

THE INFLUENCE OF FEMALE BOARD REPRESENTATION AND INSTITUTIONAL OWNERSHIP ON GREEN INNOVATION

ALI, S.¹ – UR REHMAN, R.^{2,3} – DONG, W.^{1*} – ZAHID, R. M. A.⁴

¹*School of Economics and Management, Hezhou University, Hezhou 542899, China
(e-mail: shahidali24@hotmail.com)*

²*Teesside International Business School, Teesside University, UK
(e-mail: r.rehman@tees.ac.uk)*

³*Faculty of Business, Sohar University, Sohar, Oman*

⁴*The Business School, RMIT University, Ho Chi Minh City, Vietnam
(e-mail: amrzahid@gmail.com)*

**Corresponding author
e-mail: m13870015586@163.com*

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Abstract. As global awareness of climate change intensifies, there is a pressing need to understand how corporate governance factors can drive sustainable practices. Despite recognition of the roles of diversity and institutional investors in promoting sustainability, their combined effect on green innovation in the Chinese context remains underexplored. In order to address this gap, we used advanced statistical methods including Poisson, Negative Binomial and Zero Inflated Binomial regressions to analyze a comprehensive dataset of Chinese A-share listed companies from 2010 through 2022. The findings reveal that female representation on board and institutional ownership positively correlates with green innovation. This impact intensifies as the female presence on board's upsurges. The study also highlights the moderating role of state-owned enterprises, which can amplify the relationship between institutional ownership and green innovation. These results suggest that promoting gender diversity and encouraging collaboration between institutional investors and state-owned enterprises are crucial strategies for advancing green innovation and environmentally friendly practices. The implications of this research are significant for policymakers and corporate leaders, providing insights into how gender diversity and institutional ownership can be integrated into strategies for sustainable development. This study contributes to the existing literature by integrating resource dependence theory, upper echelons theory, and legitimacy theory, offering a comprehensive understanding of the dynamics between gender diversity, institutional ownership, and green innovation.

Keywords: board structure, female presence, institutional ownership, green innovation

Introduction

Globally, climate change is one of the most serious problems, entailing immediate action by individuals and organizations. Green innovation (GI) has become increasingly important as a result of growing awareness of climate change's negative effects (Li et al., 2022). GI involves designing and developing processes, products, and methods, which mitigate climate change and ensure sustainability (Chavira et al., 2023). Organizations have increasingly adopted sustainable practices to reduce their environmental impact. Moreover, recent research has acknowledged the importance of innovation in terms of environmental sustainability. As the number of green products, services, and processes has developed, the attention paid to GI has increased (Li and Lu, 2023). Nevertheless, little research has been conducted on the factors contributing to its success. Inclusion and diversity—particularly gender diversity—contribute to innovation (He and Jiang, 2019),

and institutional investors are often seen as key to corporate sustainability (Velte, 2023). However, numerous factors involved in GI remain unexplored (Barforoush et al., 2021; Velte, 2023).

Diversity and inclusion promote innovation. Woolley et al. (2010) have found that teams with a greater proportion of women are more creative and solve problems more effectively. Several studies have shown that gender diversity promotes innovation, including Xie et al. (2020), Issa and Bensalem (2023). Wang et al. (2022) have found that female leaders are more likely to use eco-friendly practices, in addition to being associated with better environmental performance. Women are also more likely to consider the needs of the community and the environmental impacts of their decisions; this leads to a more sustainable future for the environment. Furthermore, gender diversity in leadership can increase the number of innovative ideas, leading to more successful businesses. Green patents are more likely to be granted if corporate boards are more gender diverse (Lakhal et al., 2024). It is common for women directors to provide diverse perspectives and ways of solving problems, which can lead to innovation (Issa and Bensalem, 2023).

Furthermore, the awareness of climate change problems among institutional investors not only leads to them adopting similar managerial decisions favoring pollution reduction, but it also has a substantial impact on environmental performance and GI. Through their pressure and engagement, institutional investors can encourage companies to adopt more sustainable practices, which results in improved environmental performance (Eccles et al., 2013). According to Zhao et al. (2023), institutional investors pay particular attention to environmental and social sustainability in their investment decisions. Institutional ownership (IO) plays an important role in promoting sustainable practices and GI, and it may demonstrate a company's commitment to sustainability and environmentally responsible practices. Therefore, companies are encouraged to invest in GI and improve their environmental performance (Eccles et al., 2013). IO plays a crucial role in developing and adopting GI and in investing in sustainable solutions; thus, it can be a powerful catalyst for organizations to become more sustainable.

A company's ability to engage in GI can be impacted by factors such as IO and gender diversity (Benlemlih et al., 2023). Researchers have explored female presence and IO (Kellemanns et al., 2012), and women in leadership positions have been associated with improved environmental performance (He and Jiang, 2019; Issa and Bensalem, 2023). Further, the positive correlation between environmental performance and IO has been consistent (Eccles et al., 2013). Most studies have examined the influence of IO and gender diversity on GI either in separate studies or regarding advanced countries such as USA and UK, where the institutional framework for sustainable practices is well developed. He and Jiang (2019), however, conducted their study in the context of Chinese manufacturing firms and confirmed that firms with gender diversity in their boards are more likely to engage in GI. The findings of their study are highly encouraging, motivating the researchers in this field to extend the debate further by including institutional investors and gender diversity in one equation and answer the question: are Chinese-listed firms more likely to engage in GI in the presence of female directors and IO under a diverse ownership structure?

