects investment behaviour, with firms classified as Conservative (C), Neutral (N), or Aggressive (A) based on their investment rates. This yields six portfolios: SC, SN, SA, BC, BN, and BA.

To calculate SMB factors based on BP, profitability (OP), and investment (Inv), the returns of small portfolios are averaged and subtracted from the average returns of large portfolios. Specifically, SMBBP, SMBOP, and SMBINV are derived from their respective portfolio groupings. Table 2 provides detailed calculation formulas.

*3.2.2 Independent variables.* To analyse gender diversity, this study employed different measures to assess the participation of women on the boards of directors of companies. The

**Table 2.** Factors used in the model

| Variable | Classification | Factor |
|---|---|---|
| Market | | $MRP = r_m - r_f$ |
| Size | Median | $SMB_{BP} = (SH + SN + SL)/3 - (BH + BN + BL)/3$ |
| | | $SMB_{OP} = (SR + SN + SW)/3 - (BR + BN + BW)/3$ |
| | | $SMB_{Inv} = (SC + SN + SA)/3 - (BC + BN + BA)/3$ |
| | | $SMB = (SMB_{BP} + SMB_{OP} + SMB_{Inv})/3$ |
| Value (BP) | 30th and 70th percentiles | $HML = (SH + BH)/2 - (SL + BL)/2$ |
| Profitability (OP) | 30th and 70th percentiles | $RMW = (SR + BR)/2 - (SW + BW)/2$ |
| Investment (Inv) | 30th and 70th percentiles | $CMA = (SC + BC)/2 - (SA + BA)/2$ |

**Source(s):** Authors' own work

first and most traditional factor is the number of women on the board. The second factor is the percentage of women on the board, calculated by dividing the number of women on the board by the total number of directors. Although these variables represent female participation, they are not typically considered as diversity measures, as pointed out by Abad *et al.* (2017). A board composed entirely of women, representing the maximum value of the variable, indicates a completely homogenous and non-diverse board. Therefore, this study used two additional measures to capture the diversity. According to Abad *et al.* (2017) and Stirling (1998), these two measures combine a measure of "variety" and a measure of "balance." The "variety" measure is designed to evaluate whether boards include representatives of both genders, while the "balance" measure assesses the equality between men and women represented on the board.

The diversity measure is Blau's diversity index (Blau, 1977), denoted as BLAU, as follows:

$$BLAU = 1 - \sum_{i=1}^{n} p_i^2 \tag{2}$$

where $p_i$ is the percentage of women on the board of company *i*. Note that the BLAU value ranges from 0 to 0.5, where 0 indicates low diversity and 0.5 shows high diversity.

The "balance" measure is Shannon's diversity index (Shannon, 1948), denoted as SHANNON, as follows:

$$SHANNON = -\sum_{i=1}^{n} p_i \ln p_i \tag{3}$$

where $p_i$ is the percentage of women on the board of company *i*. The index ranged from 0 to 0.69, with 0.69 indicating the highest level of diversity. The Shannon index is a logarithmic measure that makes small changes in board-gender diversity more sensitive. Although diversity indices reach their maximum when women and men are equally represented, female representation is often low, making it challenging to form boards with a female majority. Therefore, diversity indices do not replace but complement the measure of diversity, enhancing the robustness of the results (Abad *et al.*, 2017).

Additionally, this study incorporated four dummy variables following the methodology proposed by Sarang *et al.* (2024a). First, the dummy variable DW1 was applied, taking the value of 1 if the company has one woman on the board and 0 otherwise, excluding companies with more than one female director. Next, the dummy variable DW2 was used, coded as 1 if the company has two women on the board and 0 otherwise, excluding companies with more than two female directors. Subsequently, the dummy variable DW3 was adopted, coded as 1 if there are three women on the board and 0 otherwise, excluding companies with more than three female directors. Finally, the dummy variable DW4 was used, taking the value of 1 if the company has four women on the board and 0 otherwise, excluding companies with more than four female directors.

*3.2.3 Control variables.* This study selected the control variables based on empirical evidence to ensure the robustness of the analysis and minimize potential biases in the results. The first variable, ΔROA (DROA), evaluates the operational performance of companies by comparing the return on assets over two consecutive periods, as highlighted by Maury (2018) and Lys *et al.* (2015). Efficiency (EFIC), represented by the ratio of EBITDA to total assets, is used to capture the productivity of companies, based on Nguyen's study (2020). Liquidity (LIQ), measured as the ratio of current assets to current liabilities, reflects a company's short-term ability to meet its obligations, following Ng and Rezaee (2015). Tangibility (TANG), defined as the proportion of fixed assets to total assets, captures the level of investment in physical assets, as highlighted by Aljughaiman *et al.* (2022). Leverage (The LEV), measured by the ratio of debt to total assets, reflects the company's debt level, as discussed by Saleh *et al.* (2022) and Nguyen (2020). Sales growth (GROWTH), calculated as the percentage variation in revenues between two consecutive periods, seeks to capture the dynamism of the companies' operations, supported by the studies of Marchini *et al.* (2017).

Additionally, CEO duality (CEO), a dummy variable that equals 1 if the chairman of the board also holds the CEO position, and 0 otherwise, is included to capture governance structure influences, following Aljughaiman *et al.* (2022). Board independence (BIND), measured as the percentage of independent directors on the board, reflects the board's potential to act objectively, as discussed by Aljughaiman *et al.* (2022). Finally, this study included free float (FREE), calculated as the proportion of shares outstanding to total shares, to account for ownership dispersion, which is supported by Khlif *et al.* (2015).

It is important to note that the cost of equity, measured using the Fama-French Five-Factor Model, already incorporates various company characteristics, such as size, value, profitability, and investment. Therefore, the control variables were chosen to avoid conflict with the proposed model, ensuring that the results obtained are consistent and robust.

Table 3 summarizes the variables used in the empirical investigation.

### *3.3 Analytical procedures*

To analyse the relationship between gender diversity and the cost of equity, this study used a multiple linear regression method for panel data. However, previous studies, such as Yang *et al.* (2019), Farag and Mallin (2017) and Nguyên (2020), indicate that there may be an endogeneity effect between variables, and recommend the use of dynamic panel data models. This study suggests the Two-step Generalized Method of Moments system (GMM-sys) to correct such problems by combining the equation in first differences with the same equation expressed in levels, as shown in Equation (4).

$$COE_{it} = \alpha_0 + \theta COE_{it-1} + \beta_0 BD_{it} + \sum_{j=1}^{n} \beta_j Controls_{jit} + \varepsilon_{it} \tag{4}$$

where $COE_{it}$ is the cost of equity for company $i$ in year $t$; $BD_{it}$ is company $t$'s board diversity variable in year $t$, which can take on one of the different diversity variables; α, θ, and β are parameters to be estimated; and $\varepsilon_{it}$ is error.

