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ORIGINAL PAPER

Impact of corporate governance mechanisms on digitalization disclosure: the moderating effect of CEO duality

María Consuelo Pucheta-Martínez[1] · **Silvia Solimene**[2] · **Manuela Lucchese**[3] · **Ferdinando Di Carlo**[4]

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Abstract

This paper investigates the impact of Corporate Governance mechanisms (gender board diversity, independent board directors, and the presence of a CSR/Sustainability Committee) on the level of digitalization disclosure, including whether CEO duality moderates this relationship. An international sample of 323 listed and unlisted non-financial companies, collected by the Integrated Reporting Example Database for the period 2017–2022, was analysed. The findings show a positive relationship between the board's gender diversity, board independence, the presence of the CSR/Sustainability Committee, and the level of digitalization disclosure. Additionally, the results suggest that CEO duality plays a complex moderating role in the relationship between governance variables and digitalization disclosure. While it limits the effectiveness of gender diversity and the presence of a CSR/sustainability committee on the board, it appears to have a non-significant effect on independent directors. This study significantly advances our theoretical knowledge of the complex relationship between Corporate Governance and digitalization, filling a gap in existing literature. This research provides practical insights by informing companies on how to improve their governance and digitalization plans. Better governance and the right application of digital technologies will enable corporate leaders to improve transparency, accountability, and effectiveness.

Keywords Board gender diversity · Board independence · CSR committee · CEO duality · Digitalization disclosure · Agency theory

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Extended author information available on the last page of the article

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1 Introduction

This article aims to analyse the influence of Corporate Governance (CG) mechanisms (gender board diversity, independent board directors, and the presence of a Corporate Social Responsibility (CSR)/Sustainability Committee) on digitalization disclosure, as well as to explore whether CEO duality moderates this relationship.

According to CG literature (Michelon and Parbonetti 2012; Rao and Tilt 2016), the board of directors (BoD) is essential in CG mechanisms and performs a key control and monitoring function. It is also at the centre of a company's and its stakeholders' dialogue (Zampone et al. 2024), promoting greater accountability and transparency on financial and non-financial issues (Michelon and Parbonetti 2012; Martínez-Ferrero et al. 2021; Nicolò et al. 2021; Zampone et al. 2024). Among the most pressing non-financial issues, sustainability and digitalization pose the biggest challenges for organisations.

New digital technologies, such as the Internet of Things, big data, and virtual and augmented reality, are radically changing how companies produce or provide services, facilitating their transition towards sustainability (Bressanelli et al. 2018; Broccardo et al. 2023). Digital technologies enable the sustainable modernization of business models (BMs) (Li and Shen 2021) and are considered essential for companies across industries to remain competitive and avoid obsolescence (Raimo et al. 2022a; Hu et al., 2025). BoD is considered the primary lever for responding to changing organizational conditions (Bankewitz et al. 2016), as it is involved in multiple stages of the strategic and decision-making processes (Huse 2007). Additionally, digital technology has revolutionized how companies access and disclose information (Nwankpa and Datta 2017). According to Hu et al. (2025), highly digitalised companies are inclined to share information about their digital practices, recognizing that the quality of digitalization disclosure is crucial to the overall quality of a company's information disclosure. Such disclosures can underscore a company's operational efficiency and potential innovation (Anderson et al. 2006; López-Arceiz et al. 2019). In recent years, an increasing number of scholars have focused on analysing digitalization disclosure (Syed Ibrahim et al. 2022; Sukhari et al. 2023; Borrero-Domínguez et al. 2024). Researchers have examined its impact on firm value (Zeng et al. 2022; Chen and Srinivasan 2024), and its presence in annual reports (Hossnofsky and Junge 2019; Ricci et al. 2020) or on online platforms (Salvi et al. 2021). Despite extensive research on the relationship between CG mechanisms and voluntary disclosure (Cerbioni and Parbonetti 2007; Donnelly and Mulcahy 2008; Michelon and Parbonetti 2012; Cucari et al. 2018; Bueno et al. 2018), the effects of CG structure on digitalization disclosure remain relatively under-researched.

Using a sample of 323 international companies, the present study employs both qualitative and quantitative research methods.

The findings show a positive relationship between the three CG mechanism variables (board gender diversity, board independence, and CSR/Sustainability committee) and digitalization disclosure. However, the results reveal that CEO duality appears to limit the effectiveness of gender diversity and the presence of a CSR/sustainability committee (from now on, the CSR Committee) on the board, and it also has a non-significant effect on independent directors.

The present study seeks to address several gaps and, in doing so, makes important contributions. First, the study extends the limited research on the link between CG mechanisms, such as board gender diversity, board independence, and the presence of a CSR committee and voluntary digitalization disclosure. To the best of the authors' knowledge, this relationship has not been investigated in previous literature. Second, it assesses the mediating role of CEO duality on the relationship between CG and digitalization disclosure, aiming to explain how centralisation of power may affect this relationship. Third, this research contributes to expanding theoretical knowledge on the relationship between CG mechanisms and digitalization disclosure, thereby providing companies with valuable support in their decision-making processes through the dissemination of practices and activities in this area among non-financial companies. Finally, based on stakeholder-agency theory, the study provides a theoretical contribution to the literature on CG and voluntary disclosure, including digitalization. This study argues that the building of a good governance structure also depends on gender diversity within the board, the presence of independent directors, and a CSR committee. These elements improve the alignment of the needs and interests of all stakeholders, including shareholders and managers.

The rest of the study is presented as follows: Sect. 2 provides the theoretical framework; Sect. 3 illustrates a general overview of a digitalization disclosure literature and summarizes theoretical and empirical literature to develop testable hypotheses; Sect. 4 presents the methodology adopted in the study; Sect. 5 discusses the empirical findings, and Sect. 6 concludes by outlining the major implications, limitations and potential for future research.

2 Theoretical framework

Agency theory explains the rationale for managers' voluntary disclosure of information, examining the principal-agent dynamic (Firth 1980; Cooke 1989; Hossain et al. 1995). This theory serves as the theoretical framework adopted by most research on CG (Barako et al. 2006; Al-Shammari and Al-Sultan 2010; Vitolla et al. 2020; Pucheta-Martínez et al. 2021a). According to Jensen and Meckling (1976), an agency relationship emerges from a contractual agreement between a firm's shareholders (principals) and its managers (agents). Shareholders delegate decision-making authority to managers, which can lead to potential conflicts of interest when ownership and control are separated (Al-Shammari and Al-Sultan 2010). In such cases, both parties may seek to maximise their own benefits, raising concerns about whether managers will consistently prioritise shareholders' interests. This conflict creates an agency problem, requiring the firm to incur costs to monitor and control managers' behaviour to ensure alignment with shareholders' interests (Al-Shammari and Al-Sultan 2010).

The role of CG in disclosure policies is a key mechanism for mitigating agency costs, protecting shareholders, and fostering the interests of all external stakeholders (Cerbioni and Parbonetti 2007). Disclosing both financial and non-financial information is crucial for companies to show their integration of stakeholders' expectations and requirements into their operations (Gray et al. 1995; Fuente et al. 2017). A stake-

holder approach argues that organisations have a moral obligation to consider the interests of all stakeholders (Culpan and Trussel 2005). Stakeholder theory provides a lens for how organisations should engage with stakeholders to satisfy their diverse expectations (Freeman 1984; Deegan and Blomquist 2006). Taking agency theory and stakeholder theory as points of departure, Hill and Jones (1992) developed a broader paradigm that primarily explains aspects of a company's strategic behaviour and the structure of contracts between management and stakeholders: stakeholder-agency theory. The latter approach extends the paradigm of traditional agency theory and describes a company's identity as a nexus of contracts between resource holders and seekers, with managers at the centre, directly controlling the company's operational decision-making process (Nicolò and Andrades-Peña 2024:4718). Accordingly, the traditional principal-agent relationship is expanded to the complex web of relationships involving corporate managers and all actors who provide strategic resources to firms and have a legitimate claim on a firm's allocation of resources, such as all stakeholders (Hill and Jones 1992; Tauringana and Chithambo 2015; Nicolò and Andrades-Peña, 2024). A conflict of interest also arises between managers and stakeholders. Managers are more likely to prioritise short-term investments that benefit their personal finances. In contrast, stakeholders are more interested in long-term investments, also associated with sustainability initiatives that enhance global well-being (Kock et al. 2012; Tauringana and Chithambo 2015; Raimo et al. 2022b; Nicolò and Andrades-Peña, 2024). According to stakeholder-agency theory, such conflicts can be resolved and the interests of managers and stakeholders aligned through two mechanisms: internal and external (Kock et al. 2012; Raimo et al. 2022b). External mechanisms include regulations and government interventions. Internal mechanisms include those related to CG (Tauringana and Chithambo 2015). In this context, the BoD represents a primary governance mechanism to reduce this conflict of interest, as it is called to protect not only shareholders' financial interests but also ensure that the company is responsive to all stakeholders' expectations, as the sustainability effects of the company's actions (Hill and Jones 1992; Nicolò and Andrades-Peña, 2024).

Voluntary disclosure is an excellent way to apply stakeholder-agency theory, as managers with superior access to the firm's private information can disclose credible and reliable information to the market, thereby optimizing the firm (Barako et al. 2006; Al-Shammari and Al-Sultan 2010). The control exercised by the BoD can encourage the disclosure of information, including non-financial issues (García-Sánchez et al. 2023), and can ensure that the organisation is responsible towards various categories of stakeholders (Tauringana and Chithambo 2015; Raimo et al. 2022b).

The relationship between board characteristics and companies' decisions to disclose voluntary information, such as digitalization information, has been studied in several studies (Barako et al. 2006; Donnelly and Mulcahy 2008; Al-Shammari and Al-Sultan 2010; Frias-Aceituno et al. 2013; Vitolla et al. 2020). The BoD is the central control mechanism of firms (Heubeck and Meckl 2023) and determines whether voluntary disclosure is appropriate (Donnelly and Mulcahy 2008; Roman et al. 2019; Vitolla et al. 2020). They strategically choose which information to share with stakeholders, aiming to accurately represent the organisation's activities, rather than simply following a set of rules (Roman et al. 2019). Thus, sharing information about

a company's level of digital advancement helps reduce information asymmetries, especially in rapidly changing, tech-driven markets. This gives investors, and consequently stakeholders, a better understanding of a company's digital plans and lowers investment risks (Salvi et al. 2021). From this perspective, an appropriate level of board control is required for disclosure to fulfil its function of reducing information asymmetry (Vitolla et al. 2020).

