

Article

The Effect of Female Representation on Boards on Environmental, Social, and Governance Disclosure: Empirical Evidence from Saudi Highly Polluting Industries

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Abstract: This study examines the effect of female representation in boardrooms on Environmental, Social, and Governance (ESG) disclosure in listed firms in Saudi Arabia. The study examined 200 highly polluting firms from 2019 to 2023 and constructed a robust ESG disclosure index with 62 items benchmarked against international and Saudi ESG disclosure-related guidelines, as well as well-grounded literature. The findings show that female representation on firm boards is positively and significantly associated with ESG disclosure, suggesting that Saudi-listed firms that ensure and promote female representation on their boards are more likely to provide more comprehensive ESG disclosures than others. The results highlight the role of board diversity in governance reforms and its alignment with Saudi Vision 2030's gender inclusion goals. This study contributes to the corporate governance (CG) and sustainability literature by emphasizing how board gender diversity strengthens ESG reporting, regulatory compliance, and corporate resilience. The introduced findings are relevant for policymakers, investors, and corporate leaders seeking to foster sustainable business practices and improve ESG performance in emerging markets.

Keywords: female representation; environmental, social, and governance (ESG) disclosure; Saudi Vision 2030; corporate sustainability; highly polluting industries



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1. Introduction

Traditionally, corporate disclosures have focused on a firm's economic and financial performance [1]. Recent years have seen a significant expansion in corporate environmental and social disclosures [2]. Consequently, non-financial reporting and other related activities have emerged as the focus of corporate performance worldwide [3]. This trend is a result of the increased pressure from institutions and global communities to declare information on social and environmental effects [2,4]. Over the last two decades, listed corporations have been under pressure to adopt sustainable business models [5]. In line with corporate social responsibility (CSR), business organizations have emphasized their obligations to stakeholders, society, and the environment [6]. Nevertheless, because of the pressing rise in substantial global concerns such as climate change and socioeconomic inequities, CSR has

been promoted as a shift from discretionary activities to an urgent and cohesive reaction to three factors: Environmental, Social, and Governance (ESG) [2].

Hence, ESG has emerged as an important and sensitive factor for firm managers, policymakers, investors, regulators, and researchers [7]. Overall, ESG refers to how investors and firms integrate ESG into their investment and operational strategies, respectively [8]. It involves three elements: the environmental aspect, which addresses climate change prevention, emissions, and environmental responsibility; the social dimension, which pertains to an organization's treatment of its staff, society, and clients, emphasizing responsibility for its products and services, diversity, anti-corruption, and rights for people throughout the supply chain; and the governance aspect, which involves shareholders and other interested parties and adheres to the most effective procedures for corporate governance (CG) [9].

However, ESG disclosure refers to the disclosure of firms' environmental, social, and governance performance, as defined by Atz et al. (2024) [10], and is mostly associated with a lower cost of equity capital [11]. Interestingly, the enhancement of ESG attention in recent years has resulted in an increase in disclosure of information on firms' ESG measures [7]. Companies are always under pressure to release ESG information because of growing calls from stakeholders, such as owners of assets and funds [12]. Additionally, firms with ESG disclosures can obtain substantially more equity capital than firms without ESG information [13]. This financial advantage is evidence of increasing global awareness of ESG practices as a sign of organizational robustness and sustainability [2].

Notwithstanding significant advancements and the growing number of companies disclosing ESG-related information, the overall extent of ESG disclosure remains comparatively low [14]. This shortfall is attributed to corporations' failure to meet the rising need for comprehensive ESG information [15]. While more businesses engage in ESG disclosure, the quality, scope, and depth of the information provided often fail to adequately address investors' expectations [16]. Additionally, the comparability of ESG data remains extremely inadequate [11]. Moreover, several flaws in corporate sustainability mechanisms exacerbate these problems. A lack of standardization in ESG reporting frameworks hinders the comparability of disclosures across organizations, creating inconsistencies that obscure the true nature of corporate ESG performance [17]. Additionally, some managers exploit ESG disclosure mechanisms to conceal actual practices, often engaging in deliberate manipulation aimed at misleading stakeholders [18]. This lack of transparency undermines the credibility of ESG disclosures and raises concerns about the authenticity of reported achievements [17]. Another critical obstacle is the limited availability and inconsistency of ESG data, which hinders the ability to conduct meaningful analyses and make informed decisions [19]. The absence of standardized and verifiable ESG reporting frameworks often results in fragmented disclosures, making it difficult for stakeholders to assess corporate sustainability performance effectively [2]. Studies have highlighted that firms selectively disclose ESG information, leading to gaps in data reliability and comparability [13,15]. Without standardized guidelines and independent verification mechanisms, stakeholders face challenges in interpreting ESG reports, further complicating their ability to derive actionable insights [18]. Therefore, such evidence underscores the paramount need to acquire more understanding and knowledge of the factors explaining low ESG disclosures as well as the factors explaining why firms fail to offer higher-quality ESG disclosures.

Driven by these features, academics have extensively questioned the underlying causes of firms' low levels of ESG disclosure [1,9]. These studies have identified a variety of contributing factors that can be broadly classified into internal determinants, such as organizational governance [2] and managerial priorities [20], and external determinants, including regulatory environments [21] and stakeholder pressures [13]. However, among the identified factors, female representation in the boardroom remains a point

of contention [22]. Numerous studies have highlighted the positive influence of gender diversity on ESG disclosure, with female directors often linked to increased transparency and sustainability focus [23,24], whereas others argue that the effect is conditional and context-dependent [14]. Critics suggest that merely increasing the number of women on boards does not automatically lead to significant improvements in ESG practices, as the impact may vary based on organizational culture, the overall governance framework, and the extent of women's active involvement in strategic decision-making [25].

Gender diversity seems to be a commonly discussed topic on boards of directors, particularly in environmental and social matters [14,22]. Gender diversity on the board of directors affords sufficient representation of female and male executives [26]. There is global apprehension regarding the predominance of males on corporate boards, and this imbalance poses an issue in both the commercial and governmental industries [23]. Female representation on boards has gained the attention of many scholars owing to its substantial effect on corporate sustainability and environmental reports [27]. European countries and the US recognize female board representation as a positive governance indicator [28]. This ongoing debate and international trend underscore the complexity of understanding the interplay between boardroom diversity and ESG disclosure. This emphasizes the need for additional nuanced investigations to explore the association between female participation in boards and ESG disclosure practices.

In this respect, Saudi Arabia could offer an interesting setting for investigating the link between boardroom diversity and ESG disclosure. The CG landscape in the country has been changing over the last few years because of Vision 2030, which focuses on sustainability and gender mainstreaming [29]. These reforms have led to an increase in women on corporate boards, with the view of increasing diversity and inclusiveness [30]. However, the impact of these changes on enhancing ESG disclosures has not been clearly determined. Of course, Saudi Arabia's sociocultural and regulatory context may moderate women's board membership on ESG [31]. For example, cultural beliefs about gender may inhibit women from engaging in board activities that may affect sustainable development decisions [32]. On the other hand, regulatory changes that encourage companies to appoint female directors may lead female directors to have the power to share new ideas and address ESG concerns [33]. In this regard, examining the modality of Saudi Arabia's female board members in Saudi firms listed on stock markets offers a chance to share insights on the subject of global interest: gender diversity and ESG reporting. It also enables an analysis of the relationship between governance reforms and sustainability practices as well as the main findings that have emerged on the importance of culture and regulation when examining corporate results.

The current study analyzes 1000 observations from 200 firms listed in various sectors, such as energy, equipment and service, building materials, infrastructure, chemicals, oil and gas producers, construction, and other energy resources, as per the Saudi Stock Exchange classification. The evidence shows a positive and significant relationship between the proportion of female board members and the extent of Saudi firms' ESG disclosures. Specifically, the findings imply that a greater representation of women on the boards of firms is positively related to the extent of firms' ESG-related information. This suggests that board gender diversity may enhance corporate sustainability reporting by increasing accountability in corporate sustainability. As a result, this study adds substantial value to scholarly literature. First, it addresses the growing call from scholars and researchers to focus on the influence of female directors on nonfinancial reporting, particularly in the context of ESG disclosure [2,23]. Consequently, this study directly addresses the academic imperative of developing a greater understanding of the impact of female directors on non-financial disclosure, including ESG reporting. Thus, this study contributes to the

understanding of how gender diversity can enhance CG processes and, in particular, increase transparency, accountability, and responsibility in ESG issues.