In addition to the linear model, Proença and Neves (2022) describe a non-linear effect between gender diversity and performance, known as an inverted U-Shape. This means that the company's performance increases up to a certain point with increasing female participation, after which performance tends to decrease. However, because the cost of capital has an inverse relationship, it is expected that the U-shape is not inverted (Figure 2). Therefore, this can be tested using Equation (5).

**Table 3.** Variables used in the model

| Variable | Code | Equation | Expected | Source |
|---|---|---|---|---|
| *Dependent* | | | | |
| Cost of equity | COE | Risk free + $\beta_1$MRP + $\beta_2$SMB + $\beta_3$HML + $\beta_4$RMW + $\beta_5$CMA | | Foye (2018) |
| *Independent* | | | | |
| Number of women | NW | Number of women on the board | (−) | Sarang *et al.* (2024b) |
| Percentage of women | PW | Number of women divided by number of members | (−) | Sarang *et al.* (2024b) |
| Blau index | BLAU | $1 - \sum_{i=1}^{n} p_i^2$ | (−) | Đặng *et al.* (2020) |
| Shannon index | SHANNON | $-\sum_{i=1}^{n} p_i \ln p_i$ | (−) | Oradi and Izadi (2020) |
| Presence of one woman on the board | DW1 | Dummy variable takes the value of 1 if the company has one woman on the board and 0 otherwise | (−) | Sarang *et al.* (2024a) |
| Presence of two women on the board | DW2 | Dummy variable takes the value of 1 if the company has two women on the board and 0 otherwise | (−) | Sarang *et al.* (2024a) |
| Presence of three women on the board | DW3 | Dummy variable takes the value of 1 if the company has three women on the board and 0 otherwise | (−) | Sarang *et al.* (2024a) |
| Presence of four women on the board | DW4 | Dummy variable takes the value of 1 if the company has four women on the board and 0 otherwise | (−) | Sarang *et al.* (2024a) |
| *Controls* | | | | |
| ΔROA | DROA | ROA (t)/ROA (t−1) | (+/−) | Maury (2018), Lys *et al.* (2015) |
| Efficiency | EFIC | EBITDA/Total assets | (−) | Nguyen (2020) |
| Liquidity | LIQ | Current assets/Current liabilities | (−) | Ng and Rezaee (2015) |
| Tangibility | TANG | Fixed assets/Total assets | (−) | Aljughaiman *et al.* (2022) |
| Leverage | LEV | Debt/Total assets | (+) | Saleh *et al.* (2022), Nguyen (2020) |
| Sales growth | GROWTH | Revenues (t) Revenues (t−1) – 1 | (+/−) | Marchini *et al.* (2017) |
| CEO duality | CEO | Dummy variable takes the value of 1 if the chairman of the board is also the CEO, and 0 otherwise | (+) | Aljughaiman *et al.* (2022) |
| Board independence | BIND | Percentage of independent directors on the board | (−) | Aljughaiman *et al.* (2022) |
| Free float | FREE | Shares outstanding/Total Shares | (−) | Khlif *et al.* (2015) |

**Source(s):** Authors' own work

$$COE_{it} = \alpha_0 + \theta COE_{it-1} + \beta_0 BD_{it} + \beta_1 BD_{it}^2 + \sum_{j=1}^{n} \beta_j Controls_{jit} + \varepsilon_{it} \quad (5)$$

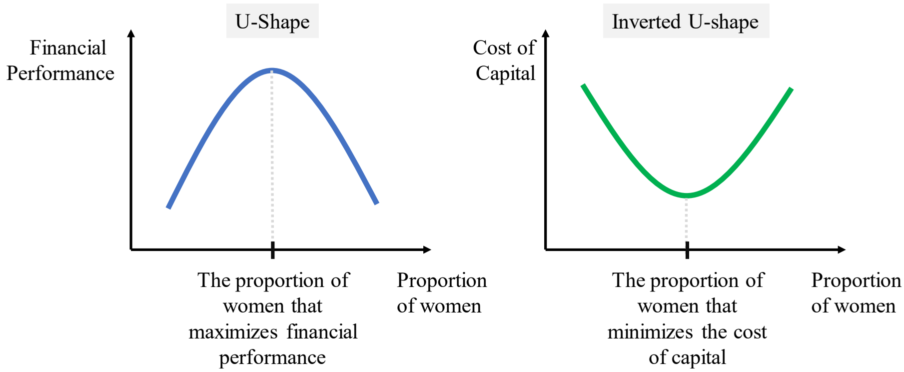


**Figure 2.** Non-linear relationship between the proportion of women and the financial performance of the company. Source(s): Authors' own work

This study used tree tests to validate the proposed methodology: the autocorrelation test (with the null hypothesis of no autocorrelation), the Sargan test (with the null hypothesis of instrument validity), and the Wald test (with the null hypothesis that the parameters are not jointly significant). This study applied GMM-sys after approving these three tests and corrected all outliers by winsorizing the data.

## 4. Results

### *4.1 Descriptive analysis*

Table 4 provides descriptive statistics for the cost of equity (COE) and gender diversity variables, followed by the control variables used in the empirical analysis.

The average cost of equity (COE) was 0.131, indicating an expected annual return of approximately 13.1%. This value is higher than the average of 9.9% in the United States (Sarang *et al.*, 2024b), 7.7% in France (Sarang *et al.*, 2024a), and 7.8% in India (Srivastava *et al.*, 2018). However, it is below the implicit cost of equity of 15.3% observed in Brazil (Jun

**Table 4.** Descriptive statistics of the variables

| | Mean | Median | Std. dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| COE | 0.131 | 0.084 | 0.273 | −0.581 | 3.477 |
| PW | 0.101 | 0.100 | 0.108 | 0.000 | 0.667 |
| NW | 1.027 | 1.000 | 1.187 | 0.000 | 8.000 |
| BLAU | 0.158 | 0.180 | 0.153 | 0.000 | 0.500 |
| SHANNON | 0.254 | 0.325 | 0.233 | 0.000 | 0.693 |
| LIQ | 1.913 | 1.652 | 1.132 | 0.203 | 10.534 |
| TANG | 0.257 | 0.218 | 0.216 | 0.000 | 0.908 |
| EFIC | 0.117 | 0.112 | 0.073 | −0.255 | 0.398 |
| LEV | 0.326 | 0.318 | 0.170 | 0.000 | 0.807 |
| GROWTH | 0.168 | 0.123 | 0.286 | −0.738 | 1.934 |
| DROA | −0.001 | −0.001 | 0.054 | −0.607 | 0.328 |
| FREE | 0.574 | 0.548 | 0.259 | 0.000 | 1.000 |
| CEO | 0.313 | 0.000 | 0.464 | 0.000 | 1.000 |
| BIND | 0.403 | 0.390 | 0.245 | 0.000 | 1.000 |

**Source(s):** Authors' own work

*et al.*, 2023). This result reflects the level of risk and required returns for equity investors across the sampled firms.