The importance of this topic offers an opportunity to shed light on two important factors, gender diversity and IO, which influence organizations' adoption of GI and their contribution to a sustainable future in the context of Chinese listed firms. A unique aspect of this study is that it explores how female board representation and IO impact GI in

tandem. Mass presence of women on boards promotes green innovation more effectively than token presence. The focus on Chinese enterprises contributes valuable policy insights by filling a significant research gap. In this study, we conducted a quantitative analysis of a large sample of firms from various industries over a larger time period to gain a comprehensive understanding of the relationship between female presence, IO, and GI. We hypothesized that the presence of women in executive roles and IO of firms would be positively associated with GI. The results of this research are expected to help corporations better understand the role of women and IO in GI. Moreover, in this study, we examined the development of GI in Chinese listed firms with and without female leadership and IO. Our findings help Chinese companies make informed decisions about best practices for a sustainable future. This research can provide essential knowledge to stakeholders and policymakers, allowing them to develop policies that promote the advancement of GI and their positive contribution to the environment. Investing in GI practices and implementing incentives to encourage their adoption should be a priority for companies.

Resource dependence theory (RDT), upper echelons theory (UET), and legitimacy theory (LT) have traditionally been used to examine female presence and GI. LT, which focuses on a firm's alignment with socially constructed values (Amorelli and García-Sánchez, 2020), asserts that firms take socially responsible measures under external pressures to satisfy stakeholder demands (Jiang et al., 2024). GI, in particular, signals a proactive commitment to the environment and is an effective way to establish legitimacy. In light of the UET (Hambrick, 2007), executives' strategic preferences are shaped by individuals, corporate traits, and industry-specific factors, thus affecting gender diversity (Hambrick and Mason, 1984). Furthermore, UET emphasizes the importance of diversity in decision-making, arguing that homogeneous groups may stifle innovation owing to conformity pressures, while diverse teams provide a broader range of perspectives, leading to better decisions (Lakhal et al., 2024). Accordingly, organizations operating in an open system are required to exchange and acquire certain resources for survival, which creates the firms' dependency on external factors. Board diversity expands existing connections, connects firms to other firms, and provides extensive resources for GI (Arora and Aliani, 2024). Additionally, IO, as agents of corporate governance, can influence GI, and they can adopt environmentally friendly managerial decisions owing to mutual awareness of climate change issues (Jiang et al., 2024). IO seeking to improve their ethical reputation and manage climate-related risks are likely to align their sustainable agendas with those of low-emission institutions. Thus, this study delves into the collaborative potential of gender-diverse boards and IO to drive GI, drawing on RDT, UET, and LT as theoretical foundations.

This study addresses a significant gap in the literature by examining how these two corporate governance factors (female presence on board and IO) interact to influence sustainable practices, particularly in the context of China. Utilizing advanced statistical methods, including Poisson, Negative Binomial, and Zero Inflated Binomial regressions, the research provides robust empirical evidence of a positive correlation between IO and GI. It further reveals that female representation on boards significantly enhances GI, with the effect becoming more pronounced as representation increases. However, the interaction between female director and IO does not have an encouraging impact on GI. Conversely, the interaction between state-owned enterprises (SOEs) and IO further strengthens the link between IO and GI. The overall results are strong across different model specifications. These findings offer valuable insights for policymakers and

corporate leaders, suggesting that promoting gender diversity and strategic collaboration with IO can significantly advance GI. The study contributes to the broader discourse on corporate governance by offering a nuanced understanding of the dynamics between gender diversity, IO, and sustainable innovation.

This study makes several distinct contributions to the literature on corporate governance and GI, building upon and differentiating from existing research in the field. First, while He and Jiang (2019) and Naveed et al. (2023) have explored the link between board gender diversity and GI, this study extends the analysis by quantifying the impact of increased female board representation on GI in Chinese firms, offering a more granular understanding of how gender diversity influences sustainability outcomes beyond what has been previously documented. Second, unlike Lin et al. (2022) and Lakhal et al. (2024), who focus on the general effects of leadership diversity, this research specifically highlights the interaction between female board presence and IO, demonstrating how these factors jointly enhance GI. This dual focus provides a novel perspective on the synergistic effects of diversity and ownership structures on sustainable practices. Third, while Zhao et al. (2023) and Wu et al. (2024) have examined the role of IO in promoting GI, this study uniquely identifies the moderating effect of SOEs on this relationship. By doing so, it challenges the findings of Yang et al. (2024) and Xu et al. (2023), who primarily focus on IOs' direct impact, by revealing the nuanced role SOEs play in amplifying these effects. Fourth, this research employs advanced statistical methodologies—such as Poisson, Negative Binomial, and Zero Inflated Binomial regressions—to provide robust empirical evidence, setting a methodological benchmark for future studies in the field. This approach offers a more comprehensive analysis compared to the methodologies used in previous studies, such as those by Liu et al. (2024) and Nadeem et al. (2020). Overall, this study advances the scholarly understanding of the complex interplay between gender diversity, IO, and GI, offering actionable insights for policymakers and corporate leaders aiming to foster sustainable development.

In the following sections, after a review of the relevant literature, we develop hypotheses based on our analysis. The Research Methods section provides a description of the study method and sample selection. Then, we discuss the results of our study and conclude by summarizing the main findings and suggesting possible directions for future research.

Review of the literature and formulation of hypotheses

Growing evidence in the literature has shown that GI provides benefits beyond environmental protection, contributing to the improvement of business performance. Corporate governance is generally not designed to be compatible with firms' innovation activities, which are characterized as high-risk, long-term, and complex (Rong et al., 2017). Environmental and ethical factors have influenced firms' implementation of environmentally friendly practices over the past few years (Naveed et al., 2023). GI is a novel concept encompassing both technological and non-technological innovation that reduces environmental threats and efficiently utilizes natural resources (Naveed et al., 2023). Its success is dependent on various factors, including the adoption of green methods (Frare and Beuren, 2022), a collaborative organizational culture (Zailani et al., 2014), a green organizational culture (Roy and Khastagir, 2016), internal motivation and external pressures (Cui and Wang, 2022), knowledge permeability (Dangelico, 2016), and executive commitment to “going green” (Naveed et al., 2023).