Second, the relationship between the attributes of the board of directors, such as board independence, size, and CEO duality, and non-financial-related disclosure, such as CSR and ESG disclosures, has been widely researched [18,34]. However, the influence of female representation on non-financial disclosures, in general, and ESG disclosure, in particular, has not received sufficient attention from researchers [23]. Undoubtedly, female representation is one of the most important qualities of the board of directors that assists firms in reducing agency conflicts and promoting information disclosure [14]. According to Al-Shaer et al. (2024) [35], female representation in the boardroom is one of the most important aspects of board effectiveness and is linked to increased CG effectiveness. Thus, this study contributes to corporate governance literature by evaluating the direct influence of board gender diversity on ESG disclosures within Saudi enterprises, thereby addressing the information gap regarding the effect of gender diversity on non-financial disclosures, specifically ESG disclosures.

Third, considering the rising global concerns about social and environmental issues, such as carbon emissions and climate change, there is a paucity of empirical information about ESG disclosure in emerging nations, such as Saudi Arabia [36,37]. Most ESG studies are conducted in advanced countries. Examples include the United Kingdom [35], the United States [38], and Canada [39]. ESG is a subset of corporate disclosures, such as the link between sustainability accounting and reporting [10]. Although social and environmental disclosures have gained significant attention from firms and researchers owing to growing awareness of social and ecological problems [4,7], only a few studies have been conducted in developing countries [13,15,21]. The applicability of findings from developed to emerging states may be limited because of differences in policy and regulation as well as political, social, and economic factors [18]. Hence, this study, which was conducted in Saudi Arabia, a developing nation, makes a distinctive scholarly contribution to the fields of CG and ESG disclosure. This study offers novel perspectives and empirical evidence from emerging markets that can be generalized to other similar markets that share comparable social, economic, and environmental factors with Saudi Arabia.

Finally, many prior studies have relied on checklists or scoring frameworks developed by agencies to measure and quantify ESG disclosures [40,41]. Organizations such as Refinitiv and Bloomberg provide ESG disclosure assessments [42,43]; however, their methodologies differ in their evaluation of the extent and quality of disclosed information [44]. These variations in disclosure criteria create inconsistencies, making it challenging to ensure the comparability and standardization of ESG disclosure across firms and industries. Furthermore, since most of these agencies use information available to the public, their ratings may not capture the totality of a firm's sustainable management practices or the qualitative characteristics of its operations [45]. Therefore, academics have begun to demand a set of criteria that would be more reliable and standardized for measuring ESG disclosure to provide a more consistent assessment of corporations' ESG reporting [46]. Unlike prior studies that have relied heavily on rating agencies for ESG evaluation, this study aims to address the concerns surrounding ESG measurement by developing a new ESG disclosure index. This index was derived from the literature and includes Saudi and global frameworks and standards concerning ESG reporting [18]. The ESG disclosure index indicates the extent of ESG disclosure presented by Saudi Arabian organizations. This study significantly contributes by offering further evidence on the efficiency, validity, and credibility of various measurement channels (self-constructed index) for quantifying ESG-related information, thereby addressing the gap in the existing research on ESG evaluation.

The subsequent sections of this paper are structured as follows. Section 2 examines the institutional context of the research. Section 3 provides a review of the literature, and Sections 4 and 5 address the theoretical framework and hypothesis development, respectively. Sections 6 and 7 outline the study's data, variables, and research methodology. Finally, Section 7 presents the empirical findings and conclusions, and Section 8 concludes the study.

2. Institutional Background

The economy of Saudi Arabia is one of the largest and most important in the Middle East and is supported by its large reserves of oil and gas. The Kingdom has been a key stakeholder in energy markets and has been part of the Organization of Petroleum Exporting Countries (OPEC) since its inception [47]. Oil has been a major contributor to GDP, government revenue, and exports of the country in the past [48]. Nevertheless, the instability of international oil prices and rising international concern for the use of renewable energy sources and sustainability have challenged Saudi Arabia to use economic diversification as a fundamental policy objective [36]. The headship of this economic change was Vision 2030, a development blueprint that began in 2016 [37]. Vision 2030 seeks to diversify the Kingdom's economy by encouraging investment in areas unrelated to oil, including tourism, finance, renewable resources, and production [29]. Notably, Saudi Arabia's sociocultural landscape has traditionally emphasized hierarchical corporate structures, limited gender diversity, and a shareholder-centric governance model. This structure has historically led to minimal ESG reporting, with firms prioritizing financial and nonfinancial disclosures. However, under Vision 2030, there has been a shift towards inclusivity, sustainability, and transparency [47]. These changes have introduced new challenges and opportunities for ESG disclosure, particularly regarding gender diversity, stakeholder engagement, and CSR initiatives [30].

Saudi Arabia has undertaken significant regulatory reforms to institutionalize ESG disclosures and align corporate practices with global sustainability standards. One of the key regulatory milestones is the Saudi Stock Exchange (Tadawul) ESG Disclosure Guidelines, which provide a structured framework for firms to report their ESG performance. These guidelines require listed companies to disclose ESG-related data to ensure consistency, comparability, and transparency in corporate reporting [49]. Additionally, the Saudi Capital Market Authority (CMA) Corporate Governance Regulations mandate the disclosure of sustainability-related risks, governance structures, and board diversity policies. CMA aims to enhance investor confidence by ensuring that firms provide comprehensive ESG disclosures that reflect their sustainability strategies [50]. Another key regulatory body influencing ESG disclosures is the Saudi Central Bank (SAMA), which has issued ESG Risk Management Guidelines. These guidelines outline reporting expectations for financial institutions, emphasizing climate risk assessment, corporate governance mechanisms, and ethical investment policies [51]. In summary, Saudi Arabia's evolving regulatory and sociocultural landscape has significantly influenced its ESG disclosure practices. While Vision 2030 remains a guiding framework for economic diversification and sustainability, specific regulatory policies, such as the CMA Corporate Governance Regulations, Tadawul ESG Guidelines, and SAMA ESG Risk Management Guidelines, play a more direct role in shaping corporate ESG disclosures. The increasing influence of institutional ownership, along with regulatory reforms promoting gender diversity and sustainability, underscores the shifting dynamics of corporate governance in Saudi Arabia.

3. Literature Review

3.1. Female Representation

The quest for equitable representation of women and men in the corporate sector has emerged as a global concern in recent years, partly due to the UN's exhortation to its member states to achieve Sustainable Development Goal No. 5: gender equality [27]. This is evidenced by heightened activism and enactment of legislation regarding board diversity in various developed and emerging nations [52]. Broadly, board gender diversity is commonly defined as the representation of people of different genders on a firm's board of directors [24]. Based on previous studies, this diversity is usually measured as the ratio of the number of female directors to the total number of boards [23]. Indeed, academic literature shows that increasing attention has been paid to the issue of female representation on company boards owing to its considerable influence on the performance and value of a company, which is important for numerous groups of stakeholders, such as policymakers and practitioners [14,25]. In this context, research indicates that female executives pose more inquiries than their male counterparts and exhibit more rigor and engagement in oversight [26,27]. Additionally, a higher number of female directors on the board may raise awareness of the board about initiatives and bring in viewpoints that may help overcome the barriers [30]. As revealed by Alahdal et al. (2024) [33], a diversified board is associated with increased focus on ethical considerations and a broader tendency to address the concerns of various stakeholders and society. For example, Topal (2019) [53] highlighted the strong link between women's empowerment and economic growth, suggesting that greater inclusivity in leadership can contribute to enhanced corporate accountability and long-term sustainability. However, research also indicates that male board members play a crucial role in governance effectiveness, with factors such as board independence, expertise, and regulatory compliance collectively shaping corporate decision-making and ethical oversight.

Studies in developed economies demonstrate a strong correlation between gender-diverse boards and ESG disclosures, especially in well-governed firms [44]. Liao et al. (2015) [54] found that UK firms with gender-diverse boards had enhanced environmental disclosure, whereas Ben-Amar et al. (2017) [55] reported that Canadian firms with more female directors were more transparent in climate reporting. Similarly, European firms with diverse boards are more likely to adopt integrated reporting, thus improving ESG performance [40]. In contrast, evidence from emerging markets is mixed, with some studies finding weak or insignificant links between gender-diverse boards and ESG disclosure. Institutional voids, weak regulations, and cultural constraints limit the influence of female directors on sustainability [33]. In South Asia, gender diversity has a weaker impact on ESG reporting due to patriarchal cultures and low board independence. Similarly, in Latin America and the MENA region, female directors face structural barriers and conservative norms, reducing their effectiveness in enhancing ESG disclosure [28,56].