Regarding gender diversity, the average percentage of women on boards (PW) was 10.1%, while the average number of women per board (NW) stood at 1.027. These results were higher than the average of 7.3% in the United States (Sarang *et al.*, 2024b), but below the 16.4% observed in France (Sarang *et al.*, 2024a) and the 18.6% in Jordan (Saleh *et al.*, 2022). Evidence from Table 4 indicates that companies, on average, have slightly more than one woman on their boards, which falls significantly short of the 30% critical mass suggested by Joecks *et al.* (2013) and far from the ideal representation of 50%, which is consistent with women's participation in Brazilian society (IBGE, 2022).

The Blau and Shannon diversity indices averaged 0.158 and 0.254, respectively, reflecting low levels of gender diversity. These indices are far from their maximum values (0.5 for Blau and 0.693 for Shannon), suggesting that Brazilian companies have substantial room for improvement in achieving gender-balanced representation.

*4.2 Linear analysis*

Table 5 presents the Pearson correlation values for the analysed variables, emphasizing the relationship between gender diversity metrics (PW and NW) and the cost of equity (COE). The analysis employed Pearson's correlation method, as the investigation focuses on linear relationships. Variance Inflation Factor (VIF) values were below 10 for all variables, indicating no multicollinearity concerns (O'brien, 2007).

The findings reveal a statistically significant negative correlation between the percentage of women on boards (PW) and the cost of equity (COE), with a coefficient of −0.078 ($p < 0.05$), suggesting that greater gender diversity reduces equity costs by improving governance and mitigating investor risks. This aligns with prior studies (Srivastava *et al.*, 2018; Jiang *et al.*, 2024; Saleh *et al.*, 2022). Both the Blau (−0.068, $p < 0.05$) and the Shannon (−0.064, $p < 0.05$) diversity indices also showed significant negative correlations, reinforcing the link between higher board diversity and lower COE. Regression analysis confirmed these linear relationships, with PW showing a significant coefficient of −0.389 and the number of women (NW) showing a coefficient of −0.019, indicating that increasing female representation on boards contributes to lower equity capital costs.

The regression results (Table 6) reveal that both the percentage of women on boards (PW) and the number of women on boards (NW) are significantly and negatively associated with the cost of equity (COE), reinforcing Hypothesis 1 (H1). PW, which represents the proportion of women on the board, has a coefficient of −0.389 ($p < 0.01$). This indicates that for every 1% increase in the proportion of women on boards, the COE decreases by 0.389% points, reflecting a meaningful reduction in the capital costs faced by firms. NW, representing the absolute number of women on a board, has a coefficient of −0.019 ($p < 0.01$). This suggests that adding one additional woman to a board reduces the COE by 0.019% points, further emphasizing the economic significance of increasing female representation.

These results align with evidence from other markets, such as France (Nguyên, 2020; Sarang *et al.*, 2024a), the U.S. (Sarang *et al.*, 2024b; Aljughaiman *et al.*, 2022), and Jordan (Saleh *et al.*, 2022), which consistently demonstrate similar negative relationships between board gender diversity and COE.

The analysis of dummy variables emphasizes the varying impacts of board gender diversity on equity costs. Having one woman on the board (DW1) is associated with a significant COE reduction (−0.063), as has two women (−0.064). However, three women (DW3) show a small positive coefficient (0.028), significant at the 5%, suggesting a potential diminishing effect. In contrast, four women (DW4) resulted in a stronger reduction (−0.090), emphasizing that a critical mass enhance governance and reduces equity costs. These findings align with Sarang *et al.* (2024a), who noted a significant COE decrease in firms with at least four female directors.

**Table 5.** Pearson correlation matrix

| | | VIF | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|---|---|
| COE | (1) | | 1.000 | | | | | |
| PW | (2) | 1.094 | −0.078** | 1.000 | | | | |
| NW | (3) | 1.089 | −0.028 | 0.821*** | 1.000 | | | |
| BLAU | (4) | 1.090 | −0.068** | 0.980*** | 0.838*** | 1.000 | | |
| SHANNON | (5) | 1.091 | −0.064** | 0.956*** | 0.832*** | 0.994*** | 1.000 | |
| LIQ | (6) | 1.092 | −0.014 | −0.056* | −0.069** | −0.064** | −0.069** | 1.000 |
| TANG | (7) | 1.238 | 0.018 | 0.023 | 0.140*** | 0.037 | 0.041 | −0.204*** |
| EFIC | (8) | 1.244 | 0.073*** | −0.012 | 0.018 | 0.000 | 0.004 | −0.088*** |
| LEV | (9) | 1.194 | −0.072*** | 0.014 | 0.132*** | 0.037 | 0.046 | −0.215*** |
| GROWTH | (10) | 1.155 | −0.133*** | 0.042 | 0.018 | 0.049 | 0.049 | −0.004 |
| DROA | (11) | 1.164 | 0.075*** | −0.037 | −0.024 | −0.043 | −0.045 | 0.002 |
| FREE | (12) | 1.172 | 0.008 | 0.105*** | 0.119*** | 0.133*** | 0.150*** | 0.000 |
| CEO | (13) | 1.095 | 0.007 | −0.048 | −0.138*** | −0.057 | −0.065* | 0.143*** |
| BIND | (14) | 1.288 | 0.022 | 0.239*** | 0.068* | 0.235*** | 0.220*** | 0.094*** |

| | | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|
| TANG | (7) | 1.000 | | | | | | |
| EFIC | (8) | 0.203** | 1.000 | | | | | |
| LEV | (9) | 0.351*** | −0.042 | 1.000 | | | | |
| GROWTH | (10) | 0.104*** | 0.180*** | 0.055** | 1.000 | | | |
| DROA | (11) | 0.010 | 0.256*** | −0.038 | 0.311*** | 1.000 | | |
| FREE | (12) | −0.131*** | −0.120*** | −0.019 | −0.054** | 0.002 | 1.000 | |
| CEO | (13) | −0.063* | 0.002 | −0.040 | 0.022 | 0.008 | −0.087** | 1.000 |
| BIND | (14) | −0.033 | 0.075** | 0.049 | 0.038 | 0.034 | 0.192*** | 0.159*** |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively
**Source(s):** Authors' own work

*4.3 Non-linear analysis*

To investigate the potential non-linear relationships between the variables, this study conducted a Spearman correlation analysis, as shown in Table 7. The analysis revealed a weak but significant negative correlation between the cost of equity (COE) and the percentage of women on the board (PW), as well as between COE and the Blau and the Shannon indices (correlation coefficients of −0.092 and −0.091, respectively).