Multiple factors other than stakeholders have been identified as contributing to GI. The main drivers include ethical obligations (Sarhan and Al-Najjar, 2022), competition (Hu et al., 2024), social expectations and legitimacy (Lee et al., 2018), social resilience (Naveed et al., 2023), and upper-echelon viewpoints (Khanchel et al., 2024). In light of the World Economic Forum's "Going Greener" call, GI has been regarded as a cost-effective means of complying with this directive. Nevertheless, GI has stronger externalities than other environmental practices, and it usually takes longer and more effort to reap the benefits (Ali et al., 2019). Based on the literature, we identify three broad categories of factors affecting GI: (1) internal factors, primarily referring to the board's individual characteristics; (2) organizational characteristics, including financial performance and company size; and (3) contextual factors, primarily referring to external pressures such as stakeholder pressures, social norms, and regulations. The pressure and involvement of IO play an important role in promoting and enhancing GI. Companies should strive to invest in GI to stay ahead of their competitors and remain attractive to IO. Wu et al. (2023) have reported that IO can increase GI investment through their pressure and engagement. Additionally, Benlemlih et al. (2023) have found that institutions' ethical and ecological investment practices are beneficial for firms to innovate in a sustainable way.

Furthermore, GI should be seen as a long-term investment that provides numerous benefits beyond merely financial performance.

Female presence and green innovation

Corporate boards dominated by women make more sustainable decisions and promote sustainable practices. A woman's cautious, long-term, and community-oriented nature frequently sets her apart from a man's tendency to prioritize wealth, reputation, and personal success (Cambrea et al., 2023). Women are more aware of the environment and more empathic, which makes them more motivated to seek solutions benefiting the environment and community (Ciasullo et al., 2022; Lakhali et al., 2024). Issa and Bensalem (2023) have indicated that female leaders have an attitude of collaboration and cooperation, which promotes the investment in GI and reduces opportunism. Green patents are more likely to be granted if corporate boards are more gender diverse (Lakhali et al., 2024). Moreover, women's relational orientation facilitates the development of stronger relationships with influential stakeholders (Galbreath, 2011), leading to innovative thinking and creative strategies—for instance, GI (Hussain et al., 2018). Additionally, Islam et al. (2022) investigated the impact of women on GI. A positive correlation exists between the performance of innovation and the presence of female directors in industries with a high environmental impact. Female representation on boards has a substantial impact on firms' environmental disclosures (Cormier et al., 2024).

In accordance with Uyar et al. (2024), female presence is associated with firms' adoption of renewable energy. In countries with greater gender equality, firms are more likely to adopt renewable energy if they have more female directors. According to Issa (2023), female directors are more likely to adopt environmental innovations. A company with a higher percentage of female directors is more likely to adopt environmental innovations—particularly those relating to renewable energy and sustainable materials.

Over the past decade, substantial research has demonstrated the importance of having female directors on corporate boards in promoting a firm's sustainability and innovation in the area of sustainability. A director with a diverse perspective and experience tends to adopt sustainable practices and make more environmentally responsible decisions. To

drive sustainability and GI within corporations, gender diversity on corporate boards is important. To determine whether female directors contribute to GI and sustainability, additional research is needed. This research will enable corporations to make better-informed decisions and ultimately lead to a more sustainable future.

H1: Female presence on boards has a positive impact on firms' Green Innovation.

Institutional ownership and green innovation

Several theories have explained IO and corporate sustainability, including institutional theories, resource-based views, resource dependence theories, stakeholder theories, and legitimacy theories. Agency theory (AT), which emphasizes IO's monitoring, provides a primary explanation (Bebchuk et al., 2017). AT explores the issue of how investors can ensure that managers operate in their interests. Traditional corporate governance research has highlighted the importance of large investors (block holders) (Shleifer and Vishny, 1986). Due to their experience and resources, IO influence corporate strategies, particularly sustainability (Basse Mama and Mandaroux, 2022). Further, their support for initiatives such as the United Nations principles for responsible investment makes them instrumental in promoting corporate sustainability (Kordsachia et al., 2021). The rise of IO activism emphasizes the importance of IO in influencing management (Velte, 2023).

Velte (2020) has demonstrated that IO positively impacts corporations' environmental performance, which indicates that IO place greater importance on environmental factors when making investment decisions. Kim et al. (2019) have found a positive correlation between IO and the adoption of environmental management systems. In some studies, IO has not been linked to environmental performance. Kordsachia et al. (2021), for instance, have found that IO does not significantly impact corporate environmental performance. Additionally, Velte (2020) has shown that IO does not influence environmental disclosure.

Effect of institutional ownership on green innovation

The second theme in the literature addresses IO and GI. Studies on this relationship have been conducted in several countries, with mixed results. IO was found to be positively correlated with GI (Wu et al., 2023). Moreover, corporate governance moderates the relationship between IO and GI. According to (Kim et al., 2019), IO enhances GI when corporate governance mechanisms are strong. GI is also more likely to be engaged by firms with strong CSR practices (Velte, 2020).

Additionally, research has recently examined how IO may be able to participate in eco-finance finance—a term that refers to funding activities promoting sustainable economic growth (Liu and Xiong, 2022). Dutordoir et al. (2024) has found a positive correlation between green bonds and IO. According to Su (2021), IO favor environmental firms or green stocks. Furthermore, according to Zhao et al. (2023), investing in GI companies results in the issuance of more green patents as well as attracts IO interested in environmental, social, and governance (ESG) issues. Furthermore, Velte (2020) discovered that IO who engage in ESG initiatives have a greater likelihood of influencing portfolio companies.