In the Saudi context, female representation on corporate boards is an emerging and evolving topic that reflects broader societal and economic reforms [31]. Saudi Vision 2030 has catalyzed significant progress by emphasizing gender equality, empowering women, and diversifying the national economy [22]. These initiatives have brought female representation in governance into sharper focus [47]. A study by Parveen (2021) [57] indicated that the female unemployment rate has decreased to around 6% since 2019 compared to roughly 60% before that period. This research has significant societal implications because Saudi women have acquired many employment options in recent years, contributing to the social and economic advancement of Saudi Arabia. Also, Klettner et al. (2016) [58] stated that the proportion of women in leadership positions, including board roles, has been gradually increasing due to changes in regulations and social perceptions. For instance,

the Saudi Stock Exchange (Tadawul) now emphasizes CG codes that promote diversity, including gender diversity, to enhance board effectiveness and accountability [59]. Further, the 2024 Gulf Cooperation Council (GCC) Board Gender Index Report indicates notable progress in increasing the number of women serving on boards of listed companies in GCC countries [60]. This reflects a growing recognition of the importance of gender diversity in CG. Nonetheless, it is crucial to acknowledge that as of now, women's involvement remains significantly insufficient to achieve parity with their male counterparts in the boardroom, particularly in nations where male dominance in the workplace is pronounced [61]. According to an OECD report (2019) [62], the average representation of women on boards in the MENA region was 4.8%. While Saudi Arabia historically had low female board representation, reaching 7% by 2019, some MENA countries, such as Libya and Yemen, had even lower representation, placing Saudi Arabia above the regional average. However, Saudi Arabia continues to lag behind several other MENA countries in terms of gender diversity on corporate boards.

3.2. Environmental, Social, and Governance Disclosures

ESG disclosures have emerged as critical tools for enhancing corporate transparency, accountability, and sustainability [2]. These disclosures enable organizations to convey their performance and objectives regarding the preservation of the environment, social accountability, and accountability to stakeholders, including regulators, shareholders, and the public [7,8]. Recent studies underscore the significance of ESG disclosures in fostering trust and confidence among stakeholders, particularly in the face of rising global sustainability challenges [10,12]. Effective ESG reporting not only enables firms to identify and mitigate risks associated with climate change, labor practices, and governance issues but also facilitates the alignment of business operations with global sustainability standards such as the SDGs [20,21]. Moreover, ESG disclosures mitigate information asymmetry, thereby enhancing investor trust and reducing the observed risks linked to a corporation's activities [13]. As global markets increasingly value sustainability, companies with robust ESG practices achieve superior financial outcomes and stronger competitive positions in the long term [14].

The literature identifies multiple drivers of ESG disclosures, including regulatory mandates, stakeholder pressure, and market competition. Regulatory initiatives, such as the Global Reporting Initiative (GRI) standards and the European Union's Non-Financial Reporting Directive (NFRD), play a pivotal role in institutionalizing ESG disclosures [63,64]. Clément et al. (2023) [46] highlighted that corporations in jurisdictions with rigorous ESG protocols are more likely to disclose detailed and reliable ESG information. Stakeholder pressure also drives ESG disclosures, particularly those of institutional investors and activist groups [12]. According to Alessa et al. (2024) [13], institutional investors increasingly demand ESG transparency as part of their investment decision-making process. Moreover, competitive pressure encourages firms to adopt ESG disclosures to differentiate themselves in the marketplace [65]. Singh et al. (2024) [66] found that firms with robust ESG disclosures tend to outperform their peers in terms of market reputation and customer loyalty.

Despite their increasing prominence, ESG disclosures face several challenges, which hinder their effectiveness and widespread adoption. A key issue is the lack of standardized reporting frameworks, which results in inconsistencies in the quality and comparability of the ESG data [2]. For instance, Adam et al. (2024) [44] emphasized the need for harmonized standards to ensure that ESG disclosures are reliable, comparable, and actionable for stakeholders. This lack of standardization creates confusion among investors and other stakeholders, limiting their ability to effectively assess and compare firms' ESG performance effectively [14]. Additionally, firms often struggle with the costs associated with data

collection, processing, and reporting, particularly in developing countries where financial and technical resources are limited [67]. These costs may serve as a considerable obstacle, particularly for small- and medium-sized businesses (SMEs), which may lack the resources to invest in comprehensive ESG reporting systems [68]. The risk of greenwashing is a significant concern when companies intentionally exaggerate or misrepresent their ESG performance to secure public endorsements or attract investments [69]. As highlighted by Liu et al. (2024) [70], the absence of rigorous verification mechanisms and third-party audits exacerbates this issue by undermining stakeholder trust and diminishing the credibility of ESG disclosure. Therefore, these challenges underscore the urgent need for enhanced regulatory oversight, the development of universally accepted ESG reporting standards, and capacity-building initiatives to support firms, particularly in emerging markets, to strengthen their ESG reporting practices [33].

Generally, the adoption and effectiveness of ESG disclosures differ between developed and developing countries. In developed economies, stringent regulations and sophisticated investor demands have resulted in advanced ESG disclosure practices [10]. For instance, the European Union's Sustainable Finance Disclosure Regulation (SFDR) has set a benchmark for ESG reporting [71]. Furthermore, the United Kingdom's Companies Act 2006 and the EU Non-Financial Reporting Directive (NFRD) require firms to disclose ESG-related information, ensuring transparency and accountability [35]. Similarly, in the United States, the Securities and Exchange Commission (SEC) has introduced climate-related disclosure rules to enhance ESG transparency [10]. These regulatory frameworks, combined with institutional investor pressure, have led to the widespread integration of ESG reporting standards such as the Global Reporting Initiative (GRI) and the Task Force on Climate-related Financial Disclosures [18].

In contrast, developing countries face challenges such as limited regulatory frameworks and resource constraints, which hinder the adoption of comprehensive ESG disclosures [72]. Nonetheless, emerging economies are making significant strides in ESG reporting, recognizing their role in driving sustainable development and attracting global investment [33]. In this regard, the Gulf Cooperation Council (GCC) region has increasingly emphasized ESG disclosure, driven by regulatory initiatives and rising investor expectations [33]. The United Arab Emirates (UAE) has made significant strides in ESG reporting through mandates from the Dubai Financial Market (DFM) and Abu Dhabi Securities Exchange (ADX). Research by Alkhawaja et al. (2023) [14] and Alessa et al. (2024) [13] indicates that UAE-listed firms generally achieve higher ESG disclosure rates than their GCC counterparts, benefiting from stronger institutional support and investor engagement. Other GCC countries, including Qatar, Kuwait, Bahrain, and Oman, have also taken steps to enhance ESG disclosure but continue to face challenges related to regulatory enforcement and corporate compliance [29]. The Qatar Stock Exchange (QSE) has introduced voluntary ESG reporting guidelines, leading to gradual improvements in transparency. Plastun et al. (2019) [21] found that while Qatar has a relatively structured ESG reporting framework, ESG disclosures in Kuwait and Bahrain remain largely voluntary, resulting in inconsistent reporting practices. In Oman, sustainability reporting frameworks exist, but Alahdal et al. (2024) [33] suggested that ESG disclosure levels vary widely among firms, with many still falling short of international best practices.

As one of the leading GCC countries in corporate governance reforms, Saudi Arabia has introduced initiatives such as the Tadawul ESG Guidelines and Vision 2030, which provide a benchmark for the performance of companies with strong ESG practices and encourage firms to align their operations with sustainability principles [36]. These efforts are closely linked to the country's ambitious Vision 2030, which emphasizes economic diversification, environmental stewardship, and social development [47]. A recent study

by Umar et al. (2024) [37] revealed that Saudi-listed firms increasingly integrate ESG disclosures into their corporate strategies in response to growing stakeholder expectations and regulatory reforms. This shift is further supported by the development of frameworks and guidelines tailored to local contexts, enabling firms to address challenges, such as climate change, resource efficiency, and social inequality [36].