Table 8 presents the results of the non-linear analysis examining the relationship between female board representation and the cost of equity (COE). The analysis includes variables for the percentage of women on the board (PW) and its squared term ($PW^2$) as well as the number of women on the board (NW) and its squared term ($NW^2$). Additionally, diversity indices (Blau and Shannon) were analysed for their impact on the COE.

The findings revealed significant non-linear effects, supporting Hypothesis 2 (H2). The coefficient for PW is −0.254, indicating that an increase in the percentage of women on the board reduces the COE. The squared term for PW ($PW^2$) is also significant and negative (−0.404), suggesting an accelerating reduction in COE as the percentage of women increases, highlighting a progressive governance benefit. These results differ from those of Aljughaiman *et al.* (2022), who observed diminishing effects beyond a 40% female board representation in the U.S. market. For NW, the coefficient is −0.050, indicating that adding women to the board reduces COE. However, the squared term ($NW^2$) is positive (0.007) and significant, indicating a diminishing marginal effect when the number of women on the board increases. This aligns with prior evidence of the non-linear dynamics in gender diversity and governance. The Blau (−0.265) and the Shannon (−0.175) indices also show significant negative effects on the COE,

**Table 6.** Linear analysis using the dynamic panel model (GMM-System)

| | Percentage of women | | Number of women | | Dummies | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat |
| COE(−1) | 0.071 | 22.190*** | 0.074 | 31.250*** | 0.083 | 25.470*** | 0.076 | 28.940*** | 0.067 | 26.060*** | 0.073 | 31.930*** |
| PW | −0.389 | −13.770*** | | | | | | | | | | |
| NW | | | −0.019 | −5.638*** | | | | | | | | |
| DW1 | | | | | −0.063 | −11.120*** | | | | | | |
| DW2 | | | | | | | −0.064 | −8.528*** | | | | |
| DW3 | | | | | | | | | 0.028 | 2.231** | | |
| DW4 | | | | | | | | | | | −0.090 | −5.999*** |
| LIQ | 0.013 | 4.124*** | 0.012 | 2.602*** | 0.008 | 1.474 | 0.010 | 2.874*** | 0.012 | 2.670*** | 0.012 | 2.568** |
| TANG | 0.004 | 0.264 | 0.014 | 0.883 | −0.081 | −4.771*** | −0.003 | −0.244 | 0.011 | 0.705 | 0.013 | 1.010 |
| EFIC | 0.258 | 8.731*** | 0.256 | 7.813*** | 0.184 | 5.198*** | 0.217 | 8.052*** | 0.193 | 5.273*** | 0.239 | 6.917*** |
| LEV | 0.051 | 2.307** | 0.061 | 2.678*** | 0.178 | 5.958*** | 0.072 | 3.077*** | 0.037 | 1.631 | 0.044 | 1.705* |
| GROWTH | −0.175 | −19.670*** | −0.183 | −18.550*** | −0.169 | −16.240*** | −0.164 | −18.200*** | −0.179 | −18.160*** | −0.189 | −17.580*** |
| DROA | 0.240 | 7.787*** | 0.255 | 6.361*** | 0.158 | 4.077*** | 0.099 | 3.800*** | 0.272 | 7.033*** | 0.245 | 6.352*** |
| FREE | −0.009 | −0.800 | −0.017 | −1.555 | −0.036 | −2.775*** | −0.039 | −4.323*** | −0.040 | −3.477*** | −0.027 | −2.391** |
| CEO | 0.008 | 1.089 | 0.010 | 1.300 | 0.003 | 0.400 | 0.026 | 3.748*** | 0.031 | 3.813*** | 0.018 | 2.507** |
| BIND | 0.000 | 0.040 | −0.030 | −2.654*** | −0.026 | −1.500 | −0.019 | −1.457 | −0.033 | −2.791*** | −0.042 | −3.547*** |
| Sector | No | | No | | No | | No | | No | | No | |
| Year | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | |
| Model | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | |
| Number | 746 | | 747 | | 501 | | 632 | | 707 | | 732 | |
| AR(1) | −4.791 | [0.0000] | −4.779 | [0.0000] | −3.659 | [0.0003] | −4.317 | [0.0000] | −4.831 | [0.0000] | −4.756 | [0.0000] |
| AR(2) | −0.469 | [0.6392] | −0.735 | [0.4623] | −0.342 | [0.7321] | −0.744 | [0.4569] | −0.765 | [0.4442] | −0.710 | [0.4778] |
| Sargan test | 89.635 | [0.4612] | 90.899 | [0.4242] | 72.732 | [0.8947] | 84.506 | [0.6150] | 87.901 | [0.5130] | 89.796 | [0.4564] |
| Wald test | 35.258 | [0.0000] | 28280.7 | [0.0000] | 19759.9 | [0.0000] | 71483.5 | [0.0000] | 32.251 | [0.0000] | 28.178 | [0.0000] |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; values in square brackets indicate the *p*-value of the tests
**Source(s):** Authors' own work

**Table 7.** Spearman correlation matrix

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|---|
| COE | (1) | 1.000 | | | | | | |
| PW | (2) | −0.092* | 1.000 | | | | | |
| NW | (3) | −0.067 | 0.911*** | 1.000 | | | | |
| BLAU | (4) | −0.091* | 1.000 | 0.911*** | 1.000 | | | |
| SHANNON | (5) | −0.091* | 1.000 | 0.911*** | 1.000 | 1.000 | | |
| LIQ | (6) | −0.016 | 0.028 | −0.041 | 0.028 | 0.028 | 1.000 | |
| TANG | (7) | −0.005 | 0.082 | 0.151 | 0.082 | 0.082 | −0.046 | 1.000 |
| EFIC | (8) | 0.104* | 0.037 | 0.063 | 0.037 | 0.036 | −0.214* | 0.281*** |
| LEV | (9) | −0.013 | 0.014 | 0.074 | 0.014 | 0.013 | −0.098 | 0.277*** |
| GROWTH | (10) | −0.154*** | 0.094* | 0.051 | 0.094 | 0.094 | −0.002 | 0.073* |
| DROA | (11) | 0.095* | −0.054 | −0.066 | −0.054 | −0.053 | 0.023 | 0.003 |
| FREE | (12) | −0.009 | 0.110** | 0.129*** | 0.110 | 0.110 | 0.172*** | −0.161** |
| CEO | (13) | 0.024 | −0.070 | −0.138 | −0.070 | −0.070 | 0.149* | −0.027 |
| BIND | (14) | 0.044 | 0.247*** | 0.129*** | 0.247*** | 0.246*** | 0.200*** | −0.015 |

| | | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|
| EFIC | (8) | 1.000 | | | | | | |
| LEV | (9) | 0.024 | 1.000 | | | | | |
| GROWTH | (10) | 0.212*** | 0.051 | 1.000 | | | | |
| DROA | (11) | 0.193*** | −0.078 | 0.2686** | 1.000 | | | |
| FREE | (12) | −0.178*** | 0.002 | −0.059 | 0.013 | 1.000 | | |
| CEO | (13) | 0.001 | −0.021 | 0.001 | 0.005 | −0.097** | 1.000 | |
| BIND | (14) | 0.023 | 0.045 | 0.037 | −0.022 | 0.215*** | 0.196*** | 1.000 |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively
**Source(s):** Authors' own work

reinforcing that higher levels of gender diversity are associated with lower equity costs. This result mirrors the findings of Sarang *et al.* (2024a) in the French market, where diversity indices demonstrate reductions in COE following gender quota implementation.