The board is the key corporate decision-making body responsible for overseeing the behaviour of managers and for balancing the interests of different stakeholders (Pekovic and Vogt 2021), also through the implementation of appropriate disclosure strategies and policies, which include both financial and non-financial issues (Michelon and Parbonetti 2012; Valls Martinez et al. 2019; De Villiers and Dimes 2021; Nicolò et al. 2021).

The analysis of governance mechanisms such as board gender diversity, board independence, and the presence of a CSR committee in relation to digitalization disclosure can be further enriched by drawing on multiple theoretical perspectives. Stakeholder-agency theory provides strong foundations for understanding these dynamics; however, incorporating additional lenses such as the resource-based view (RBV) may shed light on the importance of diversity on the BoD of the firm (Barney 1991), allowing for a more nuanced explanation of why governance mechanisms might shape disclosure practices differently across firms. In light of the RBV, the discussion can be enriched by emphasizing that governance mechanisms are strategic resources that can generate a competitive advantage by developing and utilising unique capabilities; therefore, companies develop strategies by organising their internal resources in response to environmental opportunities (Katmon et al. 2019). A gender-diverse board provides a broader spectrum of knowledge, creativity, and problem-solving approaches, enhancing the firm's ability to integrate digitalization into both strategy and reporting. Similarly, independent directors often contribute specialized expertise and external networks that support the effective oversight of digital initiatives and encourage transparent communication of their impact. CSR committees, by institutionalizing responsibility for sustainability and ethical practices, create an organisational capability to align digitalization with broader social and environmental goals, thereby strengthening disclosure as a means of signalling strategic differentiation. In this sense, CG mechanisms are not only instruments of control and legitimacy but also valuable resources that shape how effectively firms can implement and communicate their digital transformation (DT).

3 Literature review and hypothesis development

Digitalization disclosure is a voluntary reporting of the company's digitalization efforts, typically included in company reports (Pratama et al. 2023). While providing external investors with information about a company's digitalization activities, digitalization disclosure can offer significant benefits for both companies and investors, including reducing information asymmetries between them (Zhou et al. 2024). Moreover, digitalization disclosure is not required by any accounting framework, and there are no official reporting guidelines for digitalization information, which poses

challenges for measuring it (Sukhari et al. 2023:70). However, research on voluntary digitalization disclosure practices remains in its early stages (Borrero-Domínguez et al. 2024).

Previous literature, assessing the value relevance of digitalization disclosure in annual reports (Syed Ibrahim et al. 2022; Zeng et al. 2022), websites (Salvi et al. 2021), or integrated reports (Sukhari et al. 2023), finds that this sort of non-financial disclosure is useful for investors (Hossnofsky and Junge 2019; Ricci et al. 2020; Chen and Srinivasan 2024). Among others, Syed Ibrahim et al. (2022), examining the 2020 annual reports of 49 Malaysian companies, investigated the scope of disclosure on digitalization. They measure disclosure on digitalization using a qualitative approach, in which sections of the report containing the terms 'digital' and/or 'digitalization' were identified and counted. Similarly, Pratama et al. (2023) examined the presence of specific keywords related to digitalization in the annual reports of 52 Indonesian companies. Both studies revealed that information on digitalization remained at a basic level (Syed Ibrahim et al. 2022; Pratama et al. 2023).

More recently, Borrero-Domínguez et al. (2024) examined the voluntary disclosure practices relating to the DT of 50 European companies sampled, through qualitative text data mining of their annual reports from 2018 to 2022. The aim of this study is twofold. First, it proposes a set of guidelines for the voluntary disclosure of DT. Secondly, it examines the impact of various factors, including company size, industry sector, the pandemic's emergence, and CEO gender, on DT reporting practices. Their findings show that while the European companies sampled voluntarily disclose information on digitalization, they do not standardize the content of this disclosure. This is probably because the amount of information provided varies considerably between companies (Borrero-Domínguez et al. 2024).

In this regard, there is still limited understanding about the voluntary disclosure of information related to digitalization from a transnational perspective.

Moreover, there is not much evidence on how CG mechanisms influence digitalization disclosure. However, as this is a non-financial, voluntary disclosure, this paper assumes that the previous literature review, on which the subsequent development of hypotheses is based, is also valid and useful for digitalization disclosure.

3.1 Gender board diversity

Gender diversity on the BoD is considered a mechanism that can reduce conflicts of interest between managers and shareholders by promoting voluntary disclosure (Jensen and Meckling 1976; Manita et al. 2018; Gallego-Álvarez and Pucheta-Martínez 2022a; Nicolò et al. 2022). Moreover, firms with more female directors on the board are more likely to represent a wider range of stakeholder categories, as advocated by stakeholder-agency theory (Raimo et al. 2022b).

According to Liao et al. (2015:412), gender representation on the board is an important dimension of CG because women and men are traditionally, culturally, and socially different. In addition, from the RBV perspective, the synergies between male and female interactions in the BoD are valuable sources of competitive advantage (Katmon et al. 2019:453).

Several scholars have highlighted differences in communication style, personality, skills, professional experience, and educational background, among other factors (Liao et al. 2015; Vitolla et al. 2020). Nowadays, it is generally recognised that women play a key role on BoD, advocating decisions that support community, environmental, and social responsibility and align with stakeholders' interests (Manita et al. 2018; Fernández-Méndez et al. 2025). The inclusion of women makes decision-making more equitable, participative, and democratic, thereby enhancing transparency (Tejedo-Romero et al. 2017; Wasiuzzaman and Wan Mohammad 2020; Nicolò et al. 2022) and increasing board effectiveness (Coffey and Wang 1998; Heubeck and Meckl 2023).

The relevance of women on the board is often associated with greater transparency regarding sustainability (Barako and Brown 2008; Prado-Lorenzo and Garcia-Sanchez 2010; Frias-Aceituno et al. 2013; Vitolla et al. 2020). This is because they are considered more sensitive to non-financial issues than male directors (Pekovic and Vogt 2021), who are more oriented towards financial issues (Tejedo-Romero et al. 2017; Manita et al. 2018; Orazalin 2019; Nicolò et al. 2022). From a stakeholder perspective, they are often more stakeholder-oriented, with democratic leadership styles that lead to better communication of organizational values and greater attentiveness to stakeholder concerns (Manita et al. 2018; Lassoued and Khanchel 2023). Similar to sustainability issues, digitalization has become omnipresent over time, due to its potential widespread consequences for individuals, firms, and society as a whole (Hossnofsky and Junge 2019:974). Companies with board gender diversity are also seen as more progressive and better able to address new challenges (Heubeck and Meckl 2023). Previous literature has investigated the importance of board gender diversity concerning different fields, integrated reporting quality (Vitolla et al. 2020), firm's ethical culture (Di Miceli da Silveira 2022), sustainability, CSR, or ESG disclosure (Manita et al. 2018; Gerwing et al. 2022; Nicolò et al. 2023; Nicolò and Cervilla-Bellido 2025; Fernández-Méndez et al. 2025), voluntary disclosure (Vitolla et al. 2020; Nicolò et al. 2022), and innovation activity of a company (Dezsö and Ross 2012; Chen et al. 2018). Firms with greater representation of female directors invest more in innovation and achieve greater innovative success. Empirical evidence shows a positive association between board gender diversity and sustainability disclosure (e.g., Gul et al. 2011; Liao et al. 2015; Vitolla et al. 2020; Raimo et al. 2022b).

Accordingly, from the theoretical arguments presented above and prior research findings, a positive association between board gender diversity and the level of voluntary digitalization disclosure is expected.

Therefore, the following hypothesis is proposed:

H1 *There is a positive relationship between board gender diversity and the level of voluntary digitalization disclosure.*

3.2 Independent board directors

The composition of the board, particularly board independence, is highlighted as a crucial governance factor for controlling managerial actions and ensuring that shareholders' goals are achieved (Fama and Jensen 1983; Frias-Aceituno et al. 2013).

From a stakeholder-agency perspective, the presence of independent directors on the board improves the effectiveness of monitoring managerial opportunism, which compromises the interest of stakeholders (Raimo et al. 2022b; Aguilera-Caracuel et al. 2025) and potentially leads to greater voluntary disclosure in companies (Ho and Wong 2001; Heubeck and Meckl 2023). Fama and Jensen (1983) contend that having a majority of independent directors is critical to maintaining the distinction between decision-making and decision-control. This, in turn, increases the effectiveness of top management monitoring. Independent directors, driven by reputational considerations, may prioritise the interests of all stakeholders over shareholders (Lim et al. 2007; Armstrong et al. 2010; Lepore et al. 2023). Consequently, their oversight of corporate boards tends to promote greater openness to outside investors and improvements in the comprehensiveness and accuracy of disclosures, among other measures (Forker 1992; Ho and Wong 2001; Chau and Grey, 2010).

Thus, independent directors play a crucial role in providing companies with valuable human and relational capital, due to their skills, professional experience, and extensive networks (Lee 2023). This not only helps attract vital resources and manage external dependencies (Mallin and Michelon 2011) but also improves the ability to oversee and encourage transparent reporting on digital initiatives. Furthermore, from the stakeholder-agency perspective, independent directors act as mediators for broader stakeholder interests, promoting disclosure practices that meet societal expectations regarding DT. Finally, when viewed through the resource-based lens, the knowledge and external connections they offer are strategic resources that enhance the firm's ability to integrate digitalization into governance and communicate it effectively.

Previous studies have consistently found a positive relationship between the presence of independent board members and sustainability disclosure (Nicolò et al. 2023) or carbon and environmental disclosure (Liao et al. 2015; Raimo et al. 2022b). This relationship indicates that under dispersed ownership, independent boards effectively mitigate agency conflicts between managers and stakeholders, thereby enhancing voluntary disclosure. This effect of independent boards on voluntary and sustainability disclosure has been confirmed by various empirical studies (e.g., Cerbioni and Parbonetti 2007; Donnelly and Mulcahy 2008; Cucari et al. 2018). Therefore, drawing on prior research and taking these views into account, we propose a positive relationship between board independence and the level of voluntary digitalization disclosure.

Considering the theoretical perspectives, it is hypothesized that:

H2 *There is a positive influence of board independence on the level of voluntary digitalization disclosure.*

3.3 CSR/sustainability committee

The CG literature has highlighted the importance of CSR committees in helping companies adopt socially responsible practices and demonstrate a proactive commitment to sustainability (Michelon and Parbonetti 2012; Amran et al. 2014; Martínez-Ferrero et al. 2021; Zampone et al. 2024). Establishing these board subcommittees

is essential to encourage the provision of non-financial information in order to align it with stakeholder expectations (Martínez-Ferrero et al. 2021). The stakeholder approach also argues that the BoD should be motivated to create CSR committees that monitor the links and demands of stakeholders, including the implementation of both the quantity and quality of CSR actions (Gallego-Álvarez and Pucheta-Martínez 2020a:81). Additionally, from a stakeholder-agency theory perspective, the presence of a CSR committee makes it possible to better represent the interests and needs of the different categories of stakeholders (Garcìa-Sanchez et al., 2019; Raimo et al. 2022b). According to Martínez-Ferrero et al. (2021:678), a CSR committee is a board subcommittee composed of members with adequate experience and knowledge in the field. The existence of a CSR committee or a board-level individual overseeing sustainability issues indicates that the company maintains an active strategic stance toward stakeholders (Ullmann 1985). Ahmed Haji and Anifowose (2016) demonstrate that the presence of a sustainability committee encourages the incorporation of additional information in integrated reports and enhances compliance with the IIRC (International Integrated Reporting Council) framework (Vitolla et al. 2020). Thus, it plays a role in the reporting process of social and environmental information (Post et al. 2011).