4. Theoretical Framework

4.1. Stakeholder Theory

Various theories have been used to explain and rationalize why firms report on environmental and social issues, such as the stakeholder theory, which outlines a firm's attitude towards social and environmental issues due to divergent stakeholder interests [73]. This theory also assumes that firms reveal non-financial information to reduce pressure from different groups of stakeholders [74]. Amidst rising ESG concerns, including climate change and the impact of greenhouse gases (GHGs), pressure from external stakeholders has increased [18]. Stakeholders increasingly demand greater transparency and accountability in corporate operations, urging organizations to provide detailed ESG disclosures [23]. Pressure is particularly evident among institutional investors and regulatory bodies, who emphasize the role of ESG practices in reducing risks and aligning global sustainability goals [4]. Numerous studies have explored the impact of stakeholder pressure on ESG disclosures. For instance, Alessa et al. (2024) [13] argued that firms operating in industries with high environmental impacts, such as energy and manufacturing, face significant scrutiny from environmental activists and regulators, prompting more comprehensive ESG reporting. Similarly, Liu et al. (2020) [12] found that stakeholder engagement directly influences the quality and extent of ESG disclosures, as firms seek to align their reporting practices with stakeholder expectations to maintain trust and credibility.

Furthermore, stakeholder theory emphasizes that the inclusion of stakeholder representatives on a firm's board of directors is essential to ensure that the board fulfills its responsibility to protect the interests of all stakeholders [75]. Such representation enhances the board's ability to make informed and balanced decisions that align with stakeholders' diverse expectations of stakeholders [23]. Moreover, women's participation on the board plays a pivotal role in broadening its perspective, as it fosters a more inclusive approach to addressing a wide range of stakeholder concerns [14]. Research shows that gender-diverse boards are more likely to prioritize sustainability and ethical considerations, thereby enhancing the quality of ESG disclosures [27,32]. This study draws on the stakeholder theory because of its relevance in explaining the dynamics of ESG disclosures, which are persistent, ubiquitous, and significantly influenced by stakeholders. Stakeholder theory provides the most suitable framework for this study, as it effectively captures the impact of female board representation on ESG disclosures by underscoring firms' responsibility to address the interests and expectations of diverse stakeholders. Different stakeholders may impact a firm favorably or unfavorably, with their influence being either direct or indirect [76]. Firms that respond to ESG demands are often required to make strategic decisions with long-term implications for their development and sustainability. However, these decisions affect various interest groups in distinct ways [68,74]. While some stakeholders may support ESG initiatives because of their alignment with environmental, social, or ethical objectives, others may oppose them, particularly if they involve substantial costs or disrupt existing operations. This tension highlights the critical role of the board in balancing stakeholder interests while making ESG-related decisions, ensuring that the firm's strategies are sustainable and equitable in the long run [13].

4.2. Agency Theory

Agency theory is one of the foundational frameworks in CG that deals with the principal–agent model [18]. This theory posits that principal–agent conflicts of interest exist mainly because shareholders are normally in a worse informational position than executives or the board of directors. In this regard, the appointment of female directors on corporate boards is viewed as a tool to enhance CG and reduce agency issues [61]. In this context, female representation on boards improves oversight and multiple pathways through agency theory could lead to increased ESG disclosure [77]. Agency theory also points out that board diversity is essential for reducing information asymmetry and monitoring effectively [14]. Some research suggests that gender-diverse boards, comprising both women and men, may bring a broader range of perspectives, enhance independent oversight, and contribute to ethical decision-making, thereby strengthening the board's monitoring role [78]. This enhanced oversight is important for firms to declare accurate and clear ESG information [79]. Moreover, from an agency perspective, gender diversity increases board heterogeneity, enhancing the board of directors' decisions, especially in questions with many dimensions such as ESG [23]. Gender-diverse boards, comprising both women and men, may demonstrate a heightened focus on environmental and social issues and contribute to greater transparency in corporate governance practices [14]. They can influence the board's decisions and contribute to the enhancement of ESG policies and practices, thereby increasing the level of disclosure [61]. Furthermore, agency theory postulates that having different boards is more capable of mitigating managerial self-serving behavior [45]. Given the unique corporate governance landscape in Saudi Arabia, where gender diversity initiatives are gaining momentum under Vision 2030, agency theory provides a strong foundation for understanding how female board representation can mitigate governance risk and enhance ESG transparency. Thus, based on agency theory, the appointment of a diverse board comprising both women and men can enhance ESG disclosure by strengthening monitoring mechanisms, introducing diverse perspectives, reducing managerial self-interest, and improving alignment with stakeholder expectations [27]. The collective decision-making of a gender-diverse board fosters greater transparency and stronger commitment to sustainable value creation, positioning such boards as key agents of sustainable corporate governance [23].

4.3. Institutional Theory

Institutional theory provides a robust framework for understanding how organizations conform to external pressures and expectations to gain legitimacy, stability, and access to critical resources [18]. This theory posits that firms operate within a structured social environment where regulatory, normative, and cultural–cognitive forces shape corporate behaviors and decision-making processes [45]. Institutional isomorphism, as proposed by DiMaggio and Powell highlights three key mechanisms through which organizations align with prevailing institutional norms: coercive, normative, and mimetic pressures [23]. Coercive pressures stem from regulatory mandates and government policies, normative pressures arise from professional and industry expectations, and mimetic pressures drive firms to imitate the practices of leading organizations to enhance legitimacy and reduce uncertainty [33]. In the context of CG and sustainability, institutional theory provides an essential lens through which to analyze the relationship between female representation on corporate boards and ESG disclosure [23]. Organizations in Saudi Arabia's highly polluting industries are subject to increasing institutional pressures due to evolving national and international sustainability imperatives [47]. As part of Saudi Vision 2030, the Kingdom has placed a strong emphasis on gender diversity, economic diversification, and environmental

responsibility, creating a regulatory environment that encourages firms to enhance their ESG disclosure practices [29].

Furthermore, government policies, such as the Capital Market Authority's (CMA) CG regulations and the Saudi Stock Exchange (Tadawul) ESG disclosure guidelines, serve as coercive mechanisms that drive firms to increase board diversity and improve sustainability reporting [33]. Companies that fail to meet these expectations may face reputational risks, regulatory scrutiny, or challenges in accessing capital markets, reinforcing the importance of aligning with institutionalized governance standards [45]. Taken together, these institutional pressures illustrate how Saudi Vision 2030, regulatory advancements, and international sustainability standards converge to shape CG practices [4]. The increasing emphasis on female representation on boards and ESG disclosure reflects a broader institutional shift toward sustainability and inclusivity [23]. Firms that proactively respond to these pressures are more likely to enhance their ESG transparency, improve stakeholder relations, and secure long-term financial and operational stability [2]. Thus, institutional theory offers a compelling explanation for the observed relationship between board gender diversity and ESG disclosure in Saudi Arabia's highly polluting industries, underscoring the significance of regulatory alignment, in shaping corporate sustainability practices.

5. Hypotheses Development

Female Representation on Board and ESG Disclosures

Numerous studies indicate that the advantageous nature of ESG disclosures mitigates corporate risks, improves market acceptance and confidence among stakeholders, and enhances firm value [7,16,19,21]. However, "sensitive" industries firms are willing to prepare and disclose ESG reports because of the possibility of being taken to civil courts rather than a desire to enhance firms' ESG adoption [18]. Empirical evidence suggests that firms experiencing a higher cost of equity capital in a given year may respond by voluntarily increasing their ESG disclosures in the following year as a strategy to enhance transparency and reduce information asymmetry [80]. In this regard, Jafar et al. (2024) [81] indicated that ESG information disclosure significantly reduces equity capital costs. This study highlights the importance of transparent ESG disclosure practices for lowering financing costs. Because of the motivation to practice ESG, companies may participate in ESG to acquire market acceptance [2]; this study focuses on the impact of board diversity, especially in highly polluting firms, where governance, social, and environmental issues are the most relevant. Diverse board plays can serve as critical drivers of ESG compliance [27]. According to the literature on gender-based differences, women and men have different perceptions of leadership roles [14,24]. Kosakowska et al. (2024) [79] suggested that men are more likely to be described in terms of agency, whereas women are more likely to be described in terms of communion (supportive, empathic, and gentle). Thus, females are more sensitive to societal needs. In a practical sense, these communal traits seem to drive female directors to enhance the interests of stakeholders more than their male counterparts, who are more inclined towards shareholders and economic perspectives [23,26].