*4.4 Robustness analysis*

This study performed two additional tests to assess the robustness of the results. The first test examined the regression estimators. While the main analyses employed the GMM method, panel regressions with fixed and random effects, as well as OLS models, were also tested, following the approach of Srivastava *et al.* (2018). This procedure aimed to verify the consistency of results across different estimation methods.

The second test addressed the metrics used to measure the cost of equity, considering that different pricing models can significantly influence asset price assessments. Fama (1998) notes that markets can exhibit substantial deviations in price behaviour and expected returns, often referred to as "anomalies," depending on the pricing model employed. Given that Carvalho *et al.* (2021) and Foye (2018) demonstrated the suitability of the Fama-French Three-Factor Model for pricing returns of companies in Latin American countries, particularly Brazil, this study also tested that model using the GMM method.

*4.4.1 Alternative method for regression analysis.* Table 9 presents the results for both linear and non-linear models estimated using fixed effects, random effects, and the traditional OLS model. Model selection was based on the Hausman and Breusch-Pagan tests. Overall, this study predominantly selected the fixed effect model, except for the model with DW4, where the Breusch-Pagan statistic was not significant.

**Table 8.** Non-linear analysis using the dynamic panel model (GMM-System)

| | Percentage of women | | Number of women | | Blau index | | Shannon index | |
|---|---|---|---|---|---|---|---|---|
| | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat |
| COE(−1) | 0.072 | 24.310*** | 0.071 | 26.620*** | 0.069 | 24.470*** | 0.068 | 24.180*** |
| PW | −0.254 | −4.766*** | | | | | | |
| $PW^2$ | −0.404 | −2.634*** | | | | | | |
| NW | | | −0.050 | −8.685*** | | | | |
| $NW^2$ | | | 0.007 | 5.102*** | | | | |
| BLAU | | | | | −0.265 | −15.920*** | | |
| SHANNON | | | | | | | −0.175 | −16.360*** |
| LIQ | 0.013 | 4.267*** | 0.010 | 2.372** | 0.013 | 3.858*** | 0.013 | 3.703*** |
| TANG | 0.006 | 0.485 | 0.013 | 0.761 | 0.007 | 0.491 | 0.009 | 0.575 |
| EFIC | 0.244 | 8.264*** | 0.264 | 7.617*** | 0.271 | 10.010*** | 0.279 | 10.670*** |
| LEV | 0.048 | 2.117** | 0.042 | 1.844* | 0.052 | 2.969*** | 0.053 | 2.998*** |
| GROWTH | −0.174 | −21.400*** | −0.181 | −16.940*** | −0.175 | −20.950*** | −0.174 | −21.480*** |
| DROA | 0.255 | 7.682*** | 0.231 | 6.162*** | 0.229 | 7.594*** | 0.227 | 7.348*** |
| FREE | −0.015 | −1.223 | −0.011 | −1.105 | −0.005 | −0.441 | −0.002 | −0.211 |
| CEO | 0.009 | 1.247 | 0.008 | 1.057 | 0.009 | 1.353 | 0.010 | 1.391 |
| BIND | 0.000 | −0.015 | −0.017 | −1.617 | −0.003 | −0.227 | −0.006 | −0.545 |
| Sector | No | | No | | No | | No | |
| Year | Yes | | Yes | | Yes | | Yes | |
| Model | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | |
| Number | 746 | | 747 | | 746 | | 746 | |
| AR(1) | −4.806 | [0.0000] | −4.757 | [0.0000] | −4.771 | [0.0000] | −4.757 | [0.0000] |
| AR(2) | −0.456 | [0.6480] | −0.713 | [0.4759] | −0.517 | [0.6052] | −0.530 | [0.5964] |
| Sargan test | 89.874 | [0.4541] | 90.748 | [0.4285] | 90.028 | [0.4496] | 90.298 | [0.4417] |
| Wald test | 55466.6 | [0.0000] | 26636.2 | [0.0000] | 41186.5 | [0.0000] | 38059.7 | [0.0000] |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; values in square brackets indicate the *p*-value of the tests
**Source(s):** Authors' own work

The results align with the findings in Table 6 for the linear analysis, showing negative and significant coefficients for the percentage of women on the board (PW), the number of women (NW), and the dummy variables. Similarly, the non-linear results support the findings from Table 8, with the exception of the non-linear model for the percentage of women, where the coefficients were not consistent.

*4.4.2 Alternate proxies of dependent variables.* Tables 10 and 11 illustrate GMM estimates of the cost of equity using the Fama-French Three-Factor Model. In the linear analysis (Table 10), the percentage (PW) and number (NW) of women on boards have negative and significant effects on the cost of equity, reinforcing the hypothesis that greater gender diversity reduces perceived risk for investors. The dummy variables (DW) reveal additional nuances, with variable effects depending on the diversity context.

In the non-linear analysis (Table 11), the Blau and the Shannon indices also show significant and negative relationships, confirming the positive impact of heterogeneity on risk perception. The quadratic coefficient of NW suggests diminishing returns from diversity at higher levels. Robustness tests validate the models and instruments, highlighting the importance of diversity in determining the cost of equity.

## 5. Discussion

Corporate governance has been widely associated with firm value, with theories such as the agency theory (Jensen and Meckling, 1976) and the stakeholder theory (Freeman, 1984), suggesting that good governance practices, such as the inclusion of women on the board, can reduce conflicts of interest (Carter *et al.*, 2003) and improve alignment between managers and