Considering the increased focus on sustainability, the scientific debate is currently advancing towards the digitalization arena (Broccardo et al. 2023). The relationship between sustainability and digitalization can unlock better opportunities for businesses and society (Ahmad and Murray 2019; Castro et al. 2021; Broccardo et al. 2023). Furthermore, the merging of digitalization and sustainability is viewed as an exceptionally potent combination. While it presents new challenges, it also provides an opportunity to address information gaps within and across organizational boundaries (Castro et al. 2021). This combination is a transformative force, often referred to as a 'game-changer', as it enables substantial change and strategic shifts (Osburg and Lohrmann, 2017; Kiron and Unruh 2018; Broccardo et al. 2023). Forcadell et al. (2020) argue that a strong reputation for a company's sustainability can address the dilemmas and obstacles that digitalization can bring.

Prior studies generally provide evidence of a positive relationship between the presence of a CSR committee and the level of non-financial disclosure (e.g., Michelon and Parbonetti 2012; Amran et al. 2014; Liao et al. 2015; Fuente et al. 2017; Gallego-Alvarez and Pucheta-Martínez, 2020 a; Raimo et al. 2022b; Nicolò et al. 2023; Zampone et al. 2024).

Taking the above considerations into account, we suggest that the presence of a CSR committee contributes to the adoption of new digitalization-related disclosure practices.

H3 *There is a positive association between the presence of a CSR committee and the level of digitalization disclosure.*

3.4 The moderating role of CEO duality

The importance of leadership in managerial decision-making is extensively recognised in the existing literature (Saha and Kabra 2020). Role duality creates a unified

leadership structure, with one individual serving as both CEO and chairperson of the board (Al-Shammari and Al-Sultan 2010). Indeed, CEO duality refers to a scenario in which the CEO also serves as the chairperson, consolidating control over the BoD. This duality of roles leads to a concentration of managerial power (Gallego-Alvarez and Pucheta-Martinez, 2020a). This concentration in the hands of a single person increases the risk that it may be associated with achieving personal goals (Al-Shammari and Al-Sultan 2010) or short-term financial focus (Lee 2023). According to stakeholder-agency theory, CEO duality hinders the fundamental CG system of checks and balances, reducing the independence and effectiveness in monitoring management activities and addressing stakeholder interests (Nicolò and Andrades-Peña 2024:4720). Empirical research on the impact of CEO duality on voluntary disclosure has been inconclusive (Michelon and Parbonetti 2012). Some studies on this relationship offer some evidence that companies with duality disclose less information (Forker 1992; Al-Shammari and Al-Sultan 2010). However, both Ho and Wong (2001) and Cheng and Courtenay (2006) find no association between CEO duality and voluntary disclosure.

A power concentration known as CEO duality raises the possibility that the CEO's interests will take precedence over those of shareholders (Fama and Jensen 1983) or stakeholders. Because of this concentration of power, the CEO may be less inclined to consider diverse viewpoints or to disclose information that could be interpreted as harmful to their interests, which could impede the development of board gender diversity and the prioritisation of digitalization disclosure. The significance of informative asymmetry between principals and agents is also emphasised by stakeholder-agency theory. There may be less accountability and openness in disclosing digitalization in the context of CEO duality, where the CEO has substantial influence over information flow within the firm (Dalton et al. 1998). Given that gender diversity is linked to greater accountability and openness, gender-diverse boards might be better positioned to criticise management (Adams and Ferreira 2009) and push for more thorough disclosure of digitalization. CEO duality, however, can jeopardise these initiatives by restricting the board's access to and examination of pertinent data. Some studies examined CEO duality as a moderating factor rather than an antecedent. Romano et al. (2020) test whether the relationship between gender diversity and ESG performance is constrained by CEO duality. They find that CEO duality negatively moderates this relationship.

A dual board structure may facilitate CEO incumbency (Khlif and Samaha 2019) and is considered a major cause of interest misalignment (Kim et al. 2009). A powerful CEO typically has privileged knowledge of the company's competitive advantages and internal affairs (Khlif and Samaha 2019). Therefore, duality may hinder the full exchange of confidential information between the CEO and board members (Kim et al. 2009). The person who occupies both roles tends to withhold unfavourable information to outsiders (Ho and Wong 2001). According to Forker (1992), a dominant personality in both roles poses a threat to monitoring quality and is detrimental to disclosure quality and the extent of digitalized disclosure. Research concerning the moderating effect of CEO duality on the board independence-accounting phenomena relationship is quite limited in accounting and management literature (Khlif and Samaha 2019:347). For instance, Chen et al. (2017) document a negative association

between board independence and the disclosure of internal control weaknesses, and this association is stronger for firms characterised by CEO duality.

Separating the roles of CEO and board chair minimises conflicts between directors and managers and enables the board to advocate for social and environmental investments that can generate both financial and non-financial returns (García Martín and Herrero 2020). Empirical evidence presented by Mallin and Michelon (2011) suggests that CEO duality adversely affects corporate social performance. According to Lassoued and Khanchel (2023), the CEO's dual role could influence CSR disclosure strategies, making the company less likely to engage in CSR activities (Uyar et al. 2022). The presence of a CSR committee indicates a board's dedication and direction towards socially and environmentally responsible conduct, indicating the company's endeavours to foster improved and more robust stakeholder relationships (Hussain et al. 2018; Uyar et al. 2021). Therefore, we expect that CEO duality negatively moderates the association between the existence of a CSR committee and voluntary digitalization disclosure. The presence of CEO duality could impede the CSR committee's ability to engage with interested parties and incorporate their perspectives into disclosure procedures related to digitalization. The committee's access to a variety of stakeholder perspectives may be restricted by the CEO's centralized control over communication channels and decision-making procedures, which could lead to partial or biased disclosure (Solomon 2020). In a duality scenario, as Jensen (2002) shows, the CEO may prioritize short-term financial objectives over long-term sustainability considerations, leading to a reluctance to invest in comprehensive digitalization disclosure practices. This short-term orientation may hinder the CSR committee's efforts to promote responsible digitalization practices and manage associated risks effectively.

Bearing in mind the previous arguments, we expect the positive effect of gender board diversity, independence board, and the presence of a CSR committee on digitalization disclosure to be more pronounced in firms without CEO duality. Therefore, we formally present a negative moderating effect of CEO duality on the relationship between gender board diversity, independence board, and CSR Committee, and digitalization disclosure.

Accordingly, we propose the following hypothesis:

H4 *The effect of board gender diversity, board independence, and the presence of a CSR committee on digitalization disclosure is negatively moderated by CEO duality.*

4 Research methodology

4.1 Sampling process

A total of 323 international firms that published an Integrated Report (IR) between 2017 and 2022 were included in the present study. The authors chose to analyse companies' IR because it provides additional information on corporate strategy, governance, and performance, and combines financial and non-financial information in one document (Nicolò et al. 2019; Ciubotariu et al. 2021). The empirical analysis

was initially conducted on the IR published on the websites of companies inserted in the IIRC database, the so-called "Integrated Reporting Examples Database[1]". The database has been selected because this section lists those organisations whose reports refer to the IIRC or the Integrated Reporting Framework or are influenced by the Framework through participation in Integrated Reporting Networks. In line with Raimo et al. (2022b:458), the rationale for selecting the IIRC website is to ensure that the selected IRs are prepared in accordance with the guidelines and principles of the IR framework. The initial sample consisted of 533 international listed and unlisted companies. Therefore, the websites of all 533 companies were analysed. Accordingly, we selected only the documents denominated 'IR' and the Integrated Annual Report, published in English, and downloaded in PDF format. For these reasons, some companies were excluded from the sample. On the one hand, financial firms were excluded because these entities comply with different accounting rules compared to non-financial firms (115 financial companies). This makes it more difficult to compare both financial and non-financial annual reports. On the other hand, firms for which all necessary data were unavailable were also excluded (95 companies). The collection of documents was conducted manually. Therefore, our final unbalanced sample comprises 323 firms and, consequently, 1.938 firm-year observations.

Firms in our sample are domiciled in 38 different countries (see Table 1), with South Africa, Japan, and the United Kingdom accounting for the highest representation at 31,9%, 21%, and 10%, respectively. In contrast to these values, Austria, Botswana, and Colombia each represent 0,3% of the sample.

In Table 2, we list the sectors in which firms in our sample operate, using the Thomson Reuters Business Classification (TRBC).

The sectors analysed are academic and educational services, basic materials, consumer cyclical, consumer non-cyclical, energy, government activity, healthcare, industrial, technology, and utilities. As shown in Table 2, the most represented industry in our sample is industrial with 22%, followed by basic materials with 19,50% and technology with 14%. In contrast to these figures, academic and educational services account for 1,50%, and energy and government activity for 3%.

4.2 Variables measurement

4.2.1 Dependent variable

Our dependent variable, the score of digitalization disclosure, is labelled DG_SCORE. In order to measure this score, a content analysis method was adopted, which is defined as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (Krippendorff 2004:16). This tool enables a large amount of information to be collected in a systematic, objective and reliable manner (Guthrie and Parker 1990; Guthrie et al. 2004). It is required to codify the information to be investigated using predefined categories (Guthrie et al. 2004; Guthrie and Abeysekera 2006; Cinquini et al. 2012). According to Cho and Hambrick (2006:459), the methods assume that words or phrases "fre-

[1] https://examples.integratedreporting.org/ir-reporters/.