Second, because female directors possess different backgrounds and experiences than male directors, they are likely to have different orientations towards stakeholders [14]. For example, female directors are more inclined than male directors to come from areas of specialization other than business and are backed by specialists or community elites [31]. In addition, Cunningham and Ereddia (2023) [77] indicated that experienced female directors on firm boards are more likely to serve as CEOs or chief operating officers. Thus, boards with more female directors may pay more attention to ESG-related issues, as such directors may provide valuable insights on this topic [31]. Prior studies have revealed that the presence of female board members is positively associated with a firm's sustainability

performance and related disclosures such as ESG disclosures [24,35,39]. Other studies have reported a negative link between female board members and ESG disclosures [82].

Agency theory, in this case, postulates that the presence of female directors in the boardroom might be helpful in helping these firms overcome agency costs between shareholders and managers [83]. Female directors are expected to be more inquisitive than male directors and likely to be also described as being more stringent and active monitors [61]. However, some conflicts arise regarding the actual ability of female directors to influence male-dominated boardrooms [23]. For example, in highly traditional or hierarchical organizational cultures, female board members may face implicit biases or resistance from their male counterparts, which can limit their impact on ESG practices and disclosures [24]. Additionally, tokenism, in which a minimal number of women are appointed to boards without genuine empowerment, can undermine their ability to contribute meaningfully to ESG initiatives [27]. In addition to the agency perspective, stakeholder theory and institutional theory describe managerial attitudes towards stakeholders' satisfaction in addition to their wealth maximization [73]. It describes and embodies specific corporate conduct and features to mitigate corporate sustainability reporting [4]. Therefore, according to stakeholder theory, an increase in gender diversity on a firm's board increases ESG disclosure [12]. Nonetheless, conflicts arise in balancing stakeholder demand with corporate profitability [18]. Despite their focus on long-term value creation, female directors may encounter resistance from other board members or shareholders, prioritizing short-term financial returns [35]. In such cases, tensions may arise between fulfilling ESG disclosure obligations and maintaining competitive performance, particularly in industries where sustainability investments are costly [14].

Building on the robust theoretical foundation provided by agency theory, stakeholder theory, and institutional theory, as well as the compelling empirical evidence discussed, this study posits that the representation of females on corporate boards has a positive and significant effect on ESG disclosures. Their presence is likely to improve the quantity and quality of ESG information disclosed by firms, thereby fulfilling the regulatory and market-driven demands for sustainability transparency. This hypothesis reflects the critical role of female directors in strengthening CG mechanisms and enhancing transparency.

Hypothesis 1: *Female representation on a firm's board has a positive and significant influence on the ESG disclosure offered by Saudi-listed firms.*

6. Methodology

6.1. Sample Selection and Data Collection

The sample consists of 200 Saudi-listed firms, all classified as highly polluting industries based on the Saudi Exchange's classification system. These industries include energy (oil, gas, and fossil fuel activities); materials (cement, steel, and construction-related production); transportation (air, land, and sea transport); industrial manufacturing (large-scale production with high emissions); and utilities (power generation and water desalination reliant on fossil fuels). Since firms in such industries bear high social and environmental risks, such as costs and liabilities related to climate risk, they are subject to strict regulations, such as carbon emission-related regulations [18]. Thus, corporations in these sectors are expected to implement effective ESG disclosure practices by ensuring and promoting female board participation. In this setting, Bewley and Li (2000) [84] noted that enterprises that engage in high-pollution operations are more inclined to experience increased media attention. Consequently, such enterprises tend to disclose more comprehensive and relevant social and environmental information in response to increased external pressures. Furthermore, Abdelrahman et al. (2024) [23] emphasized that executives in heavily polluting sectors often

react to investor requirements by adopting corporate models that include both economic and environmental issues. Purposive sampling identified highly polluting publicly listed firms aligned with the study's ESG disclosure criteria. This method was chosen to target firms that are most relevant to the research objectives, allowing for a more focused and meaningful analysis of ESG disclosure practices.

The period from 2019 to 2023 represents a crucial phase in the implementation of Saudi Vision 2030, which was launched in 2016 [47]. By 2019, initial reforms and policies had been implemented, allowing for a more meaningful analysis of their effects. Therefore, this timeframe captures the accelerated pace of reforms, particularly those related to women's empowerment and CG, which gained momentum in the years following the Vision 2030 announcement. Moreover, this study employs secondary data from the annual reports of 200 listed Saudi firms to assess the impact of female board representation on ESG disclosure using content analysis. Widely used in non-financial disclosure research [44], content analysis enables the systematic and objective examination of textual data [45], capturing key disclosure patterns while considering context, intentions, and meanings [85]. To improve reliability, this study applied a coding scheme based on Sharma et al. (2020) [86]. The preliminary sample for this research comprises 1250 firm-year observations from 250 publicly traded companies. Two hundred and fifty observations were eliminated because of the absence of yearly reports, leading to incomplete data. Data on gender diversity and ESG disclosure were manually obtained from companies' public annual reports. A comprehensive composition of the research sample is presented in Table 1.

Table 1. Sample composition.

Sample Selection	Number of Firms	Total Observations/Years
Total number of firms extracted from Saudi Exchange (Tadawul) as of 31 December 2023	250	1250
Less		
Firms with missing data	50	250
Final sample size	200	1000

6.2. Data Analysis Procedures

The present research used statistical analysis for data description. Subsequently, we analyzed the correlation matrix, which assessed the correlations throughout each variable in the model. After a basic introduction to the data's validity, the model underwent multiple regression analysis to determine the pattern and magnitude of the associations, followed by a succession of robustness assessments aimed at verifying the resilience of the conclusions.

6.3. Dependent Variable: Quantifying the ESG Disclosures

The concepts of disclosure level and quality are not easily defined and have subjective characteristics [87]. The lack of a theoretical foundation limits the development of proxies for this concept [23]. Hence, researchers have used methods to assess disclosure level and quality by assuming that what is being assessed represents the disclosure level or quality [88]. Consequently, quantitative research using a disclosure index to assess the release of environmental data presumes that the quantity of released data on the environment with quantitative problems may offset the quality or degree of disclosure [89]. Nonetheless, quantitative disclosure is a facet of information quality, since numerical data offer almost incontrovertible facts and guarantee trustworthiness [90]. Consequently, the disclosure score system is used to convert the quality and extent of information generated by companies in their yearly reports into variables [91].

Therefore, unlike previous empirical research which used checklists or scores based on rating agencies such as MSCI ESG Ratings, Sustainalytics, Bloomberg ESG Disclosure Scores, Refinitiv ESG disclosure scores [40,42,43], to create our dependent variable, in this study, ESG disclosure was systematically measured using a rigorously developed ESG disclosure checklist, constructed in alignment with internationally recognized reporting frameworks and Saudi-specific ESG guidelines. The checklist was formulated through a dual-pronged approach that integrates key disclosure requirements from established standards, such as the Tadawul ESG Index (2021), Saudi Central Bank (SAMA) ESG Risk Management Guidelines (2022), Global Reporting Initiative (GRI) (various years), Sustainability Accounting Standards Board (SASB) (2019), and the Task Force on Climate-related Financial Disclosures (TCFD) (2017, 2021). In most cases, the number of items that need to be disclosed is large and virtually unlimited [92]. Consequently, the efficacy of the ranking scale as an indicator of disclosure is contingent on the chosen criteria [93]. This study used content analysis of annual reports. This has been achieved through the judicious incorporation of elements endorsed by several Saudi and international frameworks and norms. This aligns with Abdelrahman et al. (2024) [18]. Hence, this ESG disclosure index is relatively broader and more inclusive than those suggested by Li et al. (2024) [94], who use 55 disclosure items to assess ESG disclosure in China.

As a result of this managed process, a new ESG disclosure index was developed from the 62 disclosure items grouped under three categories (ESG). Validity and reliability are the two most basic and crucial components when assessing the quality of measurement tools, which is good for study [95]. Accordingly, for the scouring indicator to serve as a valid and reliable metric for assessing the disclosure quality or degree, it is essential to validate the measurement method [23]. Subsequently, to enhance the accuracy and dependability of the ESG disclosure index, an initial compilation of the ESG checklist was presented to specialists in sustainability, greenhouse gas emissions, and pollution. Furthermore, the initial checklist referred to two scholars who specialize in corporate governance, corporate social responsibility, ecological and sustainability accounting, and ESG reporting. Seventy preliminary ESG-reporting indicators were submitted for validation and authentication. Academics and assigned experts recommended the removal of five elements from the preliminary index of ESG disclosure, which originally had 70 items. This method is consistent with Abdelrahman et al. (2024) [45], who provided an expert with an initial checklist element to solicit their judgements on the assigned reporting index to evaluate the degree of voluntary information disclosure.