A number of studies—particularly those that focus on environmental performance, GI, and green finance—have highlighted the importance of IO in promoting sustainability. Despite mixed evidence regarding the relationship between IO and GI, IO exert a considerable influence over companies to adopt more sustainable practices. Identifying

and examining the mechanisms by which IO can promote sustainability requires additional research.

H2: Institutional ownership is positively associated with Green Innovation.

Token vs mass female presence on boards

Women being underrepresented on corporate boards has long been a topic of discussion in the literature. Recent studies have analyzed the effect of token female representation (TFR) versus mass female representation (MFR) on board decisions, firm performances, and sustainability. Women often represent TFR on boards due to diversity quotas and legal requirements, and they are more likely to influence decisions if they are represented in MFR.

According to Amorelli and García-Sánchez (2020) TFR affects firms' sustainability more than MFR. Using TFR does not substantially influence ESG outcomes. Nevertheless, ESG performance—and thus the achievement of sustainability goals—has been positively correlated with a critical MFR.

Yarram and Adapa (2021) have also examined the impact of TFR vs. MFR on GI. Based on the researchers' conclusions, TFR negatively affects GI, whereas MFR positively affects. In contrast to TFR, who might feel isolated and lack influence in decision-making, MRF can provide diverse perspectives and experiences (Amorelli and García-Sánchez, 2020). Thus, MRF is necessary for companies to benefit from female presence and gain the positive GI effects associated with MRF.

He and Jiang (2019) investigated how the presence of women on their boards affects firms' GI. Similarly, the stewardship functions of IO and their compliance with national codes further enhance their credibility as sustainable investors. In addition to advocating for responsible and sustainable corporate practices, their efforts are crucial in fighting climate change and gender diversity (Velte, 2023). According to Issa and Bensalem (2023), companies with MRF tend to be more innovative and sustainable than those with only TRF. Thus, a MRF can produce sustainable outcomes and GI by bringing a diversity of perspectives and experiences to the table (Wang et al., 2022). The promotion of gender diversity on corporate boards is crucial to driving sustainability and GI, and women's involvement in corporate governance facilitates GI. Women are becoming catalysts for sustainable practices in corporate boardrooms, and they can also moderate IOs' relationship with GI. IO advocate for sustainable corporate practices and adhere to national codes, in addition to gender diversity (Velte, 2023). The expectation is that the nexus between IO and GI will be moderated when these two factors—IO and gender-diverse boards—intersect. Further research is necessary to fully understand how MRF impacts sustainability outcomes and GI.

H3: Women's mass representation in leadership moderates the nexus between institutional ownership and Green Innovation.

Ownership structure's moderating role in institutional ownership and green innovation

GI and IO have been extensively examined in the literature in the context of both state-owned (SOEs) and non-state corporations (NSOEs). The relationship between IO and GI is stronger for NSOEs (Hu et al., 2021) than for SOEs. NSOEs are more likely to adopt sustainable practices when they have IO. According to Hu et al. (2021), corporate environmental responsibility is positively impacted by IO in Chinese NSOEs.

Other studies have also demonstrated the relevance of IO in SOEs (Tonurist and Karo, 2016). Government policies and regulations relating to sustainable practices may

therefore lead to SOEs more frequently investing in GI. In their study, Tonurist and Karo (2016) have found a positive correlation between SOEs and corporate environmental responsibility; the ownership structure may moderate this relationship. NSOEs may be more likely to innovate greenly if their ownership structure is dispersed more widely (He and Jiang, 2019). When the government holds a greater stake in SOEs, IO may have a considerable impact on GI (Tonurist and Karo, 2016).

Ali et al. (2019) have found that institutions with a higher proportion of dispersed ownership were more likely to engage in GIs than companies with a lower proportion of dispersed ownership. The results of this study suggest that IO and GI are both more positively correlated in NSOEs with a more widely distributed ownership structure (He and Jiang, 2019). In contrast, in SOEs with a more concentrated ownership structure, the relationship between IO and GI may be stronger (Rong et al., 2017). IO can influence GI in different ways depending on the type of corporation and its structure. In the comparison of SOEs and NSOEs, it is important to consider the ownership structure when examining the relationship between IO and GI. Based on the literature review, we propose the following hypothesis:

H4: Ownership structure moderates the relationship between institutional ownership and Green Innovation.

Research methods

Sample

During the study period, we collected data from two major Chinese databases comprising financial, environmental, and non-financial variables for Chinese A-share listed companies between 2010 and 2022. In contrast to previous studies, which applied survey questionnaires for calculating GI, potentially introducing bias and heterogeneity (Song et al., 2020). We used a patent-based metric to measure GI activities following Acharya and Xu (2017) and Lakhal et al. (2024). Specifically, we measured innovation based on the number and nature of patents granted. GI were identified using the international patent classification (IPC). Pan et al. (2021) and Naveed et al. (2023) examined the intentions of listed companies to adopt GI by using information obtained from Chinese Research Data Services (CRDS). According to this method, GI can be more reliably measured than with traditional survey methods, aligning with existing literature (Pan et al., 2021; Naveed et al., 2023; Liu et al., 2024). We measured various financial and non-financial variables using the China Stock Market and Accounting Research (CSMAR) database, which yielded a final sample size of 65,286 firm years.