Table 1 Number of observations by Country

Country	Obs	Percentage	Cumulative
Australia	24	1,24	1,24
Austria	6	0,31	1,55
Belgium	12	0,62	2,17
Botswana	6	0,31	2,48
Brazil	24	1,24	3,72
Colombia	6	0,31	4,02
Costa Rica	6	0,31	4,33
Denmark	6	0,31	4,64
Finland	18	0,93	5,57
France	30	1,55	7,12
Germany	42	2,17	9,29
Hong Kong	18	0,93	10,22
India	30	1,55	11,76
Italy	60	3,10	14,86
Japan	408	21,05	35,91
Jersey	6	0,31	36,22
Korea	18	0,93	37,15
Kuwait	6	0,31	37,46
Luxembourg	12	0,62	38,08
Malaysia	18	0,93	39,01
Mauritius	6	0,31	39,32
Mexico	12	0,62	39,94
Netherlands	60	3,10	43,03
New Zealand	36	1,86	44,89
Norway	6	0,31	45,20
Poland	6	0,31	45,51
Russia	6	0,31	45,82
Saudi Arabia	12	0,62	46,44
Singapore	12	0,62	47,06
South Africa	618	31,89	78,95
Spain	48	2,48	81,42
Sri Lanka	30	1,55	82,97
Swaziland	6	0,31	83,28
Sweden	30	1,55	84,83
Switzerland	24	1,24	86,07
Taiwan	6	0,31	86,38
Thailand	6	0,31	86,69
United Arab Emirates	6	0,31	87,00
United Kingdom	198	10,22	97,21
United States of America	54	2,79	100,00
Total	1.938	100	

quently used are cognitively central and reflect what is most on the user's mind". In a similar context, many authors use this method in prior disclosure studies (Hossnofsky and Junge 2019; Bernini et al., 2022). The coding process was performed through automatic content analysis, which is often preferred because it is faster and more consistent than manual coding techniques (Kondracki et al. 2002:226). Therefore, in line with the approach of Zeng et al. (2022), this study uses text-mining techniques to

Table 2 Number of observations by activity sector

TRBC economic sector	Obs	Percentage	Cumulative
Academic and educational services	30	1,55	1,55
Basics materials	378	19,50	21,05
Consumer cyclicals	222	11,46	32,51
Consumer non-cyclicals	270	13,93	46,44
Energy	66	3,41	49,85
Government activity	66	3,41	53,25
Healthcare	114	5,88	59,13
Industrial	426	21,98	81,11
Technology	276	14,24	95,36
Utilities	90	4,64	100,00
Total	1.938	100,000	

extract digitalization-related keywords from firms' IR and constructs a digitalization index based on these keywords. The framework proposed by Broccardo et al. (2023) identifies a list of information items in order to assess the presence of digitalization-related terms. Broccardo et al. (2023), through a literature review, identified the new opportunities that digitalization can bring to each BM block, starting with the nine blocks of the BM Canvas proposed by Osterwalder and Pigneur (2010). To build the dictionary, these elements represent the key components for its construction, i.e., a list of words associated with a given category (see Table 3).

The coding process was performed using automatic content analysis with a special tool called Lexos v4.0 2019, Wheaton Lexomics. This software provided us with the absolute number of words in the dictionaries, which, when compared to the total number of words in the documents, serves as an index to assess the extent of the BM's migration towards issues such as sustainability and digitalization.

As previously seen in other studies (Tavana et al. 2022; Yang and Deng 2023), the disclosure index adopted to analyse the frequency of words in the dictionary in the companies' IR, we used the ratio between the frequency of words provided by Broccardo et al. (2023) in the IR and the total number of words.

$$\text{Digitalization Disclosure Score (DG\_SCORE)} = \frac{\text{Total number of dictionaries' keyword frequencies}}{\text{Total number of word in the IR}}$$

According to Raimo et al. (2022b), constructing a disclosure index is the most appropriate method, as it lends validity to the analysis and enables the subsequent use of econometric models to identify the factors that influence the observed extent of disclosure.

4.2.2 Independent variables

Board gender diversity is the first independent variable, labelled as B_GENDER_DIVERSITY, and it is calculated as the percentage of female directors on boards, as the total number of female directors on boards on the total number of directors on boards (Nicolò et al. 2021, 2023; Raimo et al. 2022b; Nicolò and Cervilla-Bellido 2025). The second independent variable analysed is the percentage of independent

Table 3 Information Items about Broccardo et al. (2023)'s framework

Word's dictionaries
key* partner*, new online partner*, new online partner†, opportunities to share among partner, opportunities to share among partners, more opportunity* to share among partners†, ecosystem for creation improved†, stakeholder engagement facilitated†, new investor*, entrepreneurship democratized lower barriers for entrepreneurs†, barriers for entrepreneur*, involvement by local authorities and prosumers facilitated†, key activity*, more efficient logistic*, efficient logistic*, remanufacturing facilitated†, remanufacturing, reusing facilitated†, reusing, recycling facilitated†, recycling, more automatized processes†, automatized process*, more efficient transactions†, efficient transaction*, key resource*, resource*, use of instore technology†, instore technology, technology*, digital technology*, digital tool*, resources easier to share†, use of renewable resources and raw materials†, renewable resource*, raw material*, more efficient use of resources and capabilities†, time reduction*, cost*, cost structure, improved cost structure due more efficiency†, more research and development investments†, research and development investments†, lower costs per unit†, costs per unit, more R&D†, more research and development, research and development, R&D, value proposition*, customized products and service†, servitization*, virtual and dematerialized products†, virtual, virtual product*, dematerialized product*, dematerialization, sustainable and smart products†, sustainable product*, sustainable product†, smart product*, new value proposition*, more information to customers†, information to customers†, opportunities of value co-creation with consumers†, opportunities of value co-creation†, potentially cheaper products†, cheaper product*, circular economy increase†, circular economy*, CE, customer segment*, new customer segments for sustainable and smart products†, customer segment for sustainable and smart product†, surge of prosumer†, prosumer*, consumer*, customer relationship*, closer relationship*, longer run relationship†, opportunities for co-creation†, more legitimacy vis-` a-vis consumers†, legitimacy, asset sharing among clients†, asset sharing, better grasp of customers' needs†, need of customer*, relations based on social proof†, social proof*, higher social trust*, social trust*, fostering of good behavior*†, fostering of good behaviour†, good behaviour*, relationship facilitated via platforms or apps†, platform or app*, community building†, community*, channel*, online sales†, lower transaction cost*†, transaction cost†*, vertical integration facilitated†, more use of digital sale platform*†, digital platform*, omni channels strategies†, shared infrastructure*, revenue*, revenues flow*, flow, new revenue streams due to servitization†, stable revenues due to servitization*, more licensing*, licensing, digital*, digitization*, digitalization*, digital transformation*, digital technology*, digital tool*.

*Words marked with this symbol were also considered in plural form.

† Keywords marked with this symbol were also entered in the dictionary individually.

directors on the board, labelled as BOARD_INDEPENDENCE, and it was calculated as the percentage of independent board members as reported by the company, as the total number of independent directors on the board on the total number of board directors (Liao et al. 2015; Raimo et al. 2022b; Nicolò et al. 2023). The presence of a CSR Committee is the third independent variable, denoted as CSR_COMM, and it is represented by a dummy variable that takes the value 1 if the company has a CSR Committee and 0, otherwise (Liao et al. 2015; Pucheta-Martínez et al. 2021a; Raimo

et al. 2022b; Nicolò et al. 2023; Zampone et al. 2024). Finally, we use the moderator variable CEO duality, denoted as CEO_DUALITY, calculated as a dummy variable coded 1 if the CEO also serves as chairperson of the board and 0 otherwise (Gallego-Álvarez and Pucheta-Martínez 2022a; Nicolò et al. 2023). The data related to independent variables used in this research were collected from the Refinitiv (Thomson Reuters) database.

4.2.3 Control variables

Based on prior literature, we also considered several factors that may influence the level of digitalization disclosure, including variables beyond CG characteristics that may affect voluntary disclosure. The NUMBER OF MEETINGS, which refers to the number of board meetings held during the year, is the first important control variable (Liao et al. 2015; Nicolò and Andrades-Peña 2024). The return on assets (ROA) has also been controlled, labelled as ROA, and calculated as operating income before interest and taxes divided by total assets (Liao et al. 2015; Pucheta-Martínez et al., 2021b). Another control variable is firm leverage (LEVERAGE), calculated as debt divided by total assets (Liao et al. 2015; Pucheta-Martínez et al., 2021a). Higher leverage in companies is expected to increase agency costs because it gives managers greater potential to transfer wealth from debt holders. Therefore, companies with high leverage may choose to disclose more information to mitigate agency costs and reassure debt holders. Moreover, we control for firm size, denoted by FIRM_SIZE and calculated as the log of total assets (Pucheta-Martínez et al., 2021b; Borrero-Domínguez et al. 2024). According to stakeholder-agency theory, separating management and ownership incurs costs, which are particularly evident in larger corporations. These firms are subject to increased political scrutiny and regulatory oversight, including price controls, threats of nationalization, and social responsibility mandates. Consequently, companies are motivated to disclose more information in their annual reports to enhance their reputations, reduce public intervention, and discourage government interference (Watts and Zimmerman 1978). The present study also includes several control variables to capture country-specific characteristics. Firstly, political structure is measured by a dummy variable that takes the value 1 if the company operates in a democratic country and 0 otherwise (Williams 1999; Hoover and Fafatas 2018). The type of POLITICAL_SYSTEM (democracy vs. authoritarianism) directly influences transparency norms, disclosure expectations, and accountability mechanisms. In democracies, governments (and, by extension, firms) often face greater pressure to be open and transparent, including through digitalization initiatives. In authoritarian regimes, disclosure may be more selective, controlled, or propagandistic. Secondly, cultural norms are proxied by the Uncertainty Avoidance Index (UAI), following the national cultural dimension model created by Hofstede (2010), which reflects a country's tendency to reduce ambiguity and can result in more structured disclosure practices (Pucheta-Martínez et al. 2021b; Roy and Mukherjee 2025). Thirdly, economic conditions are represented by Gross Domestic Product per capita (GDP_PC), an indicator of development that affects both companies' information resources and social demand for transparency. It is measured by the log of GDP (Gallego-Álvarez and Pucheta-Martínez, 2020b; Guo et al. 2022). The legal institutions developed by

La Porta et al. (1998) are among the most widely used country-level institutional indicators in governance and disclosure research, reflecting the formal rules, legal systems, and regulatory environments that shape disclosure practices. LEGAL_SYSTEM is measured as a dummy variable that takes the value 1 if the country operates under a civil-law system and 0 otherwise (La Porta et al. 1998; Gallego-Álvarez and Pucheta-Martínez, 2020). The sector in which firms operate is also controlled (Hoelscher and Seavey 2014; Borrero-Domínguez et al. 2024). We have used the TRBC sectoral classification of the Refinitiv (Thomson Reuters) database. We use ten sectors: academic and educational services (ACADEMIC AND EDUCATIONAL SERVICES), basic materials (BASIC MATERIALS), consumer cyclical (CONSUMER CYCLICAL), consumer non-cyclical (CONSUMER NON-CYCLICAL), energy (ENERGY), government activity (GOVERNMENT ACTIVITY), Healthcare (HEALTHCARE), industrial (INDUSTRIALS), technology (TECHNOLOGY), and utilities (UTILITIES). The sector (SECTOR) is measured as a dummy variable, coded 1 if the company operates in the sector and 0 otherwise. Studies (Al-Shammari and Al-Sultan 2010) suggest that industry affiliation significantly affects voluntary disclosure. In our study, we included industry membership as a control variable to account for industry-specific factors that could influence voluntary disclosure and to capture sensitivity to political costs not captured by other industry-specific proxies (Ball and Foster 1982; Al-Shammari and Al-Sultan 2010; Borrero-Domínguez et al. 2024). Finally, the year effects are also considered (YEAR) in the model by including a set of dummy variables. In Table 4, the summary of all variables used in this article is provided. The firm-level control variables were collected from the Refinitiv (Thomson Reuters) database, while the country-level control variables were obtained from the World Bank database.