In addition, we aimed to reduce bias in determining the relevance of the research instrument used as well as to ensure inter-observer reliability. First, the corporate annual reports are used in the analysis before any action is taken; second, the pilot is conducted to check that all items of disclosure across firms are afforded similar attention and handling [96]. Therefore, the ESG disclosure index comprising 65 disclosure items was subjected to a pilot test. Three elements that none of the chosen corporations reported in the period prior to the survey are omitted from the index. Consequently, the final ESG disclosure index consisted of 62 reporting components. Several studies support the use of the unweighted method for scoring items [23,44]. Freedman et al. (2012) [97] found no significant differences in outcomes between weighted and unweighted approaches, but weighted scoring may introduce subjectivity [18]. To ensure objectivity, this study applies the unweighted method, aligning it with international and domestic ESG reporting standards, which do not prioritize any specific disclosure items or user groups. Furthermore, the unweighted technique lacks the subjectivity issues present in the weighted methodology, and any bias that may arise from the use of an incorrect weight [98]. Ultimately, the scores were recorded for each item on the list. If an item was reported, a value of 1 was assigned to each company;

otherwise, a value of 0 was allocated to each company. The extent of ESG disclosure is measured by the aggregate number of ESG elements reported by companies. This aligns with Abdelrahman et al. (2024) [23].

6.4. Independent Variables

This study defines female representation as the proportion of female directors on a firm's board. This proportion provides the level of gender diversity in the board. Consequently, to evaluate the impact of female participation on ESG reporting, female participation was quantified by the ratio of female directors to the overall number of directors on a firm's board [99]. This method provides a quantifiable and comparable assessment of female representation across firms and is consistent [100]. Prior studies have consistently used similar measures to examine the relationship between gender diversity and corporate outcomes, including ESG disclosure [54,55]. Additionally, regulatory initiatives such as Saudi Vision 2030 have emphasized gender diversity in leadership, making it a relevant corporate governance metric in emerging markets [33].

6.5. Control Variables

The dependent variable examined in this research was ESG disclosure. Numerous control factors found in previous studies are associated with ESG disclosure. This research employs the following control variables: company size (SIZE), profitability (PRO), firm age (FAGE), liquidity (LIO), leverage (LEV), and institutional ownership (IO) (see Table 2). This outcome aligns with the conclusions of Ho and Park (2019) [11], Cordazzo et al. (2020) [63], Khanchel et al. (2022) [101], and Al-Shaer et al. (2024) [35]. The model used in this investigation is as follows:

$$ESGDit = \beta_0 + \beta_1 Femaleit + \beta_2 PROit + \beta_3 FSIZEit + \beta_4 AGEit + \beta_5 LIOit + \beta_6 LEVit + \beta_7 IOit + \epsilon it$$

Table 2. Definition of variables.

Variable	Acronym	Measurement
Dependent Variable		
ESG disclosures	ESGD	The checklist consists of a minimum of 0 items and a maximum of 62 items
Independent Variable		
Female representation	Female	The number of female board members by the total number of board members, and multiplying the result by 100%
Control Variables		
Firm profitability	PRO	Net income divided by total assets
Firm size	SIZE	The logarithm of total assets
Firm age	AGE	The total years of operation for the firm up to the end of 2023
Leverage	LEV	Total debt divided by total assets
Liquidity	LIQ	Current assets divided by current liabilities
Intuition ownership	IO	The proportion of dividing the total number of common shares held by all institutional owners by the total common shares outstanding at year-end

7. Empirical Results

7.1. Descriptive Analysis

Table 3 displays the descriptive statistics for the entire sample, including 200 corporations across the five years of data. These statistics comprised the mean, minimum, and maximum values and standard deviations for all variables related to this study. Table 3

shows the descriptive statistics for the ESGD variable, where the average value is 17%, with the minimum and maximum levels of 0% and 67%, respectively. This indicates that ESGD in Saudi Arabia remains relatively low. Female representation (measured percentage of female directors) ranged from 0 to 44%, with a mean of 13%, which provides strong evidence that female representation on Saudi firms' boards is still insufficient, and males dominate remarkably. Regarding the control variables, Table 3 reports that FSIZE varied from 10.7 to 9.52%, with an average of 7.24%. Meanwhile, PRO ranged from a minimum of -2.8% to a maximum of 50% with a mean of 13.5%, indicating that almost 13.5% of the sampled firms during the investigation period tended to be profitable. Regarding firms' FAGE and LIQ, the descriptive results show that firms' FAGE ranged from a minimum of 3 years to a maximum of 83 years, with a mean of 31 years, indicating that, on average, the investigated sample involved old firms. Meanwhile, the firms' LIQ ranged from 5.4% to 29.13%, with a mean of 2.72%. As for LEV, Table 3 shows that all firms are leveraged through some form of debt financing, with a maximum of 2.61, a mean of 43%, indicating that 43% of the sampled firms in the current study are dependent on debt. Regarding ownership structure, the IO average is 62%, ranging from 3% to 98% for the sampled firms.

Table 3. Descriptive statistics.

Variables	Mean	Standard Deviation	Minimum	Maximum
ESGD	0.171	0.164	0.060	0.678
Female	0.1304	0.1230	0.000	0.4455
FSIZE	7.244	1.333	0.107	9.518
PRO	0.134	0.120	-0.027	0.500
AGE	31.981	13.174	3.000	83.000
LIQ	2.727	3.523	0.054	29.138
LEV	0.436	0.223	0.026	2.610
IO	0.622	0.202	0.031	0.986

Notes: The descriptive statistics are based on pooled observations across the full panel dataset (2019–2023): The variables used in this study are defined as follows: ESGD refers to Environmental, Social, and Governance Disclosure, while Female represents the proportion of female members on the board. FSIZE denotes the size of the firm, and PRO indicates firm profitability. AGE reflects the number of years the firm has been in operation, whereas LIQ measures the firm's liquidity. LEV captures the firm's leverage, and IO represents institutional ownership.

7.2. Correlation Matrix

Correlation analysis revealed the key relationships between the variables studied. Female representation on the board, the independent variable, exhibits negligible correlation (0.0018) with ESG disclosure, the dependent variable. Among the control variables, institutional ownership (IO) shows the strongest positive correlation with ESG disclosure (0.4498), followed by firm profitability (PRO) with a moderate positive correlation (0.4302). Firm size (FSIZE), however, demonstrates a weak negative correlation with ESG disclosure (-0.1025), while firm age (AGE) shows a weak positive correlation (0.1666). Liquidity (LIQ) and leverage (LEV) have minimal negative and positive correlations with ESG disclosure, at -0.0944 and 0.0832, respectively. These findings highlight the varying degrees of influence these factors may have on ESG disclosure in the analyzed dataset.

7.3. Diagnostic Tests

There is a possibility of causality between the dependent and independent variables due to the type of data used in this study. Therefore, it may not be appropriate to use ordinary least squares (OLS) to address these issues. To determine which regression model used fixed or random effects, the Hausman test was carried out. This modeling approach

has been previously used in other studies [44]. Therefore, the findings of the Hausman test indicate that a random-effects regression is appropriate. To ensure that the results obtained were not misleading, diagnostic tests were conducted on the model for linearity, multicollinearity, presence of outliers, heteroscedasticity, and autocorrelation [40] (see Table 4). Thus, the scatter plot test revealed that the relationship between the independent variable and the independent variables in the study model can be described as linear [102]. Table 5 also shows that there is low multicollinearity between the study variables, since none of them had a correlation coefficient of more than 0.80 [103]. To test for multicollinearity, a variance inflation factor (VIF) test was performed. Because the value exceeds 10, according to Gujarati et al. (2003) [104], this implies a high level of multicollinearity. Therefore, the VIF values shown in Table 5 indicate no multicollinearity in the study. Regarding heteroscedasticity, the Breusch–Pagan/Cook–Weisberg test of heteroscedasticity was conducted, whereas for autocorrelation in the panel data, the Wooldridge test was conducted [105]. Both tests indicated the existence of these problems. Subsequently, as per Rogers et al. (1994) [106], appropriate standard errors clustered at the company level are employed in order to rectify the predicted ESGD model (see Table 6).

Table 4. Breusch–Pagan/Cook–Weisberg and Wooldridge tests.