Companies listed on stock exchanges may be more motivated to invest in GI as a result of growing societal concerns about the environment. In 2012, the China Securities Regulatory Commission established three-digit industrial classification codes to identify subsectors. Women's lack of representation in groups and organizations can limit their influence (Kanter, 1977). The presence of female directors on the company's board serves as an independent variable in this research (Zahid et al., 2020; Naveed et al., 2021). In this case, we can see how having more women directors can benefit GI. Additionally, in order to assess the role of tokenism and critical mass on GI, we use proxies with one, two, three, and four women. Specifically, we are interested in testing whether firms' participation in GI is affected by a 'critical mass' of female directors. To determine whether female directors' sway grows with female board inclusion, we measure the number of female board directors relative to the total number of directors, denoted as

'female presence. In this study, we measured IO as a percentage of shares held by institutional investors divided by the total number of shares outstanding for the firm (Rong et al., 2017; Benlemlih et al., 2023; Velte, 2023; Zhao et al., 2023). We used a database compiled by the CSMAR to collect IO information. SOEs are, however, dummy variables =1 if the firm is classified as a state-owned entity under CSMAR. We conducted an additional analysis using the percentage change in IO. *Figure 1* shows theoretical framework of this study.

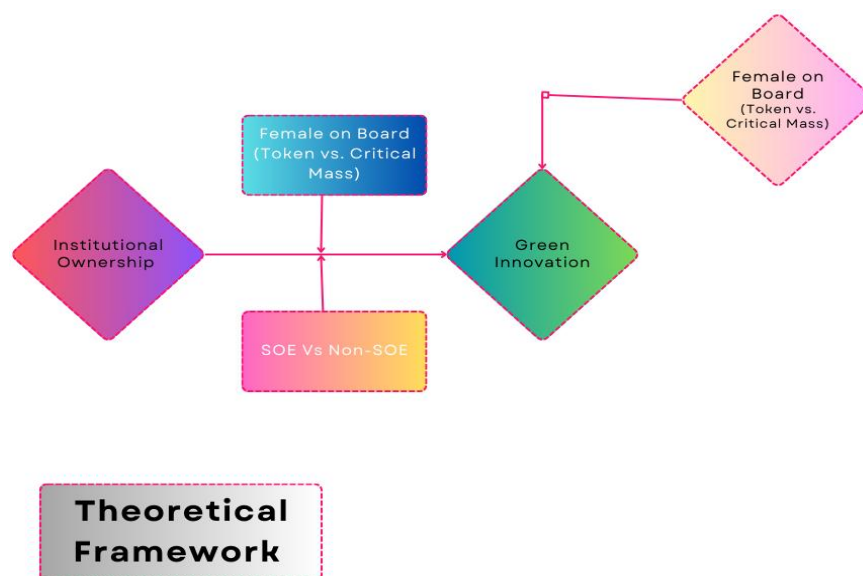


Figure 1. Theoretical framework

This study incorporates governance and firm-level control variables, based on research on GI determinants (He and Jiang, 2019; Naveed et al., 2023; Benlemlih et al., 2023; Liu et al., 2024). To control the potential effects of firm-level attributes, we incorporate R&D, firm size, and leverage into the model. Additionally, there are governance-level controls such as executive shares, director compensations, board size, and the number of independent directors. With these control variables included, we can isolate the true effects of female presence on boards and IO. Detailed information about corporate descriptions, financial statements, executive characteristics, and corporate patents can be found in the database of the CSMAR.

Methods

This study analyzed the impact of female presence on boards and IO on GI using Poisson regression, negative binomial regression, and zero-inflated binomial regression. Initially, Poisson regression was examined due to the dependent variable's count nature. When diagnostic tests indicated overdispersion in the data, however, negative binomial regression was selected since it was more effective at addressing this issue. Furthermore, zero-inflated binomial regression was applied to handle the excess zeros observed in our dataset, resulting in a better fit for modeling green innovation probability. The methods selected ensured that our data was analyzed accurately and robustly. Similar methodologies have also been employed in related research settings by Piperopoulos et al. (2023), and Liu et al. (2024).

Results and discussion

According to *Table 1*, the average of female directors per board of directors among the sample companies is 1.304. Despite having a maximum of 10 female directors, many of these companies do not prioritize gender diversity.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
IO	24332	4.588	5.325	0	74.99
GI	65286	.218	4.917	0	509
Board Size	47800	10.055	2.69	1	31
Independent Director	47800	3.485	1.45	0	13
Female Director	47800	1.304	1.208	0	10
R & D Investment	4432	2204.789	1273.586	1	4411
Executives Shares	45757	22132760	75840721	0	2.507e+09
Directors Shares	45870	42496276	1.205e+08	0	3.161e+09
Directors Compensations	45111	2102468.7	3168754.4	0	1.222e+08
Size	53989	21.772	1.51	10.842	31.138
Leverage	53989	.526	4.154	-.195	877.256

The average holding among IO is 4.588%, with a maximum holding of 74.99%. Firms in the sample appear to differ significantly in terms of IO.

According to the sample companies, the average score for GI is 0.218. GI seems to be active in some companies but low in most. The maximum score is 509, which indicates that some companies are actively engaged in GI.

Based on these descriptive statistics, the companies included in the sample should increase their focus on gender diversity and GI. The presence of female directors on boards and IO must be further examined as these relationships cannot be inferred solely from these statistics.

Table 2 shows that IO, female presence, and GI have a pairwise correlation. The correlation between IO and GI is weak and positive, with a coefficient of 0.04; accordingly, the variables exhibit a marginally significant relationship.

Table 2. Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) IO	1.000										
(2) GI	0.040*	1.000									
(3) Board Size	-0.010	0.049*	1.000								
(4) Independent Director	-0.007	0.038*	0.627*	1.000							
(5) Female Director	0.011	0.020*	0.240*	0.237*	1.000						
(6) R & D Investment	0.025	0.022	-0.012	-0.019	0.034	1.000					
(7) Executives Shares	-0.009	0.013	-0.036*	0.067*	0.066*	-0.017	1.000				
(8) Directors Shares	-0.010	0.007	-0.039*	0.078*	0.073*	-0.003	0.725*	1.000			
(9) Directors Compensations	0.067*	0.033*	0.189*	0.196*	0.099*	-0.031	0.136*	0.172*	1.000		
(10) Firm Size	0.023*	0.110*	0.322*	0.331*	0.019*	-0.007	0.070*	0.109*	0.387*	1.000	
(11) Leverage	-0.004	0.000	0.016*	0.011	0.000	-0.006	-0.008	-0.009	-0.006	-0.050*	1.000

*** p<0.01, ** p<0.05, * p<0.1

GI is correlated with female directorship, with a coefficient of 0.02. Board diversity and GI are positively correlated, which indicates that gender diversity is crucial to the progress of GI. This suggests that companies need to prioritize gender diversity in leadership positions to make GI thrive.