4.2.4 Baseline model

A quantitative methodology was applied in order to test the relationship between CG mechanisms and the level of disclosure on digitalization. The procedure used for running the baseline model will be the generalized method of moments (GMM) proposed by Arellano and Bond (1991) and Blundell and Bond (1998).

The hypotheses will be evaluated using the model described below:

$$
\begin{aligned}
\mathrm{DG}_{\mathrm{SCORE\,it}} = & \beta_0 + \beta_1\,\mathrm{GENDER\_DIVERSITY}_{it} + \beta_2 \mathrm{BOARD\_INDEPENDENCE}_{it} \\
& + \beta_3 \mathrm{CSR\_COMMITTEE}_{it} + \beta_4 \mathrm{CEO\_DUALITY}_{it} \\
& + \beta_5 \mathrm{CEO\_DUALITY}_{it}\,\mathrm{x}\,\mathrm{GENDER\_DIVERSITY}_{it} \\
& + \beta_6 \mathrm{CEO\_DUALITY}_{it}\,\mathrm{x}\,\mathit{BOARD}\_\mathrm{INDEPENDENCE}_{it} \\
& + \beta_7 \mathrm{CEO\_DUALITY}_{it}\,\mathrm{x}\,\mathit{CSR}\_\mathrm{COMMITTEE}_{it} + \beta_8 \mathrm{NUMBER\_OF\_MEETINGS}_{it} \\
& + \beta_9 \mathrm{ROA}_{it} + \beta_{10} \mathrm{LEVERAGE}_{it} + \beta_{11} \mathrm{FIRM\_SIZE}_{it} + \beta_{12} \mathrm{GDP\_PC}_{it} \\
& + \beta_{13} \mathrm{POLITICAL\_SYSTEM}_{it} + \beta_{14} \mathrm{UAI}_{it} + \beta_{15} \mathrm{LEGAL\_SYSTEM}_{it} \\
& + \sum \beta_k \mathrm{SECTOR}_i + \sum \beta_j \mathrm{YEAR}_t + \pi_i + \Omega_{it}
\end{aligned}
$$

The subscripts "i" and "t" denote the company and year, respectively. In the regression, the coefficients are denoted by βi, and πi + Ωit represents the random error term. πi signifies the unobservable heterogeneity (firm-specific or firm-fixed effects) characterizing each firm but remaining constant over time, while Ωit varies between

Table 4 Variables description

Variables	Description	References
DG_SCORE	Measured as a score based on the number of words in the IR according to the Framework adapted by Broccardo et al. (2023)	Broccardo et al. (2023)
B_GENDER_DIVERSITY	Percentage of female directors on boards = Total number of female directors on boards/Total number of directors on boards	Nicolò et al. 2021), 2023); Raimo et al. 2022b); Nicolò and Cervilla-Bellido (2025).
BOARD_INDEPENDENCE	Percentage of independent board members as reported by the company = Total number of independent directors on boards / Total number of board directors	Liao et al. (2015); Raimo et al. 2022b); Nicolò et al. (2023).
CSR_COMM	Does the company have a CSR committee or team? A dummy variable that takes the value 1 if the company has a CSR Committee and 0, otherwise	Liao et al. (2015); Pucheta-Martínez et al. (2021a, 2021b) Raimo et al. 2022b); Nicolò et al. (2023); Zampone et al. (2024).
CEO_DUALITY	Does the CEO simultaneously chair the board or does the chairman of the board? A dummy variable that takes the value 1 if the same person serves simultaneously as CEO and President of the board and 0, otherwise	Gallego-Álvarez and Pucheta-Martínez 2022a); Nicolò et al. (2023)
NUMBER OF MEETINGS	The number of board meetings during the year	Liao et al. (2015); Nicolò and Andrades-Peña (2024).
ROA	Operate income before interests and taxes over total assets	Liao et al. (2015); Pucheta-Martínez et al. (2021a)
LEVERAGE	Debt over total assets	Liao et al. (2015); Pucheta-Martínez et al. (2021b)
FIRM_SIZE	The log of total assets	Pucheta-Martínez et al. (2021a, 2021b); Borrero-Domínguez et al. (2024)
GDP_PC	The log of Gross Domestic Product per capita of each country	Gallego-Álvarez and Pucheta-Martínez 2020b); Guo et al. (2022)
POLITICAL_SYSTEM	Dummy variable: that takes the value 1 if the company operates in a democratic country, and 0 otherwise	Williams (1999); Hoover and Fafatas (2018).
UNCERTAINTY AVOIDANCE INDEX	Uncertainty avoidance is one of the six culture dimensions addressed by Hofstede (2010) and ranges from 0 to 100	Hofstede (2010) Pucheta-Martínez et al. (2021b); Roy and Mukherjee (2025).

Table 4 (continued)

Variables	Description	References
LEGAL_SYSTEM	Dummy variable: that takes the value 1 if the company operates in a country with civil law, and 0 otherwise	Gallego-Álvarez and Pucheta-Martínez (2020); Guo et al. (2022).
ACADEMIC AND EDUCATIONAL SERVICES	Dummy variable: 1 = Academic Educational Services; 0 = Otherwise	Al-Shammari and Al-Sultan (2010); Pucheta-Martínez et al. (2021a, 2021b); Borrero-Domínguez et al. (2024).
BASICS MATERIALS	Dummy variable: 1 = Basic Materials; 0 = Otherwise	
CONSUMER CYCLICAL	Dummy variable: 1 = Consumer Cyclicals; 0 = Otherwise	
CONSUMER NON-CYCLICAL	Dummy variable: 1 = Consumer Non-Cyclicals; 0 = Otherwise	
ENERGY	Dummy variable: 1 = Energy; 0 = Otherwise	
GOVERNMENT ACTIVITY	Dummy variable: 1 = GovernmentActivity; 0 = Otherwise	
HEALTHCARE	Dummy variable: 1 = Healthcare; 0 = Otherwise	
INDUSTRIALS	Dummy variable: 1 = Industrials; 0 = Otherwise	
TECHNOLOGY	Dummy variable: 1 = Technology; 0 = Otherwise	
UTILITIES	Dummy variable: 1 = Utilities; 0 = Otherwise	

firms over time. To mitigate potential endogeneity bias (Wintoki et al. 2012), which could yield inaccurate estimates, we employed the two-step system GMM estimation proposed by Arellano and Bond (1991) and Blundell and Bond (1998). The GMM estimator is preferred for its efficiency and consistency as it controls for unobservable heterogeneity.

The GMM technique offers several diagnostic tests to evaluate model fitness and the presence of serial correlation. These include the Wald $\chi 2$ test, Arellano–Bond tests AR(1) and AR(2), and the Hansen test. The Wald $\chi 2$ test assesses model fitness, while the Arellano–Bond tests AR(1) and AR(2) determine the existence of serial correlation. Additionally, the Hansen test assesses the appropriateness of the model's instruments by testing for a correlation between the instruments and the error term.

5 Analysis of results

5.1 Descriptive statistics

The descriptive statistics for the dependent and independent variables, including means and standard deviations (SDs), are shown in Table 5.

The dependent variable, relating to the companies' digitalization disclosure (DG_SCORE), averaged 0,06%. This score shows that the level of digitalization of information disclosed by firms in our sample was moderate. The term 'moderate' is attributable to the choice of the IR as the corporate document for calculating the disclosure ratio. The latter, which combines financial and non-financial information in

Table 5 – Descriptive Statistics

Variables	Obs	Mean	SD	Min	Max	Lower q.	Median	Upper q.
DG_SCORE	1.938	0,01	0,00	0,00	0,02	0,00	0,01	0,01
B_GENDER_DIVERSITY (%)	1.938	0,18	0,17	0,00	0,75	0,00	0,16	0,31
CSR_COMM	1.938	0,65	0,48	0,00	1,00	0,00	1,00	1,00
BOARD_INDEPENDENCE (%)	1.938	0,41	0,33	0,00	1,00	0,00	0,46	0,67
CEO_DUALITY	1.938	0,08	0,27	0,00	1,00	0,00	0,00	0,00
NUMBER OF MEETINGS	1.938	5,97	6,01	0,00	38,00	0,00	5,00	10,00
GDP_PC	1.938	60,50	21,39	8,00	95,00	9,38	10,51	10,56
POLITICAL_SYSTEM	1.938	0,94	0,24	0,00	1,00	1,00	1,00	1,00
UNCERTAINTY AVOIDANCE INDEX	1.938	10,12	0,64	8,80	11,39	49,00	49,00	86,00
LEGAL_SYSTEM	1.938	0,45	0,50	0,00	1,00	0,00	0,00	0,00
ROA (%)	1.938	3,54	9,77	− 113,54	165,56	0,00	3,11	6,44
LEVERAGE	1.938	0,76	2,21	− 45,82	45,74	0,07	0,44	1,02
FIRM_SIZE	1.938	19,69	9,94	0,00	31,50	21,15	23,35	25,62
ACADEMIC AND EDUCATIONAL SERVICES	1.938	0,02	0,12	0,00	1,00	0,00	0,00	0,00
BASICS_MATERIALS	1.938	0,20	0,40	0,00	1,00	0,00	0,00	0,00
CONSUMER CYCLICALS	1.938	0,11	0,32	0,00	1,00	0,00	0,00	0,00
CONSUMER NON_CYCLICALS	1.938	0,14	0,35	0,00	1,00	0,00	0,00	0,00
ENERGY	1.938	0,03	0,18	0,00	1,00	0,00	0,00	0,00
GOVERNMENT_ACTIVITY	1.938	0,03	0,18	0,00	1,00	0,00	0,00	0,00
HEALTHCARE	1.938	0,06	0,24	0,00	1,00	0,00	0,00	0,00
INDUSTRIALS	1.938	0,22	0,41	0,00	1,00	0,00	0,00	0,00
TECHNOLOGY	1.938	0,14	0,35	0,00	1,00	0,00	0,00	0,00
UTILITIES	1.938	0,05	0,21	0,00	1,00	0,00	0,00	0,00

one document, is often rich in data, resulting in a longer document. Compared with the number of terms related to digitalization, DG_SCORE likely yields lower results. Moreover, the variables relating to the proportion of women on the board (B_GENDER_DIVERSITY), the proportion of independent directors (BOARD_INDEPENDENCE), and the presence of a CSR Committee (CSR_COMM) have averages of 17%, 41%, and 65%, respectively. Additionally, in 7,7% of the firms in the sample, the CEO also serves as chairperson of the board (CEO_DUALITY). Furthermore, on average, the companies in the sample hold almost 6 meetings per year (NUMBER OF MEETINGS), achieve a return on assets (ROA) of 3,5%, leverage is about 7% (LEVERAGE), and the company size is (FIRM_SIZE), on average, 19 (measured as the log of total assets). Most countries have a medium-high income level, as indicated by the average GDP_PC variable (60,5), reflecting a prevalence of developed economies. On the other hand, the average POLITICAL_SYSTEM score of approximately 0,9 shows that most of the companies sampled operate in democratic countries. However, the average UAI score of 10,12 (on Hofstede's scale of 0-100) indicates that the countries in the sample generally have a culture that is not particularly oriented

towards avoiding uncertainty. Moreover, the average legal system score of 0,45 indicates that just under half of the observations refer to countries with a civil law system.