Breusch–Pagan/Cook–Weisberg Test		Wooldridge Test	
chi2(1)=	28.72	F (1,199)=	191.008
Prob > chi2=	0.0000	Prob > F=	0.0000

Table 5. Correlation matrix.

	ESG	Gender	PRO	SIZE	AGE	LIQ	LEV	IO	VIF
ESGD	1.0000								
Gender	0.0018	1.0000							1.00
PRO	0.4302	−0.0342	1.0000						1.07
SIZE	−0.1025	−0.0164	−0.0999	1.0000					1.04
AGE	0.1666	0.0288	−0.0038	−0.1163	1.0000				1.02
LIQ	−0.0944	0.0146	−0.1060	0.0711	−0.0386	1.0000			1.43
LEV	0.0832	0.0012	0.0748	−0.0460	−0.0078	−0.5408	1.0000		1.42
IO	0.4498	0.0161	0.2308	−0.1184	0.0844	−0.0507	0.0724	1.0000	1.08

Notes: The table presents the correlation coefficients among the primary variables included in the analysis. These coefficients indicate the strength and direction of the linear relationships between the variables. The definitions of the variables are provided in Table 3. Additionally, the Variance Inflation Factor (VIF) is included to assess the presence of multicollinearity among the independent variables.

Table 6. Random effect regression results.

Variables	Coefficients	t-Sat
Female	0.0010	3.03 ***
PRO	0.3825	7.33 ***
SIZE	0.0027	0.48
AGE	0.0032	4.81 ***
LIQ	−0.0006	−0.57
LEV	0.0228	1.00

Table 6. *Cont.*

Variables	Coefficients	t-Sat
IO	0.4957	12.79 ***
Constant	−0.3479	−6.24 ***
R ²	0.31	
Number of observations	1000	
Prob > chi2	0.0000	
Wald chi2(7)	408.87	
Hausman Test	Prob > chi2 > 0.05	

Notes: Refer to Table 3 for the definitions of variables: *** $p < 0.01$.

7.4. Regression Results and Discussion

Table 6 illustrates the estimates of random effects for Model 1. The F-statistic for Model 1 was statistically significant, with a p -value of less than 0.01, indicating the model's statistical validity. The adjusted R-squared value for the model was 31%, indicating that the independent variables accounted for 31% of the variation in the dependent variables. The R-squared value is deemed adequate for evaluating the influence of CG variables on environmental, social, and governance disclosure and is similar to findings from other research [31]. As expected, Table 6 of the regression analysis highlights a positive and significant association between the proportion of female directors and ESGD among Saudi-listed firms ($t = 3.03$, $p < 0.01$). This suggests that firms operating in highly regulated sectors may strategically enhance board diversity as a compliance-driven response to ESG-related mandates, prioritizing regulatory adherence over genuine, intrinsic commitment to ESG principles. This finding is corroborated by De Masi et al. (2021) [107] and Wan Mohammad et al. (2023) [22], who investigate a positive and substantial link between the proportion of female directors and the extent of ESG disclosure. Consequently, the results of the present investigation align with those in the empirical literature.

Furthermore, the reported results align with the theoretical perspectives of stakeholders and agency theories. For example, stakeholder theory posits that firms are responsible for a broad range of stakeholders including employees, customers, investors, communities, and the environment [75]. In the context of our findings, women's participation in boardrooms can be perceived as a response to the demands of diverse stakeholders who increasingly seek transparency, social responsibility, and sustainability from firms. Therefore, by promoting gender diversity, firms may signal their commitment to broader social values including equality and environmental stewardship. Moreover, according to agency theory, board diversity, including female representation, can serve as a governance mechanism for reducing agency problems [83]. Female directors have different perspectives, experiences, and decision-making styles, which may enhance the effectiveness of the board in overseeing management and improving the quality of CG [31]. Their involvement in decision-making could lead to more rigorous oversight of ESG factors, thereby encouraging greater ESG disclosures [35]. Consequently, the favorable association between female presence on the board and ESG disclosures supports the notion that board diversity enhances governance and accountability.

Regarding the control variables, the study model included six control variables for studying ESGD. The regression results for these variables are as follows: As shown in Table 6, this study succeeded in proving the statistically significant positive influence of PRO as measured by return on equity (ROE) on ESGD. This finding suggests that highly profitable firms are more likely to provide ESG-related information. However, the effect of SIZE on ESGD was not statistically significant. This finding suggests that ESGD does not

differ among all firm sizes evaluated as the logarithm of the total assets of firms listed in Saudi Arabia. The results indicate a positive and significant influence of FAGE on ESGD. Moreover, Table 6 indicates the insignificant influence of LIQ and LEV on ESG. Accordingly, there was no strong, meaningful, or statistically significant influence of the LIQ and LEV on ESGD. In contrast, IO had a positive and significant influence on ESGD. This finding indicates that firms with institutional investors in control are willing to provide more ESG-related information.

7.5. Additional Analysis

To establish the robustness of the primary results, additional tests were performed to examine the influence of female representation on individual ESG components [102]. This approach involved breaking down the developed ESG disclosure index into three primary components: Environmental Disclosure (ED), Social Disclosure (SD), and Governance Disclosure (GD). Each component was analyzed independently to assess whether the relationship between female board representation and EGSD was consistent across the individual dimensions of the ESG. This analysis was critical for several reasons. First, it provides deeper insights into the relationship between female board representation and ESG disclosures, allowing for a more nuanced understanding of how board diversity influences corporate transparency. Given that the statistical relationship identified in this study does not establish causality, this breakdown helped clarify whether the observed association was uniformly distributed across different ESG dimensions or driven by specific governance and regulatory factors. Furthermore, this approach acknowledges that firms in highly regulated sectors may strategically enhance board diversity to align with governance mandates rather than as a direct result of an intrinsic commitment to ESG principles. As a result, by examining each ESG component separately, the analysis contributes to a more comprehensive understanding of the role of board gender diversity in shaping corporate sustainability practices within the broader institutional and regulatory context. Thus, the results of the analysis (see Table 7) emphasize that female representation on the board is positively and significantly related to each individual ESG component. Accordingly, these results align with the main analysis, where the ESG disclosure index demonstrates a favorable and strong correlation with women's participation in boardrooms. This underscores the strength of the basic outcomes.

Table 7. Additional tests results.

Variables	ED Model		SD Model		GD Model	
	Coefficients	t-Sat	Coefficients	t-Sat	Coefficients	t-Sat
Female	0.3468	5.13 ***	0.3035	6.03 ***	0.3396	6.34 ***
PRO	4.8840	0.52	3.9270	0.57	−4.798	−0.65
SIZE	5.7037	2.38 **	3.9973	2.24 ***	2.1613	1.14
AGE	−0.8689	−1.83 **	0.0484	0.14	−0.5919	−1.57 *
LIQ	0.6142	1.12	0.4031	0.99	0.3198	0.74
LEV	25.2633	3.10 **	4.188	0.69	−0.5432	−0.08
IO	2.7592	0.24 **	17.9361	2.13 ***	2.4198	0.27 *
R2	0.11		0.09		0.06	
Number of observations	1000		1000		1000	
Prob > chi2	0.0000		0.0000		0.0000	

Notes: ED: environmental disclosure; SD: social disclosure; GD: governance disclosure. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

7.6. Endogeneity Concerns

Endogeneity concerns arise in the relationship between board diversity and ESG disclosure, particularly due to the possibility of reverse causality, firms committed to ESG principles may be more likely to appoint female directors rather than female representation driving enhanced ESG disclosure [33]. To mitigate this issue, the study employs the System Generalized Method of Moments (System GMM), which helps control for simultaneity bias and omitted variable bias by using lagged values of the dependent and independent variables as instruments [44,102]. This method ensures that the estimated relationship between female board representation and ESG disclosure is less likely to be driven by unobserved firm characteristics or reverse causality. As shown in Table 8, the regression results indicated that female representation on corporate boards has a positive and statistically significant effect on ESG disclosure (0.000558 **), supporting the argument that board diversity contributes to enhanced transparency and sustainability reporting. While the effect size is relatively small, its significance indicates that firms with more female directors tend to provide more comprehensive ESG disclosures. This aligns with stakeholder, agency, and institutional theories, which suggest that diverse boards strengthen governance, enhance oversight, and better address stakeholder expectations [18,23]. Institutional theory further highlights how organizations adapt to societal norms and pressures, enhancing their legitimacy, resilience, and long-term sustainability. However, the modest magnitude of the effect suggests that while board diversity plays a role, other factors such as regulatory pressure and investor influence may be stronger determinants of ESG disclosure. The use of System GMM reinforces the credibility of these findings, demonstrating that the positive link between board diversity and ESG reporting is not merely a reflection of pre-existing ESG commitments but rather an independent governance characteristic that strengthens transparency.