**Table 9.** Regression with other estimators

| | Linear Percentage of women | Number of women | Dummies | | | | Non-linear Percentage of women | Number of women | Blau | Shannon |
|---|---|---|---|---|---|---|---|---|---|---|
| Const. | −36.341*** | −29.486*** | −38.267*** | | −27.231*** | −26.364*** | −36.562*** | −31.306*** | −35.050*** | −34.344*** |
| | (−5.562) | (−4.599) | (−4.417) | | (−4.103) | (−4.119) | (−5.586) | (−4.832) | (−5.397) | (−5.326) |
| PW | −0.520*** | | | | | | −0.384 | | | |
| | (−4.353) | | | | | | (−1.579) | | | |
| $PW^2$ | | | | | | | −0.436 | | | |
| | | | | | | | (−0.641) | | | |
| NW | | −0.025** | | | | | | −0.058*** | | |
| | | (−2.321) | | | | | | (−2.739) | | |
| $NW^2$ | | | | | | | | 0.008* | | |
| | | | | | | | | (1.820) | | |
| DW1 | | | −0.086*** | | | | | | | |
| | | | (−2.970) | | | | | | | |
| DW2 | | | | −0.051* | | | | | | |
| | | | | (−1.955) | | | | | | |
| DW3 | | | | | 0.000 | | | | | |
| | | | | | (0.001) | | | | | |
| DW4 | | | | | | −0.090 | | | | |
| | | | | | | (−1.404) | | | | |
| BLAU | | | | | | | | | −0.341*** | |
| | | | | | | | | | (−4.052) | |
| SHANNON | | | | | | | | | | −0.220*** |
| | | | | | | | | | | (−4.003) |
| LIQ | 0.015 | 0.015 | 0.010 | 0.009 | 0.016 | 0.015 | 0.015 | 0.015 | 0.014 | 0.014 |
| | (0.884) | (0.866) | (0.514) | (0.814) | (0.931) | (0.884) | (0.888) | (0.885) | (0.868) | (0.852) |
| TANG | 0.067 | 0.054 | −0.069 | −0.024 | 0.051 | 0.029 | 0.071 | 0.069 | 0.058 | 0.055 |
| | (0.393) | (0.308) | (−0.302) | (−0.447) | (0.276) | (0.165) | (0.413) | (0.394) | (0.340) | (0.319) |
| EFIC | 0.003 | 0.034 | −0.131 | 0.303* | 0.078 | 0.073 | −0.012 | 0.033 | 0.030 | 0.047 |
| | (0.013) | (0.148) | (−0.452) | (1.959) | (0.329) | (0.311) | (−0.052) | (0.143) | (0.132) | (0.207) |

(*continued*)

**Table 9.** Continued

| | Linear Percentage of women | Number of women | Dummies | | | | Non-linear Percentage of women | Number of women | Blau | Shannon |
|---|---|---|---|---|---|---|---|---|---|---|
| LEV | 0.078 | 0.055 | 0.381$^{**}$ | 0.046 | 0.062 | 0.037 | 0.077 | 0.053 | 0.077 | 0.077 |
| | (0.639) | (0.441) | (2.198) | (0.684) | (0.470) | (0.288) | (0.627) | (0.422) | (0.628) | (0.629) |
| GROWTH | −0.145$^{***}$ | −0.152$^{***}$ | −0.152$^{***}$ | −0.167$^{***}$ | −0.156$^{***}$ | −0.156$^{***}$ | −0.146$^{***}$ | −0.150$^{***}$ | −0.145$^{***}$ | −0.146$^{***}$ |
| | (−3.722) | (−3.817) | (−2.949) | (−4.167) | (−3.826) | (−3.871) | (−3.743) | (−3.752) | (−3.701) | (−3.717) |
| DROA | 0.406$^{**}$ | 0.388$^{*}$ | 0.534$^{**}$ | 0.271 | 0.374$^{*}$ | 0.359$^{*}$ | 0.416$^{**}$ | 0.371$^{*}$ | 0.390$^{*}$ | 0.384$^{*}$ |
| | (1.990) | (1.862) | (2.093) | (1.238) | (1.714) | (1.673) | (2.033) | (1.778) | (1.906) | (1.875) |
| FREE | −0.156$^{**}$ | −0.163$^{**}$ | −0.306$^{***}$ | −0.007 | −0.183$^{**}$ | −0.175$^{**}$ | −0.159$^{**}$ | −0.159$^{*}$ | −0.153$^{*}$ | −0.153$^{*}$ |
| | (−1.966) | (−2.014) | (−3.122) | (−0.160) | (−2.209) | (−2.140) | (−1.996) | (−1.958) | (−1.926) | (−1.924) |
| CEO | −0.027 | −0.026 | −0.048 | 0.030 | −0.021 | −0.025 | −0.025 | −0.028 | −0.030 | −0.030 |
| | (−0.745) | (−0.711) | (−1.094) | (1.335) | (−0.550) | (−0.673) | (−0.695) | (−0.749) | (−0.810) | (−0.834) |
| BIND | −0.218$^{***}$ | −0.224$^{***}$ | −0.188$^{***}$ | 0.015$^{***}$ | −0.231$^{***}$ | −0.225$^{***}$ | −0.221$^{***}$ | −0.217$^{***}$ | −0.215$^{***}$ | −0.215$^{***}$ |
| | (−3.192) | (−3.205) | (−2.238) | (0.342) | (−3.207) | (−3.181) | (−3.221) | (−3.100) | (−3.138) | (−3.130) |
| Sector | No | No | No | No | No | No | No | No | No | No |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Model | Fixed Effect | Fixed Effect | Fixed Effect | OLS | Fixed Effect | Fixed Effect | Fixed Effect | Fixed Effect | Fixed Effect | Fixed Effect |
| Number | 778 | 779 | 532 | 667 | 740 | 764 | 778 | 779 | 778 | 778 |
| BP | 4.49$^{**}$ | 4.11$^{**}$ | 6.97$^{***}$ | 2.56 | 2.80$^{*}$ | 4.48$^{**}$ | 4.50$^{**}$ | 4.02$^{**}$ | 4.38$^{**}$ | 4.36$^{**}$ |
| H. test | 53.89$^{***}$ | 45.48$^{***}$ | 41.61$^{***}$ | 42.21 | 37.5615 | 42.51$^{***}$ | 54.71$^{***}$ | 47.06$^{***}$ | 52.67$^{***}$ | 52.18$^{***}$ |
| Stat F | 5.99$^{***}$ | 4.53$^{***}$ | 4.96$^{***}$ | 27.11$^{***}$ | 3.98$^{***}$ | 4.07$^{***}$ | 5.52$^{***}$ | 4.45$^{***}$ | 5.75$^{***}$ | 5.71$^{***}$ |
| Wald | | | | | | | | | | |

**Note(s):** BP represents the Breusch-Pagan test statistic and H. test represents the Hausman test statistic. $^{*}$, $^{**}$, and $^{***}$ denote significance levels of 10%, 5%, and 1%, respectively. Z-statistic or t-statistic is presented in parentheses. The values of the Breusch-Pagan and Hausman statistics were used to determine the choice of the regression model. The Breusch-Pagan test was used to assess the appropriateness of the random effects model versus a traditional Ordinary Least Squares (OLS) model. A significant value in the Breusch-Pagan test suggests that the random effects model is more appropriate than the OLS model. On the other hand, the Hausman test was used to compare the fixed effects and random effects models. A significant value in the Hausman test indicates that the fixed effects model is preferred, as it suggests that the random effects model is inconsistent due to correlation between the random effects and the explanatory variables