According to these correlations, IO and female directorship are important factors that influence GI in the sample of companies studied. To uncover these relationships, further research is required as correlations do not always imply causation. Variables other than those considered in the analysis may also contribute to the GI of these companies.

When the variance of the response variable is greater than the mean of the dataset, negative binomial regression may be used to model an over dispersed count dataset (Table 3). In the context of this study, which examines the relationship between female presence, IO, and GI, the negative binomial regression model is appropriate as the dependent variable; GI represents the number of green patents filed by the firm, and the data indicate overdispersion.

Table 3. Negative binomial regression

	(1) GI	(2) GI	(3) GI	(4) GI
IO	.231*** (.064)	.22*** (.060)	.23*** (.081)	.22*** (.075)
Firm Size	.82*** (.0825)	.75*** (.075)	.67*** (.072)	.697*** (.07)
Leverage	-1.46*** (.42)	-1.38*** (.39)	-1.35*** (.42)	-1.35*** (.43)
Board Size		.10** (.044)	0.09* (.050)	.097* (.051)
Independent director		-.091 (.067)	-.046 (.13)	-.044 (.075)
Female director		.60*** (.17)		
SOE			.17** (.08)	.15** (.082)
SOE x IO				.04 (.13)
Constants	-20.43*** (1.64)	-19.53*** (1.5)	-16.82*** (1.49)	-16.76*** (1.54)
Year Dummy	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES
lnalpha: _cons	2.935*** (.086)	2.89*** (.080)	3.081*** (.084)	3.08*** (.084)
Observations	22535	22534	19709	19709
Pseudo R ²	.063	.0935	.058	.057

As indicated by coefficient estimates of .231, the results of the negative binomial regression indicate that IO has both a significant and positive impact on GI. The negative and significant impact of leverage on GI is indicated by the coefficient estimate of -1.46. In addition, the organization's size with coefficient 0.82 substantial a significant role in influencing GI (He and Jiang, 2019), which is, in turn, not significantly affected by the number of independent directors (coefficient -0.091).

Based on a coefficient estimate of 0.60, female directors are associated with GI in a positive and significant manner. According to the results of the study, gender diversity and green performance are positively correlated (Naveed et al., 2023). SOEs appear to have a positive relationship with GI as the coefficient is 0.17. However, SOEs and IO do not interact significantly with coefficient 0.04; in other words, the influence of IO on GI is unmoderated by the firm's ownership structure.

As a result of negative binomial regression, we gain considerable insight into how IO and the presence of women affect GI. The presence of IO and women in the innovation process has a positive impact.

We performed Poisson regression analysis using count data—for example, how many green patents a firm filed. *Table 4* shows GI, how many green patents the firm has filed in the last two years. GI is the number of green patents the firm has filed in the last two years. An estimation coefficient, standard error, and level of statistical significance are provided for each independent variable in the model.

Table 4. Poisson regression result

	(1) GI	(2) GI	(3) GI	(4) GI	(5) GI
IO	.17*** (.06)	.19*** (.08)	.18*** (.09)	.19*** (.09)	.19*** (.08)
Firm Size	0.85*** (.08)	.87*** (.09)	.88*** (.01)	.87*** (.012)	.86*** (.014)
Leverage	-1.54*** (.45)	-1.58*** (.46)	-1.59*** (.47)	-1.59*** (.47)	-1.58*** (.46)
Board Size		.64*** (.06)	.65*** (.062)	.66*** (.062)	.68*** (.061)
Independent Director		.73*** (.21)	.74*** (.22)	.74*** (.21)	.77*** (.24)
Female Director		2.18*** (.17)	1.91*** (.15)	1.95*** (.16)	1.99*** (.15)
Executives Shares		.12*** (.010)	.13*** (.011)	.13*** (.011)	.15*** (.011)
Directors Shares		-.042*** (.012)	-.041*** (.010)	-.042*** (.011)	-.041*** (.012)
Directors Compensations		.032*** (0.011)	.033*** (.017)	.034*** (.018)	.037*** (.020)
SOEs			0.1*** (0.01)	0.12*** (0.01)	
SOE*IO				.065*** (.021)	
Constants	-22.58*** (.13)	-21.495*** (.381)	-20.42*** (.396)	-21.55*** (.455)	-21.12*** (.484)
Year Dummy	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES
Observations	22535	12360	11650	11650	12360
Pseudo R ²	.19	.19	.21	.18	.19

Our study found that the company's size has a significant and positive effect with coefficient 0.85 on the quantity of green patent applications filed by large companies. Furthermore, the coefficients (0.17, 0.19, 0.18, 0.19, and 0.19 in all models) for IO, which

measure internationalization extent, are significant and positive. This indicates that international firms are more likely to contribute to GI.

GI is, however, negatively correlated with the variable *lev* (coefficient -1.54), which measures the firm's leverage, which indicates that firms with higher debt levels are less likely to engage in GI. This is likely because firms with higher debt levels need to focus more on reducing their debt and thus have fewer resources available for GI. The coefficient (0.73) for the variable *independent director*, which measures the independence of the firm's directors, is positive and significant. In this regard, companies with independent directors are more likely to engage in GI. Furthermore, this suggests that independent directors are a valuable asset to firms, not only from a corporate governance standpoint but also in terms of their ability to facilitate GI.