In Table 6, we show the correlation matrix calculated to check for multicollinearity problems. Consistent with previous studies (Gujarati 2009), when the absolute value of the correlation coefficient falls below 0,8, it indicates a reduced likelihood of multicollinearity.

Table 6 shows that none of the correlation coefficients exceed 0,8. Therefore, based on this analysis, we can conclude that multicollinearity is not a significant problem. Additionally, to identify collinearity among the independent variables, the variance inflation factor (VIF) test was performed.

As shown in Table 7, the VIF values were all below the critical limit of 10 (Nicolò et al. 2021). This indicates that multicollinearity was not a significant issue.

5.2 Discussion of the multivariate analysis

Table 8 shows the results of our hypothesis test. Three models were constructed that explore how gender diversity, board independence, and the presence of a CSR Committee influence the level of digitalization disclosure. In addition, we built three additional models to examine the moderating effect of CEO duality on board gender diversity, board independence, and the existence of a CSR committee and the disclosure of digital-related information.

In Model 1, we analyse the effect of the percentage of women on the board on the level of digitalization disclosure. The variable B_GENDER_DIVERSITY exhibits a positive sign, as predicted, and is statistically significant. For this reason, we cannot reject hypothesis 1, suggesting that a BoD composed of more women tends to increase the level of digitalization disclosure. Regarding the hypothesis tested, in line with expectations, the results of the first model show that gender diversity, understood as the participation of women on BoDs, has a significant and positive impact on the level of voluntary disclosure of digitalization provided by the companies in the sample through the IR analysis. This result is consistent with previous literature (Vitolla et al. 2020; Nicolò et al. 2022) and supports the rationale behind stakeholder-agency theory. This suggests that board gender diversity may positively affect digitalization disclosure by strengthening oversight, mitigating groupthink, enhancing decision-making, increasing stakeholder trust, and highlighting accountability and reputation management. The combination of these considerations may help align the interests of stakeholders and management, resulting in a transparent and comprehensive digitalization disclosure. Consequently, a greater presence of women on the board increases the effectiveness of CG mechanisms, as women are more likely than their male counterparts to address the interests of a wider range of stakeholders (Manita et al. 2018; Nicolò et al. 2022). Moreover, they are more diligent and impartial in performing monitoring tasks (Manita et al. 2018). These peculiar attitudes, in turn, stimulate greater voluntary disclosure of relevant corporate resources, such as digitalization, as the findings confirm.

In Model 2, we analyse how board independence impacts digitalization disclosure. The coefficient is positive, as predicted, and it is statistically significant. This evidence supports hypothesis 2. The result is consistent with previous studies, which

support a positive relationship between board independence and voluntary disclosure (García-Meca and Sánchez-Ballesta, 2010; Donnelly and Mulcahy 2008; Gallego-Álvarez and Pucheta-Martínez, 2020). For instance, García-Meca and Sánchez-Ballesta (2010) found a significant correlation between board independence and voluntary disclosure. Arcay and Vazquez (2005), Cheng and Courtenay (2006), and Lim et al. (2007) have identified a positive correlation between boards predominantly composed of independent directors and the level of voluntary disclosure in Spain, Singapore, and Australia, respectively (Donnelly and Mulcahy 2008). Our results align with stakeholder-agency theory, which suggests that a high number of independent members improves monitoring skills and increases stakeholder orientation (Raimo et al. 2022b). Moreover, independent directors promote transparency and influence sustainability disclosure (Cheng and Courtenay 2006; Jo and Harjoto 2011) because they are selected for their reputation, professional expertise, experience, skills, and impartiality, enabling them to effectively monitor management behaviour (Gallego-Álvarez and Pucheta-Martínez, 2020).

Model 3 presents the findings for the impact of the existence of a CSR committee on digitalization disclosure. The coefficient is positive, as predicted, and it is statistically significant. Thus, the third hypothesis is also supported, showing that the presence of a CSR committee can enhance the level of digitalization disclosure. This result aligns with prior literature, which generally supports a positive relationship between the presence of a CSR committee and the level of non-financial disclosure (Fuente et al. 2017; Gallego-Álvarez and Pucheta-Martínez, 2020; Zampone et al. 2024). According to Amran et al. (2014), the presence of a CSR committee is seen as a valuable resource and may contribute to increased disclosure, particularly to address stakeholders' demands. This finding supports stakeholder-agency perspectives. On the one hand, the presence of a CSR committee enables the interests and needs of various stakeholder categories to be represented more effectively (Raimo et al. 2022b). On the other hand, the committee's presence enables a high level of monitoring, which increases the company's interest in sustainability issues. Consequently, this committee ensures greater disclosure of sustainability information by actively participating in its collection (Raimo et al. 2022b). Moreover, CSR committees should monitor stakeholders' needs and the effectiveness of sustainability actions implemented (Gallego-Álvarez and Pucheta-Martínez, 2020).

In Models 4–6, we examine the moderating effect of CEO duality on board gender diversity, board independence, the presence of a CSR Committee, and digitalization disclosure. Model 4 shows the interaction between board gender diversity and CEO duality on digitalization disclosure. To analyse this relationship, we constructed the interaction CEO_DUALITY × B_GENDER_DIVERSITY. The variable exhibits a negative, and it is statistically significant. This finding suggests that CEO duality negatively moderates the positive effect of a higher presence of women on the board on digitalization disclosure. Results partially confirm the fourth hypothesis: CEO duality negatively moderates the positive effect of female directors on voluntary disclosure in the digitalization field. This result aligns with the study by Romano et al. (2020), although it focuses on sustainability performance. Indeed, when the same person holds both the positions of CEO and chairman, the risks of conflict of interest, abuse of power, and lack of participation in the decision-making process by

Table 6 Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DG_SCORE (1)	1													
B_GENDER_DIVERSITY (2)	0,043*	1												
BOARD_INDEPENDENCE (3)	0,035	0,797***	1											
CSR_COMM (4)	0,103***	0,690***	0,789***	1										
CEO_DUALITY (5)	0,139***	0,100***	0,126***	0,175***	1									
NUMBER OF MEETINGS (6)	0,192***	0,418***	0,521***	0,633***	0,263***	1								
ROA (7)	0,079***	0,142***	0,111***	0,143***	0,008	0,038*	1							
LEVERAGE (8)	0,020	0,126***	0,119***	0,126***	0,069***	0,111***	− 0,063***	1						
FIRM_SIZE (9)	0,111***	0,315***	0,377***	0,448***	0,122***	0,345***	0,109***	0,133***	1					
GDP_PC (10)	0,154***	− 0,025	0,039*	− 0,006	0,190***	0,297***	− 0,049**	0,003	0,022	1				
POLITICAL_SYSTEM (11)	0,061***	0,125***	0,097***	0,095***	0,073***	0,080***	0,042*	− 0,024	0,106***	− 0,015	1			
UAI (12)	0,253***	− 0,238***	− 0,178***	0,050**	0,246***	0,248***	− 0,012	0,029	0,210***	0,308***	0,193***	1		
LEGAL_SYSTEM (13)	0,201***	− 0,134***	− 0,075***	0,060***	0,213***	0,302***	0,015	0,043	0,186***	0,595***	0,070***	0,798***	1	

Table 6 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ACADEMIC AND EDUCATIONAL SERVICES (14)	0,002	− 0,077***	− 0,097***	− 0,118***	− 0,036	− 0,104***	− 0,026	− 0,035	− 0,191***	0,003	0,032	− 0,104***	− 0,114***	1
BASICS MATERIALS (15)	− 0,039*	0,077***	0,133***	0,088***	− 0,083***	− 0,009	0,105***	− 0,048**	0,102***	− 0,128***	− 0,009	− 0,093***	− 0,070***	− 0,062***
CONSUMER CYCLICAL (16)	− 0,068***	0,052**	0,012	0,009	− 0,086***	− 0,104***	0,023	0,050**	0,054	− 0,101***	0,008	− 0,034	− 0,073***	− 0,045**
CONSUMER NON-CYCLICAL (17)	0,000	0,071***	0,054	0,083***	0,013	0,029	0,037	− 0,003	0,091***	− 0,044	0,063***	− 0,016	− 0,024	− 0,050**
ENERGY (18)	− 0,110***	0,065***	0,072***	0,054	− 0,044	0,029	− 0,039*	− 0,047**	0,034	0,075***	− 0,025	− 0,011	0,001	− 0,024
GOVERNMENT ACTIVITY (19)	− 0,097***	− 0,201***	− 0,237***	− 0,256***	− 0,054	− 0,187***	− 0,068***	− 0,065***	− 0,372***	− 0,056	− 0,097***	− 0,154***	− 0,136***	− 0,024
HEALTHCARE (20)	− 0,017	0,071***	0,087***	0,041*	0,068***	0,063***	− 0,051**	− 0,001	0,052**	0,055	0,063***	0,006	0,011	− 0,031
INDUSTRIALS (21)	− 0,058	− 0,167***	− 0,170***	− 0,102***	0,025	0,019	− 0,061***	− 0,010	− 0,127***	0,101***	− 0,025	0,123***	0,134***	− 0,067***
TECHNOLOGY (22)	0,359***	− 0,010	− 0,012	0,017	0,093***	0,065***	0,014	0,041*	0,067***	0,060***	0,021	0,118***	0,093***	− 0,051**
UTILITIES (23)	− 0,110***	0,085***	0,100***	0,054	0,093***	0,111***	− 0,032	0,087***	0,060***	0,090***	− 0,069***	0,011	0,036	− 0,028
AFRICA (24)	− 0,107***	0,078***	0,000	− 0,010	− 0,173***	− 0,300***	0,041*	− 0,031	− 0,074***	− 0,796***	0,171***	− 0,376***	− 0,635***	0,019
AMERICAS (25)	− 0,094***	− 0,062***	0,029	− 0,045**	0,088***	− 0,031	− 0,134***	0,039*	− 0,040*	0,066***	0,059***	0,013	0,009	0,083***