**Source(s):** Authors' own work

**Table 10.** Linear analysis of the cost of equity estimated by the Fama-French three-factor model

| | Percentage of women | | Number of women | | Dummies | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat |
| COE(−1) | 0.088 | 29.670*** | 0.092 | 29.920*** | 0.094 | 26.190*** | 0.082 | 22.910*** | 0.088 | 26.880*** | 0.089 | 33.010*** |
| PW | −0.241 | −8.370*** | | | | | | | | | | |
| NW | | | −0.011 | −2.977*** | | | | | | | | |
| DW1 | | | | | −0.045 | −9.192*** | | | | | | |
| DW2 | | | | | | | −0.062 | −7.631*** | | | | |
| DW3 | | | | | | | | | 0.062 | 5.707*** | | |
| DW4 | | | | | | | | | | | −0.083 | −4.006*** |
| LIQ | 0.008 | 1.659* | 0.010 | 1.980** | 0.012 | 2.129** | 0.008 | 1.595 | 0.010 | 2.077** | 0.010 | 2.013** |
| TANG | −0.008 | −0.613 | −0.002 | −0.100 | −0.063 | −5.024*** | 0.000 | −0.002 | −0.018 | −1.537 | 0.003 | 0.187 |
| EFIC | 0.185 | 4.162*** | 0.179 | 3.447*** | 0.053 | 1.134 | 0.103 | 2.470** | 0.161 | 3.636*** | 0.169 | 3.528*** |
| LEV | 0.053 | 2.455** | 0.065 | 2.777*** | 0.177 | 6.442*** | 0.081 | 3.418*** | 0.053 | 1.919* | 0.052 | 1.934* |
| GROWTH | −0.146 | −14.290*** | −0.154 | −11.240*** | −0.136 | −9.242*** | −0.131 | −14.130*** | −0.148 | −13.790*** | −0.154 | −12.290*** |
| DROA | −0.054 | −1.191 | −0.047 | −0.889 | −0.034 | −0.560 | −0.166 | −4.082*** | −0.056 | −1.084 | −0.079 | −1.592 |
| FREE | −0.018 | −1.509 | −0.025 | −1.845* | −0.036 | −3.009*** | −0.039 | −3.808*** | −0.041 | −3.680*** | −0.030 | −2.358** |
| CEO | 0.004 | 0.415 | 0.008 | 0.739 | 0.004 | 0.535 | 0.024 | 2.644*** | 0.022 | 2.294** | 0.012 | 1.115 |
| BIND | 0.023 | 1.575 | 0.000 | −0.010 | −0.017 | −1.075 | 0.020 | 1.628 | −0.005 | −0.415 | −0.007 | −0.527 |
| Sector | No | | No | | No | | No | | No | | No | |
| Year | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | |
| Model | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | |
| Number | 746 | | 747 | | 501 | | 632 | | 707 | | 732 | |
| AR(1) | −4.914 | [0.0000] | −4.919 | [0.0000] | −3.838 | [0.0001] | −4.229 | [0.0000] | −4.759 | [0.0000] | −4.867 | [0.0000] |
| AR(2) | −1.326 | [0.1848] | −1.580 | [0.1141] | −1.268 | [0.2049] | −1.400 | [0.1615] | −1.668 | [0.0953] | −1.547 | [0.1219] |
| Sargan test | 88.810 | [0.4857] | 89.167 | [0.4751] | 70.794 | [0.9222] | 81.247 | [0.7083] | 87.741 | [0.5179] | 89.133 | [0.4761] |
| Wald test | 52412.4 | [0.0000] | 51944.1 | [0.0000] | 33599.7 | [0.0000] | 38308.8 | [0.0000] | 45.695 | [0.0000] | 51.245 | [0.0000] |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Values in square brackets indicate the *p*-value of the tests
**Source(s):** Authors' own work

**Table 11.** Non-linear analysis of the cost of equity estimated by the Fama-French three-factor model

| | Percentage of women | | Number of women | | Blau index | | Shannon index | |
|---|---|---|---|---|---|---|---|---|
| | Coef | Stat | Coef | Stat | Coef | Stat | Coef | Stat |
| COE(−1) | 0.088 | 29.270*** | 0.090 | 28.320*** | 0.089 | 30.110*** | 0.088 | 29.890*** |
| PW | −0.238 | −4.032*** | | | | | | |
| $PW^2$ | −0.015 | −0.090 | | | | | | |
| NW | | | −0.034 | −6.240*** | | | | |
| $NW^2$ | | | 0.006 | 3.569*** | | | | |
| BLAU | | | | | −0.169 | −8.909*** | | |
| SHANNON | | | | | | | −0.111 | −9.926*** |
| LIQ | 0.008 | 1.772* | 0.009 | 1.886* | 0.008 | 1.595 | 0.008 | 1.628 |
| TANG | −0.005 | −0.299 | −0.006 | −0.473 | −0.006 | −0.464 | −0.005 | −0.367 |
| EFIC | 0.173 | 3.233*** | 0.202 | 4.247*** | 0.193 | 4.382*** | 0.198 | 4.486*** |
| LEV | 0.055 | 2.487** | 0.050 | 2.307** | 0.055 | 2.529** | 0.057 | 2.614*** |
| GROWTH | −0.145 | −13.810*** | −0.148 | −11.940*** | −0.145 | −13.810*** | −0.145 | −13.880*** |
| DROA | −0.045 | −1.000 | −0.075 | −1.411 | −0.055 | −1.240 | −0.057 | −1.263 |
| FREE | −0.018 | −1.473 | −0.018 | −1.501 | −0.015 | −1.303 | −0.013 | −1.157 |
| CEO | 0.005 | 0.462 | 0.006 | 0.520 | 0.005 | 0.449 | 0.005 | 0.495 |
| BIND | 0.024 | 1.575 | 0.009 | 0.745 | 0.022 | 1.531 | 0.020 | 1.431 |
| Sector | No | | No | | No | | No | |
| Year | Yes | | Yes | | Yes | | Yes | |
| Model | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | | GMM-Sys 2 steps | |
| Number | 746 | | 747 | | 746 | | 746 | |
| AR(1) | −4.916 | [0.0000] | −4.861 | [0.0000] | −4.893 | [0.0000] | −4.887 | [0.0000] |
| AR(2) | −1.337 | [0.1812] | −1.567 | [0.1172] | −1.355 | [0.1753] | −1.359 | [0.1741] |
| Sargan test | 89.215 | [0.4737] | 89.402 | [0.4681] | 88.920 | [0.4825] | 89.027 | [0.4793] |
| Wald test | 48213.3 | [0.0000] | 53841.4 | [0.0000] | 50647.7 | [0.0000] | 47117.7 | [0.0000] |

**Note(s):** *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Values in square brackets indicate the *p*-value of the tests
**Source(s):** Authors' own work

shareholders. This alignment results in decreased risk perceived by investors (Maxfield and Wang, 2024) and, consequently, a lower cost of capital (Nguyên, 2020).