Additionally, the relationship between SOEs and GI is significant and positive (coefficient .1), which suggests that SOEs perform better in GI than their counterparts. Similarly, SOEs and IO have a significant interaction with coefficient 0.065, which suggests that SOEs moderate the relationship between IO and GI. Therefore, IO can play a prominent role in promoting GI in SOEs, and SOEs must work together with IO to maximize the potential of GI.

Based on our analysis of this sample of Chinese firms, we conclude that IO and female presence influence firms' GI engagement substantially.

Table 5 shows a negative binomial regression analysis conducted to investigate the relationship between female presence, IO, and GI. A negative binomial regression model is appropriate in this situation as the dependent variable (count of GI) is a non-negative integer with an over dispersed distribution (the variance exceeds the mean).

Moreover, IO affects GI positively and significantly. The coefficient is 0.22 (in model 1) and the p-value less than 0.01. The results suggest that GI is more common among firms with large IO; thus, IO is an important factor when it comes to GI. Companies should consider increasing IO to promote GI initiatives.

Additionally, 0.76 and 0.06, the coefficients of firm size and board size, respectively, are positive and significant factors influencing GI. Based on this finding, larger firms and firms with large board sizes are more likely to engage in GI compared to smaller firms.

According to our results, female presence has a positive and significant effect on GI, with coefficients between 0.61 and 2.21, and the relationship becomes stronger with an increase in female representation on the board. Women's token representation on the board of directors a significant impact on GI (coefficient 0.06), but this relationship becomes stronger with mass representation of women on the board with coefficient 2.21. The evidence shows that firms with a greater proportion of female directors are more likely to invest in GI.

A further finding of the study is that the interaction between female presence and IO has a positive and significant impact on the emergence of GI; thus, IO positively impacts GI in firms with more female representation. GI is positively impacted by female representation, particularly in firms that hold a high level of IO. It is, however, heavily influenced by the firm's type of ownership and size.

Table 6 shows a Poisson regression for the female variable in the context of GI. Poisson regression is an important statistical tool for modeling count data, such as how many GI patents a company files. It is especially useful when non-negative integers are recorded in the dependent variable and normality is not assumed.

Table 5. *Negative binomial regression_female*

	(1) GI	(2) GI	(3) GI	(4) GI	(5) GI	(6) GI	(7) GI	(8) GI	(9) GI	(10) GI
IO	.22*** (.06)	.31*** (.10)	.23*** (.06)	.25*** (.077)	.23*** (.06)	.26*** (.07)	.24*** (.06)	.23** (.06)	.24*** (.06)	.23*** (.06)
Board Size	.06** (.03)	.067** (.029)	.07** (.03)	.076** (.03)	.06** (.031)	.06** (.031)	.06** (.031)	.07** (.031)	.076** (.031)	0.076** (.031)
Female Director	.61*** (.17)	.46*** (.14)								
Firm Size	.76*** (.077)	.77*** (.077)	.76*** (.077)	.77*** (.077)	.78*** (.07)	.79*** (.079)	.77*** (.079)	.77*** (.079)	.77*** (.078)	.77*** (.078)
Leverage	-1.38*** (.39)	-1.42*** (.39)	-1.58*** (.40)	-1.59*** (.41)	-1.55*** (.40)	-1.55*** (.40)	-1.61*** (.41)	-1.61*** (.41)	- 1.57*** (.41)	-1.57*** (.41)
Female Director x IO		.13** (.12)								
Female 2			.60*** (.18)	.52*** (.16)						
Female 2 x IO				.06 (.11)						
Female 1					.06 (.12)	.02 (.14)				
Female 1 x IO						.08* (.04)				
Female 3							.79*** (.21)	.81*** (.26)		
Female 3 x IO								.016* (.14)		
Female 4									2.03*** (.28)	2.21*** (.36)
Female 4 x IO										.13* (.065)
Constants	- 19.53*** (1.52)	- 19.74*** (1.56)	- 19.86*** (1.51)	- 19.95*** (1.52)	- 20.217*** (1.58)	- 20.29*** (1.57)	-20.0*** (1.58)	- 20.06** (1.57)	- 20.18** (1.57)	- 20.17*** (1.56)
Year Dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
lnalpha:_cons	2.89*** (.080)	2.89*** (.079)	2.89*** (.082)	2.89*** (.082)	2.92*** (.083)	2.92*** (.083)	2.90*** (.083)	2.90*** (.083)	2.90*** (.083)	2.90*** (.084)
Observations	22534	22534	22534	22534	22534	22534	22534	22534	22534	22534
Pseudo R ²	.093	.094	.093	.091	.090	.090	.092	.092	.094	.093

Standard errors are in parentheses; *** p<.01, ** p<.05, * p<.1

According to *Table 6*, the number of GI patents filed by a company is related to women's presence in senior management positions. We observe statistically significant coefficients for the female variable at 1%; accordingly, a high number of GI patents is associated with the presence of women in senior management positions. The presence of women on the board of directors has a significant impact on a company's long-term performance, and this relationship becomes more substantial as the proportion of women

on the board increases from token to mass representation. As observed in *Table 6*, token women have a positive and statistically significant (coefficient 0.17) impact on GI. According to model 10, in case of a mass representation of women on the board, the relationship becomes stronger, as indicated by the coefficient of 2.39. In terms of GI, mass female representation on boards is regarded as more influential and drives companies to perform better when it comes to GI. This suggests that the representation of female directors on boards is a powerful driver in increasing GI output, and companies should strive to create an environment of gender diversity on boards. This is similar to adding fertilizer to a garden; the combination of diverse voices gives the board the nutrients it needs to grow and flourish. Companies that invest in gender diversity on their board are setting themselves up for long-term sustainability and success.