Table 6 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ASIA (26)	0,262***	− 0,378***	− 0,292***	− 0,049**	0,060***	0,179***	− 0,012	− 0,002	0,156***	0,293***	− 0,356***	0,571***	0,465***	− 0,081***
EUROPE (27)	− 0,089***	0,342***	0,275***	0,125***	0,094***	0,165***	0,042*	0,032	0,004	0,491***	0,133***	− 0,156***	0,247**	0,029
OCEANIA (28)	− 0,045**	− 0,037	0,008	− 0,113***	− 0,052**	− 0,051**	− 0,018	− 0,046**	− 0,169***	0,144***	0,045**	− 0,089***	− 0,162***	− 0,022

	15	16	17	18	19	20	21	22	23	24	25	26	27
DG_SCORE (1)													
B_GENDER_DIVERSITY (2)													
BOARD_INDEPENDENCE (3)													
CSR_COMM (4)													
CEO_DUALITY (5)													
NUMBER OF MEETINGS (6)													
ROA (7)													
LEVERAGE (8)													
FIRM_SIZE (9)													
GDP_PC (10)													
POLITICAL_SYSTEM (11)													
UAI (12)													

Table 6 (continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27
LEGAL_ SYSTEM (13)													
ACADEMIC AND EDU-CATIONAL SERVICES (14)													
BASICS MATERIALS (15)	1												
CONSUMER CYCLICAL (16)	− 0,177***	1											
CONSUMER NON-CYCLI-CAL (17)	− 0,198***	− 0,145***	1										
ENERGY (18)	− 0,092***	− 0,068***	− 0,076***	1									
GOVERN-MENT ACTIVITY (19)	− 0,092***	− 0,068***	− 0,076***	− 0,035	1								
HEALTH-CARE (20)	− 0,123***	− 0,090***	− 0,101***	− 0,047**	− 0,047**	1							
INDUSTRI-ALS (21)	− 0,261***	− 0,191***	− 0,214***	− 0,100***	− 0,100***	− 0,133***	1						
TECHNOL-OGY (22)	− 0,201***	− 0,147***	− 0,164***	− 0,077***	− 0,077***	− 0,102***	− 0,216***	1					
UTILITIES (23)	− 0,109***	− 0,079***	− 0,09***	− 0,041*	− 0,041*	− 0,055	− 0,117***	− 0,090***	1				
AFRICA (24)	0,122***	0,059***	0,024	− 0,059	0,087***	− 0,007	− 0,084***	− 0,040*	− 0,154***	1			
AMERICAS (25)	0,024	− 0,085***	0,025	− 0,044	− 0,044	0,118***	− 0,058	− 0,056	0,146***	− 0,165***	1		

Table 6 (continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27
ASIA (26)	− 0,129***	0,003	0,015	− 0,046**	− 0,046**	0,012	0,117***	0,087***	− 0,046**	− 0,451***	− 0,152***	1	
EUROPE (27)	0,008	0,003	− 0,044	0,104***	− 0,009	− 0,046**	− 0,047**	0,009	0,084***	− 0,451***	− 0,152***	− 0,417***	1
OCEANIA (28)	− 0,043	− 0,064***	− 0,020	0,065***	− 0,034	− 0,045**	0,121***	− 0,073***	0,130***	− 0,125***	− 0,042*	− 0,115***	− 0,115***

*p<.1; **p<.05; ***p<.01

Table 7 – VIF calculations

Variable	VIF	1/VIF
LEGAL_SYSTEM	4,87	0,205
BOARD_INDEPENDENCE	4,27	0,234
UNCERTAINTY AVOIDANCE INDEX	4,24	0,236
CSR_COMM	3,89	0,257
B_GENDER_DIVERSITY	3,07	0,325
NUMBER OF MEETING	2,09	0,479
GDP_PC	2	0,500
FIRM_SIZE	1,36	0,738
CEO_DUALITY	1,14	0,878
POLITICAL_SYSTEM	1,12	0,893
ROA	1,05	0,952
LEVERAGE	1,04	0,959

other directors increase, thus reducing the representation of other stakeholders on the BoDs and negatively affecting the company's sustainability practices (Romano et al. 2020). Therefore, the potential benefits of increased board gender diversity appear to be outweighed by the negative aspects of CEO duality (Romano et al. 2020). This finding may indicate the need for more balanced leadership to fully reap the benefits of board gender diversity. It may be that the presence of female directors alone is not enough to influence disclosure in the absence of other governance practices. Stakeholder-agency theory suggests that separating the CEO and chairperson roles would help avert potential conflicts of interest, in which managers may pursue their own interests to the detriment of other stakeholders. The present result confirms this theoretical framework: duality status negatively influences the relationship between gender diversity and voluntary disclosure related to digitalization.

Model 5 shows the interaction between CEO duality and the board's independence on digitalization disclosure. The interaction coefficient is negative but not statistically significant, suggesting we cannot draw firm conclusions about this moderation. Therefore, the hypothesis that CEO duality negatively moderates the association between board independence and digitalization disclosure cannot be accepted. This result is consistent with the idea that CEO duality does not affect the positive effect of board independence on digitalization disclosure, being inconsistent with the results of previous studies (Cerbioni and Parbonetti 2007). The CEO may not have a major impact on the association between independent directors and the disclosure of digitalization, given independent directors' duty to prioritize shareholders, remain impartial, and uphold governance regulations. Their duties and obligations are structured to limit the CEO's influence on their decisions, especially on important ones such as digitalization. The absence of a moderating effect of CEO duality on the relationship between board independence and digitalization disclosure may reflect the expectation that independent directors will monitor performance when the CEO is not the board chair. While CEO duality concentrates power at the top and might therefore undermine the board's effectiveness, the independent directors still have a formal duty to the organization to counter the duality's constraining influence by ensuring some measure of accountability, and therefore, these independent directors would have to retain some form of mitigating power in either circumstance. There are also factors of increasing regulatory and societal expectations regarding the disclosure

Table 8 Multivariate analysis results of the GMM

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
	p > |t|		p > |t|		p > |t|		p > |t|		p > |t|		p > |t|	
DG_SCORE (t-1)	0,30	***	0,324	***	0,317	***	0,335	***	0,285	***	0,352	***
B_GENDER_DIVERSITY	0,000	***					0,003	***				
BOARD_INDEPENDENDENCE			0,002	***					0,001	***		
CSR_COMM					0,001	***					0,00	
NUMBER OF MEETINGS	0,000		− 0,000		− 0,000		− 0,000		− 0,000		0,000	*
ROA	0,000		0,000		0,000		0,00		0,000		0,000	
LEVERAGE	− 0,000		0,002		0,000		− 0,000		− 0,000		0,000	
FIRM_SIZE	− 0,000		− 0,001	**	− 0,000		0,00		− 0,000		− 0,000	
GDP_PC	0,000	***	0,001	***	0,001	***	0,001	**	0,001	**	0,001	**
POLITICAL_SYSTEM	0,000		0,001	**	0,001		0,000		0,001		0,001	
UAI	0,000		0,000		0,000		0,000		0,000		0,000	
LEGAL_SYSTEM	− 0,000		− 0,000		− 0,000		− 0,000		0,000		− 0,000	
ACADEMIC AND EDUCATIONAL SERVICES	0,001	**	0,001		0,002	**	0,002	*	0,002	**	0,001	
BASICS_MATERIALS	0,001	**	0,000		0,001	*	0,001		0,001		0,000	
CONSUMER CYCLICAL	0,000		0,000		0,000		0,001		0,001		0,000	
CONSUMER NON_CYCLICALS	0,000		0,000		0,000		0,000		0,001		0,000	
ENERGY	− 0,000		− 0,001		− 0,000		− 0,001		− 0,000		0,000	
GOVERNMENT_ACTIVITY	0,000		− 0,001		0,000		0,000		0,000		0,000	
HEALTHCARE	0,000		− 0,001		0,000		0,000		0,000		0,001	
INDUSTRIALS	0,000		0,000		0,000		0,000		0,000		0,000	
TECHNOLOGY	0,000	***	0,002	***	0,002	***	0,002	***	0,002	***	0,002	***
Oceania	0,000	**	− 0,001	***	− 0,001	**	− 0,001		− 0,001		− 0,001	*
Americas	− 0,001	***	− 0,002	***	− 0,001	***	− 0,001	**	− 0,002	**	− 0,001	
Asia	0,000		0,001		0,000		− 0,000		0,000		− 0,000	
Europe	− 0,001	***	− 0,001	***	− 0,001	***	− 0,001	*	− 0,001	***	− 0,001	***
Y2018	− 0,001	***	− 0,000	**	− 0,001	***	− 0,001		− 0,000	***	− 0,000	**

Table 8 (continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
Y2019	− 0,001		− 0,000	*	− 0,001	**	− 0,001		− 0,000	*	− 0,000	
Y2021	0,001		0,000		0,000		0,000		0,000		− 0,000	
Y2022	− 0,001		− 0,001	**	− 0,001		− 0,001		− 0,000		− 0,000	
_cons	− 0,001	**	− 0,005	*	− 0,007	***	− 0,004	*	− 0,005		− 0,006	*
CEO_Duality							0,007	**	0,00412		0,002	**
CEO_Duality x B_GENDER_DIVERSITY							− 0,024	*				
CEO_Duality x B_INDEPENDENT									− 0,0051			
CEO_Duality x CSR_COMM											− 0,002	*
Wald χ2 test	10.213,01	***	9.499,34	***	10.462,6	***	8.759,85	***	9.878,52	***	5.708,89	***
Arellano-Bond test AR (1) (z, p > |z|)	0,000	***	0,000	***	0,000	***	0,000	***	0,000	***	0,000	***
Arellano-Bond test AR (2) (z, p > |z|	0,161		0,185		0,157		0,239		0,186		0,766	
Hansen Test (chi-square, p >|χ 2|)	0,101		0,193		0,108		0,163		0,129		0,150	

*p<.1; **p<.05; ***p<.01

of digitalization that may enable a dual CEO and chair to control other matters of disclosure, but will probably not prevent some measure of reporting, and thus will not neutralize the expected suppression. Hence, the independent directors will remain accountable, irrespective of the CEO's dual role, for digitalization disclosures. Additionally, the lack of a moderating effect of CEO duality on the relationship between board independence and digitalization disclosure may be because disclosing digitalization is increasingly viewed as a strategic move to showcase innovation and competitiveness, helping both management and the board. In this light, even if the CEO wears two hats, there's little motivation for independent directors to hold back from pushing for more transparency. After all, better disclosure of digital initiatives can boost the company's reputation, attract investors, and foster long-term value creation. Consequently, the interests of a dual CEO-chair and independent directors may align around the advantages of digitalization disclosure, reducing any potential negative impact of CEO duality on the board's ability to monitor effectively.