The literature remains divergent regarding gender diversity as a proxy for firm value (Gaio *et al.*, 2024). Based on the premise that the relationship between gender diversity and firm value may be indirect (Sarang *et al.*, 2024b), initially reflected in a reduction in the cost of capital, a crucial factor for value creation, this research highlighted that the presence of women on Brazilian corporate boards (PW) has a significant and negative relationship with the cost of equity (see Table 6). This finding aligns with studies on emerging markets, such as those by Srivastava *et al.* (2018), Saleh *et al.* (2022), and Jiang *et al.* (2024).

The inclusion of women on boards can be interpreted as an indicator of better governance practices, enhancing the supervision and monitoring of company activities (Pucheta-Martínez and Bel-Oms, 2019), which, in turn, reduces perceived risk (Muhammad *et al.*, 2023; Maxfield and Wang, 2024) and the cost of capital.

Specifically, when examining the number of women on boards (NW), the relationship was also significant and negative. However, the analysis of the dummy variable (see Table 6) for each participation of women revealed more nuanced results: the presence of one woman on the board was significant and negative, as was the presence of two or four women. In the case of three women, the impact was significant and positive. This finding suggests that the relationship between diversity and the cost of capital may not be linear, corroborating Kanter's (1977) critical mass theory, which posits that the impact of women on boards becomes more pronounced as the number of female members increases. Nevertheless, this challenge the idea that the minimum number of women required on boards is four, as suggested by Sarang *et al.* (2024a).

Delving deeper, the quadratic analysis provided additional comprehensions. The relationship between the percentage of women on boards (PW) and the cost of capital is significant and negative for both the PW variable and its squared term (see Table 8), indicating that the presence of women on boards is associated with a reduction in the cost of capital up to a certain point. The parameters of −0.0496879 for the number of women (NW) and 0.00728255 for the square of the number of women ($NW^2$) reveal an inverted U-shaped relationship between the number of women on boards and the cost of equity. Using the first derivative, it was determined that the optimal number of women minimizing the cost of capital is approximately three to four members, supporting the critical mass theory (Kanter, 1977) and the findings of Sarang *et al.* (2024a).

In conclusion, this study shows that gender diversity on Brazilian corporate boards significantly reduces the cost of capital, even when only one woman is present. However, this effect is more pronounced when four women participate, underscoring the importance of diversity in enhancing corporate governance and ultimately creating value for shareholders.

### *5.1 Theoretical implications*

This study contributes to the literature on the relationship between board gender diversity and the cost of equity (COE), with a focus on Latin America, an underexplored region in this context. Our findings align with and extend critical mass theory (Kanter, 1977) by providing evidence that a minimum representation of women on boards is necessary to achieve significant reductions in COE. This study also highlights non-linear relationships, suggesting that the benefits of diversity are maximized at specific thresholds of female representation. These perceptions support and refine the business case for gender diversity, reinforcing its role in enhancing transparency, reducing informational asymmetry, and improving firm value.

By employing the Fama-French Five-Factor Model, as applied in Foye (2018) and Carvalho *et al.* (2021), this research ensures robust empirical analysis to assess the relationship between gender diversity and COE. This methodological approach enhances the reliability of the findings and provides a comprehensive framework for examining the transmission mechanisms of diversity in equity costs.

### *5.2 Managerial/policy implications*

From a managerial perspective, the results emphasize the importance of achieving substantial representation of women on corporate boards, not only for compliance but also as a strategic initiative to reduce capital costs and enhance firm value. Boards with symbolic representation, such as those with only one female member, have already generated impacts on the COE. However, the presence of four women amplifies this effect, suggesting that even modest increases in female representation can meaningfully influence the decision-making processes and reduce equity costs. Firms should prioritize inclusive recruitment policies and develop initiatives to prepare and support women in leadership roles.

For policymakers, these findings justify the introduction and enforcement of quotas or incentives to increase female representation on boards. Countries in Latin America could consider adopting measures similar to those in Europe, where gender quotas have proven effective in improving diversity and reducing COE. Policies should focus on setting thresholds for minimum representation because token representation is insufficient to achieve the desired outcomes. Stakeholders, including investors, should view gender diversity as a sign of effective governance and long-term sustainability. Enhanced gender diversity can strengthen investor confidence, reduce perceived risk, and improve a firm's reputation. These outcomes align with the broader goals of regulatory bodies and societal expectations of equitable and transparent governance practices.

*5.3 Limitations and future research agenda*

This study had some limitations. A broader database, which currently covers the 2010–2023 period, could be expanded to include a larger number of companies and longer timeframes, thus improving the robustness and generalizability of the results. The reliance on secondary data also introduces potential quality and reliability issues.

Future research should consider larger and more diverse datasets and primary data collection to ensure greater accuracy. Expanding the analysis beyond the Fama-French three- and five-factor models to other cost of capital metrics could offer additional visions. Comparative studies across countries with different legal and regulatory contexts could help better understand regional variations in the impact of gender diversity on the cost of equity capital.

Incorporating advanced methodologies, such as difference-in-differences (Diff-in-Diff) and propensity score matching, could address endogeneity and enhance causal inference. Exploring other Latin American markets, as Aguinis *et al.* (2020) and Gaio *et al.* (2024) suggested, would further improve the generalizability of the findings.

## 6. Conclusions

This study examines the relationship between gender diversity on boards of publicly traded Brazilian companies and the cost of equity. Using various metrics, such as the number and percentage of women, the Blau index and the Shannon index, this study captured different dimensions of diversity and assessed potential non-linear effects.

The findings of this study show that greater female representation on boards is associated with a lower cost of equity, supporting Hypothesis 1 and aligning with prior studies, such as Nguyên (2020) and Sarang *et al.* (2024a). This finding highlights the role of gender diversity in strengthening corporate governance, enhancing investor confidence, and reducing perceived risk.

This study also identified a non-linear relationship, where increasing female representation reduces the cost of equity up to a certain point, beyond which the effect diminishes. This supports Hypothesis 2 and aligns with the critical mass theory discussed by Campos-García and Zúñiga-Vicente (2023). Robustness checks confirmed the consistent influence of gender diversity across the periods and models.

Compared to studies such as Sarang *et al.* (2024b) in North America, and Srivastava *et al.* (2018) in India, this research extends the understanding of Brazilian companies by addressing gaps in emerging market contexts. Consistent with Gonzalez-Ruiz *et al.* (2024), the findings of this study suggest that gender diversity policies influence broader corporate financing conditions in Latin America.

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**Corresponding author**
Luiz Eduardo Gaio can be contacted at: luiz.gaio@ymail.com