Table 8. System GMM regression results.

Variables	ESGD
L.ESGD	0.857 *** (0.0400)
Female	0.000558 ** (0.000248)
PRO	0.0771 *** (0.0277)
IO	0.0837 *** (0.0180)
SIZE	−0.00960 (0.00829)
AGE	0.000164 (0.000262)
LIQ	−0.00250 (0.00482)
LEV	−0.0675 *** (0.0199)
Year effects	YES
Constant	0.103 (0.0805)
AR(1)	−7.54 ***
AR(2)	−0.03
Hansen test	34.25
Prob > chi2	0.271
Number of groups	200
Number of instruments	42
F-stat	995.75
Prob > F	0.000

Note: *** $p < 0.01$; ** $p < 0.05$.

8. Conclusions, Implications, Limitations, and Future Research

This study assesses the impact of female representation on the environmental, social, and governance disclosure provided by Saudi-listed firms, particularly in highly polluting industries. The study included 200 firms and 1000 observations over a five-year period from 2019 to 2023. On the way to achieve the study goals, a comprehensive ESG disclosure index was developed in line with several international and Saudi ESG frameworks as well as well-grounded literature. Compared to prior studies, the ESG disclosure index developed in this study is more comprehensive (62 items). As anticipated, this research found significant support for the hypothesis that Saudi firms with higher female board representation are associated with greater ESG disclosures. This finding highlights the potential links between gender diversity, corporate transparency, and sustainability. Female directors are often associated with stronger ethical perspectives, a stakeholder-oriented approach, and commitment to environmental and social responsibility, which may influence the extent of ESG disclosure. However, while the results indicate a positive and significant association, they do not establish a direct causal relationship, as firms may also enhance board diversity in response to external governance mandates and regulatory pressure. To build on these findings, Saudi policymakers should consider regulatory frameworks to increase board diversity, align Saudi ESG disclosure standards with global frameworks, such as GRI and SASB, and offer financial incentives for gender-inclusive governance. Furthermore, expanding leadership development programs for women can strengthen accountability and ESG commitments. These measures will enhance corporate governance, promote sustainability, and support Saudi Arabia's Vision 2030 Goals.

Thus, this study fills a gap in the literature on the relationship between female representation on boards and ESG disclosure. By providing empirical evidence of a significant association between female board representation and the extent of ESG disclosure, this study contributes to the understanding of the potential role of gender diversity in corporate sustainability practices. Although the findings indicate that firms with more female directors tend to engage in more robust ESG disclosures, they do not establish a direct causal relationship. Instead, regulatory compliance, institutional pressures, or broader corporate governance frameworks may influence the observed association. This contribution is particularly relevant in the context of Saudi Arabia, where the integration of women into leadership positions is a relatively recent phenomenon and its implications for ESG disclosure have been largely underexplored in prior studies. Moreover, this study offers significant political and practical implications for major stakeholders in Saudi Arabia by emphasizing the critical role of female representation on corporate boards in enhancing ESG disclosure. A marginal increase in female board representation can directly enhance ESG disclosure scores by promoting more collaborative decision-making, boosting transparency, and emphasizing long-term sustainability goals. Female directors often bring fresh perspectives that help companies better identify and manage ESG risks, resulting in more thorough and accurate disclosures. Ultimately, increasing female representation can lead to tangible improvements in ESG performance, benefiting regulators, investors, and companies by fostering greater corporate responsibility and long-term value creation. Consequently, regulators such as the Saudi Capital Market Authority (CMA) can leverage these insights to design and implement policies that not only encourage but potentially mandate greater female representation on boards. Specific policy measures could include introducing minimum quotas for female directors, ensuring that gender diversity is not merely a token gesture but a fundamental part of corporate governance. Alternatively, voluntary guidelines and incentives, such as tax benefits or public recognition, could be provided to firms that take significant steps toward increasing female representation on boards. This approach may offer more flexibility while still promoting diversity. Furthermore, institutional and socially responsible investors (SRIs) can use the findings of this study to refine their investment strategies. Recognizing that female representation on boards serves as a signal of higher corporate governance quality and a stronger commitment to sustainability, SRIs could adjust their investment criteria to prioritize companies that demonstrate both gender diversity and a focus on long-term ESG goals. Investors increasingly view diversity as a driver of better decision-making, innovation, and performance, and this insight could prompt them to shift their portfolios toward companies that align with these values.

Moreover, to address the pipeline issue, firms could implement mentorship and leadership development programs aimed at grooming women for executive and board-level roles. These programs would help ensure that women have the necessary experience, skills, and networks to succeed in leadership positions, fostering a more sustainable and diverse leadership culture within companies. Providing women with access to training, professional development, and networking opportunities can bridge the gap between junior roles and board positions, ensuring a steady flow of female talent into senior leadership. Additionally, our comprehensive ESG disclosure (ESGD) index, developed for this study, provides a robust and nuanced framework for measuring the quality and extent of ESG-related disclosures made by listed Saudi firms. This index was meticulously constructed by integrating specific environmental, social, and governance indicators derived from global ESG standards such as the Global Reporting Initiative (GRI) and Sustainability Accounting Standards Board (SASB), while tailoring them to align with the Saudi regulatory and cultural context. Therefore, by aggregating these indicators into a single holistic measure, the ESGD index allows for a detailed assessment of firms' transparency and

commitment to sustainability practices. This study has several limitations; each of which opens new possibilities for further research. First, it focuses exclusively on listed firms in Saudi Arabia, limiting the generalizability of the findings to other countries or regions. Given that the appointment of female directors in Saudi Arabia is a relatively recent development, the effectiveness of these directors in influencing board decisions remains uncertain due to sociocultural and regulatory barriers. While their inclusion on boards may signal progress in gender diversity, it is unclear whether female directors are genuinely empowered to shape strategic decisions or if their roles are primarily symbolic. Saudi Arabia's sociocultural barriers include deeply ingrained gender norms that often place women in subordinate roles within both the family and the workplace. Traditional views of gender, where men are seen as the primary decision-makers, can limit the influence female directors can have in the boardroom. Despite formal appointments to leadership positions, female directors may face significant resistance from male counterparts, which could lead to tokenism rather than genuine involvement in decision-making. To fully understand the impact of female board representation on corporate governance and ESG practices, future studies must analyze the broader governance structures, corporate culture, and board dynamics within these firms. These factors are crucial in determining the extent to which female directors can meaningfully contribute to decision-making processes.

Second, this study primarily focuses on the role of female representation on corporate boards in shaping ESG disclosure in highly polluting industries in Saudi Arabia. While we acknowledge that board effectiveness is influenced by various attributes, such as board independence, expertise, leadership structure, and committee oversight, these factors fall outside the scope of our research. Given this limitation, we recognize that our findings provide a partial perspective on board dynamics and do not encompass all the elements that may impact ESG disclosure. Future research could explore a more comprehensive approach by integrating multiple board characteristics to gain a holistic understanding of their collective influence on corporate transparency and governance. Third, this study's reliance on a comprehensive ESG disclosure index, while innovative, may not capture certain qualitative aspects of sustainability reporting such as the strategic intent behind disclosures or stakeholder perceptions of these disclosures. Future research could incorporate qualitative methodologies, such as interviews or case studies, to provide richer insights into the motivations and impacts of ESG practices, particularly in relation to gender-diverse boards. Fourth, this study primarily examines the direct relationship between female representation on boards and ESG disclosures without considering potential mediating or moderating variables. For example, future research could investigate how organizational culture, board independence, and external pressures such as regulatory mandates or societal expectations influence this relationship. Understanding these mechanisms could provide a more nuanced perspective on how and why gender diversity affects corporate ESG practice. Finally, this study focuses exclusively on highly polluting industries, which may introduce potential selection bias. Firms in these sectors are subject to heightened regulatory scrutiny and external pressures related to environmental sustainability, which could influence both their ESG disclosure practices and the impact of female board representation. As a result, the findings may not be generalizable to less polluting industries, where regulatory pressures and corporate sustainability priorities may differ. Future research could expand the analysis to include firms from lower-emission industries to determine whether the observed relationship between board gender diversity and ESG disclosure persists across different regulatory and operational contexts.

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