Model 6 shows the interaction between CEO duality and the presence of a CSR committee on digitalization disclosure. To do this, we constructed the interaction CEO_DUALITY × CSR_COMM. This relationship is negative, as expected, and statistically significant. Thus, the hypothesis that CEO duality between a CSR committee and digitalization disclosure has a negative impact cannot be rejected. This finding suggests that the relationship between the CSR committee and digitalization disclosure is negatively affected by CEO duality. This finding can be explained by considering that combining the roles of CEO and chair reduces the board's effective power over the sustainability and independence of committees, thereby weakening their ability to promote transparent practices and voluntary disclosure policies.

The results from Models 4, 5, and 6 indicate that Hypothesis 4 in this research can only be partially accepted, as the interaction between CEO_Duality and board independence is not statistically significant. In the relationship between gender board diversity and the presence of the CSR Committee, the moderating effect of CEO duality appears to have a negative impact on digitalization disclosure levels.

Regarding the control variables, it is noteworthy that the technology sector is the only statistically significant variable in all six models. Since environmental pressures and risks associated with digitalization affect them more than others, these companies have stronger incentives to voluntarily disclose information about DT processes (Borrero-Domínguez et al. 2024). The number-of-meetings variable is statistically significant only in Model 6. The control variable, firm size, is significant only in Model 2. The GDP_PC variable is consistently positive across all models, indicating that stronger economic environments support more structured digital disclosure practices, likely due to external pressures, more stringent standards, and greater demand for information. The POLITICAL_SYSTEM variable is significant only in Model 2. The academic and educational services sector is significant in Models 1, 3, 4, and 5. The basic materials sector is significant in Models 1 and 3. Among the countries, only the variable Europe is statistically significant in all models. While the variable 'America' is significant in Models 1, 2, 3, 4, and 5, and 'Oceania' in Models 1, 2, 3, and 5. The remaining variables are not statistically significant.

6 Conclusion

The aim of this study is to analyse the impact of CG mechanisms (board gender diversity, board independence, and CSR committee) on the disclosure of digitalization-related information, thereby making an innovative contribution to the academic debate on the factors that may affect companies' non-financial disclosure practices. In this way, it offers further insight into how CG mechanisms can enhance companies' transparency and accountability to their stakeholders. Using a sample of 323 international companies from around 38 countries, data were collected on the characteristics of CG structure (presence of women on the board, board independence, and CSR committee presence) over 6 years (2017–2022), providing empirical evidence on how these characteristics did or did not play a role in companies' voluntary disclosure. Based on stakeholder-agency theory, this research theoretically contributes to the debate in the literature on governance and non-financial disclosure. Our research also analysed the moderating role of CEO duality in the relationship between the three CG mechanisms and digitalization disclosure.

Our findings suggest that board gender diversity is positively associated with digitalization disclosure, confirming our hypothesis that gender-diversified boards lead to greater transparency. This means that having more women on boards leads to a wider range of perspectives and a greater emphasis on voluntary disclosure practices. Additionally, evidence shows that board independence has a positive and significant effect on digitalization disclosure, supporting the thesis that independent directors enhance transparency by bringing impartiality and supervisory capabilities to bear. Moreover, our evidence shows that the presence of a CSR Committee significantly improves disclosure of digitalization, underscoring its critical role in ensuring corporate transparency by meeting stakeholder expectations. To enhance transparency in digitalization, businesses should improve board gender diversity, ensure board independence, and establish effective CSR Committees.

However, the results demonstrate an ambiguous impact of CEO duality on those connections. Notably, CEO duality significantly moderates the relationships between the percentage of women, the presence of the CSR Committee on the board, and the disclosure of digitalization, consistent with the expected negative effect. This could mean, on the one hand, that the CEO's duality may limit the effectiveness of gender diversity in promoting greater transparency in digitalization, possibly due to a centralisation of decision-making power that reduces the value of the different perspectives offered by a more diverse board. On the other hand, this result may indicate that the centralisation of power, represented by CEO duality, limits the promotion of sustainability and digital disclosure when a CSR committee is present. It may reflect the CEO's personal commitment to these goals. Alternatively, CEO duality does not significantly moderate the relationship between independent directors on boards and the level of disclosure on digitalization. This result could indicate that CEO duality does not affect independent directors' ability to improve disclosure on digitalization; perhaps other variables or dynamics within the board may be more relevant in this context. In general, this research shows that specific CG structures are essential for promoting the disclosure of digitalization while also indicating the consequences of the moderating role of CEO duality.

The practical and theoretical implications of the present study are wide-ranging, and the results may be of particular interest to academics, companies, and policymakers. First, the study offers a fresh, innovative approach by integrating CG mechanisms with digitalization, addressing a notable gap in existing research. Typically, studies look at these areas separately or focus solely on how digitalization affects CG. By exploring the interaction between these two fields, we gain a more complete understanding of their mutual influence. This research significantly advances our theoretical knowledge of the complex relationship between CG and digitalization. Moreover, this study could be replicated in the future by considering all other categories of companies adopting IR, as listed in the official IIRC database, to compare the various models used to disclose information on digitalization. Second, the present research provides practical insights by showcasing best practices and effective actions. These insights help companies, especially those outside the financial sector, to be informed on how to improve their governance and digitalization plans. Better governance, along with the right application of digital technologies, will enable company leaders to improve transparency, accountability, and effectiveness. The findings can guide companies in improving their governance systems. By adopting more detailed and regular voluntary disclosure practices, they can improve transparency and stakeholder confidence, particularly regarding digitalization and sustainability initiatives. In doing so, they will not only meet the needs of current investors but also those of future investors. Third, policymakers and regulators could consider this evidence as an incentive to further promote policies and reforms to improve gender equality since women's participation on boards promotes transparency, accountability, and balance at all levels of corporate decision-making. They could also pay more attention to independent directors, who are likely to be impartial and critically minded, reducing the risk of conflicts of interest and increasing investor confidence. In addition, they need to consider that CSR committees can facilitate the integration of sustainable practices into corporate strategy by improving the company's environmental and social performance and reporting. Governance policies can also lead to a separation of the roles of the CEO and the chairperson of the board, thereby promoting a decentralisation of power and improving the balance of decision-making when CEO duality interacts with board gender diversity and the presence of a CSR committee. On the contrary, the result that CEO duality does not affect the relationship between board independence and digitalization disclosure carries several important implications. From a practical standpoint, it suggests that independent directors maintain their essential monitoring and advisory functions, regardless of the degree of leadership centralization. This reinforces the idea that board independence is a key driver of transparency. Politically, it suggests that regulatory efforts should prioritize strengthening the role and influence of independent directors rather than focusing on limiting CEO duality. Theoretically, this finding challenges the agency theory assumption that CEO duality weakens board oversight, suggesting instead that independent directors have the legitimacy and expertise to foster disclosure. Finally, while the manuscript highlights some practical implications, it could really benefit from offering more specific recommendations for companies. Companies could improve gender diversity on their boards by adopting inclusive recruitment strategies and developing leadership programs tailored for women. It is also crucial that independent directors are given

clear responsibilities for overseeing digital matters and receive training on current technological trends. Additionally, CSR committees could incorporate digitalization into their objectives to better align technology with sustainability goals. In cases where the CEO also holds the chair position, companies may consider implementing safeguards, such as appointing a lead independent director or enhancing board committees, to ensure a balance of power and maintain transparency in digitalization disclosures. Therefore, a governance structure comprising more independent directors, greater gender diversity, and a CSR committee can act as a real strategic lever. It facilitates voluntary disclosure, such as that relating to digitalization, making it more transparent, comparable, and useful to the market. This is particularly important given that companies are aiming to align with new global standards (IFRS S1/S2) and regional frameworks (CSRD/ESRS), which are changing disclosure and reporting rules and introducing "digital" requirements (cybersecurity and/or taxonomies). When governance manages these elements effectively, digital disclosure becomes an informational and reputational asset, with expected impacts on performance and the confidence of investors and stakeholders.

Furthermore, we would like to acknowledge that our research was purely exploratory and may have some limitations. Firstly, the sample size could be further expanded, rather than being restricted to IR adopters. Therefore, future studies could explore other categories of companies. Secondly, the choice of keywords included in the dictionary can be a limitation; it could be expanded in order to capture as much information as possible. Thirdly, another limitation could be the choice of only three CG mechanisms. It would be useful in future research to investigate whether the presence of other committees, such as the audit or remuneration committee, also plays a role in this context. Lastly, additional variables could be included to consider further aspects.

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Author contributions *Conceptualization*: María Consuelo Pucheta-Martínez, Silvia Solimene, Manuela Lucchese, Ferdinando Di Carlo; *Methodology*: María Consuelo Pucheta-Martínez, Silvia Solimene, Manuela Lucchese; *Formal analysis and investigation*: María Consuelo Pucheta-Martínez, Silvia Solimene, Manuela Lucchese, Ferdinando Di Carlo; *Writing - original draft preparation*: María Consuelo Pucheta-Martínez, Silvia Solimene; *Writing - review and editing*: María Consuelo Pucheta-Martínez, Manuela Lucchese, Ferdinando Di Carlo.

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Authors and Affiliations

María Consuelo Pucheta-Martínez[1] · Silvia Solimene[2] · Manuela Lucchese[3] · Ferdinando Di Carlo[4]

✉ María Consuelo Pucheta-Martínez
pucheta@uji.es

Silvia Solimene
ssolimene@unisa.it

Manuela Lucchese
manuela.lucchese@unicampania.it

Ferdinando Di Carlo
ferdinando.dicarlo@unibas.it

[1] Department of Finance and Accounting, Universidad Jaume I, Castellon, Spain

[2] Department of Management & Innovation Systems, University of Salerno, Salerno, Italy

[3] Department of Economics, University of Campania "Luigi Vanvitelli", Capua, CE, Italy

[4] Department for Humanistic, Scientific and Social Innovation, University of Basilicata, Potenza, Italy