Table 6. *Poisson regression_female*

VARIABLES	(1) GI	(2) GI	(3) GI	(4) GI	(5) GI	(6) GI	(7) GI	(8) GI	(9) GI	(10) GI
IO	0.11*** (0.04)	0.25** (0.11)	0.10 (0.07)	0.20*** (0.07)	0.11 (0.07)	0.082 (0.085)	0.10 (0.075)	0.09 (0.07)	0.11 (0.075)	0.10 (0.07)
Board Size	0.23*** (0.05)	0.22*** (0.05)	0.22*** (0.05)	0.21*** (0.04)	0.23*** (0.05)	0.24*** (0.06)	0.23*** (0.057)	0.22*** (0.06)	0.23*** (0.056)	0.22*** (0.06)
Independent Directors	0.31*** (0.07)	0.30*** (0.07)	0.29*** (0.08)	0.28*** (0.08)	0.29*** (0.08)	0.30*** (0.083)	0.29*** (0.083)	0.29*** (0.084)	0.29*** (0.083)	0.294*** (0.083)
Firm Size	1.06*** (0.14)	1.08*** (0.13)	1.07*** (0.13)	1.08*** (0.12)	1.04*** (0.13)	1.03*** (0.13)	1.05*** (0.14)	1.05*** (0.14)	1.06*** (0.13)	1.06*** (0.13)
Leverage	-2.70*** (0.44)	-2.88*** (0.44)	-2.72*** (0.44)	-2.77*** (0.41)	-2.67*** (0.42)	-2.57*** (0.43)	-2.75*** (0.44)	-2.72*** (0.45)	-2.73*** (0.44)	-2.73*** (0.52)
Female Dir.	0.17** (0.08)	0.015 (0.20)								
Female x IO		0.30* (0.16)								
Female1			0.15* (0.18)	0.32** (0.14)						
Female1 x IO				0.36*** (0.11)						
Female 2					0.47* (0.27)	0.78*** (0.25)				
Female2 x IO						0.24* (0.13)				
Female3							0.56* (0.37)	0.89*** (0.33)		
Female3 x IO								0.26* (0.13)		
Female4									1.67*** (0.35)	2.39*** (0.52)
Female4 x IO										0.47* (0.25)
Constants	- 25.33*** (3.14)	- 25.91*** (2.9)	- 25.60*** (2.93)	- 24.69*** (2.81)	- 25.07*** (2.87)	- 24.69*** (2.84)	- 25.28*** (2.91)	- 25.18*** (2.96)	- 25.37*** (2.95)	- 25.35*** (2.95)
Year Dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	22,534	22,534	22,534	22,534	22,534	22,534	22,534	22,534	22,534	22,534

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The number of GI patents filed by a company is positively correlated with IO with a coefficient of 0.11, and a higher level of IO is associated with more GI by companies. Overall, *Table 6* suggests that the presence of women and that of IO are significant variables when it comes to understanding GI. To improve GI and build a promising common future, gender diversity and IO should be encouraged in companies to enhance female presence and IO. In other words, GI needs a combination of female presence, IO, and other factors to reach its full potential.

In *Table 7*, we examine the effect of female presence and IO on GI using a zero inflated binomial regression. Patent count data are commonly affected by excess zeros, which can be accounted for with zero inflated binomial regression.

Table 7. Zero inflated binomial regression

	(1) GI	(2) GI	(3) GI	(4) GI	(5) GI	(6) GI	(7) GI	(8) GI	(9) GI	(10) GI
IO	.23*** (.05)	.32*** (.10)	.24*** (.063)	.28*** (.078)	.24*** (.061)	.26*** (.076)	.25*** (.063)	.24*** (.066)	.25*** (.063)	.25*** (.065)
Firm Size	.76*** (.077)	.77*** (.077)	.79*** (.079)	.79*** (.078)	.77*** (.076)	.77*** (.077)	.78*** (.080)	.77*** (.080)	.78*** (.079)	.78*** (.079)
Leverage	-1.37*** (.39)	-1.41*** (.39)	-1.55*** (.40)	-1.54*** (.40)	-1.57*** (.40)	-1.59*** (.41)	-1.61*** (.41)	-1.61*** (.41)	-1.56*** (.41)	-1.56*** (.41)
Board Size	.69** (.31)	.69** (.30)	.61* (.32)	.60* (.31)	.78** (.31)	.83*** (.31)	.75** (.32)	.75** (.32)	.81** (.33)	.81** (.32)
Independent D.	-.82 (.77)	-.90 (.76)	-1.09 (.77)	-1.18 (.75)	-.94 (.75)					
Female Dir.	.60*** (.17)	.44*** (.14)								
Female x IO		.14 (.12)								
Female 1			.05 (.12)	.05 (.14)						
Female 1 x IO				.10* (.10)						
Female2					.60*** (.17)	.53*** (.16)				
Female2 x IO						.06 (.11)				
Female3							.79*** (.21)	.82*** (.26)		
Female3 x IO								.02 (.15)		
Female 4									2.02*** (.28)	2.21*** (.36)
Female4 x IO										.13* (.065)
Constants	- 20.24*** (1.54)	- 20.43*** (1.55)	- 20.71*** (1.60)	- 20.71*** (1.59)	- 20.63*** (1.52)	- 21.13*** (1.62)	- 21.07*** (1.69)	- 21.06*** (1.69)	- 21.34*** (1.69)	- 21.33*** (1.69)
Year Dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
inflate:loginssh	8.35 (8.14)	8.63 (7.91)	7.17 (9.9)	7.25 (9.53)	7.73 (10.13)	7.76 (10.16)	7.60 (9.98)	7.55 (10.16)	7.97 (9.3)	7.92 (9.39)
inflate:_cons	-27.41 (26.78)	-28.32 (26.03)	-23.47 (32.53)	-23.71 (31.29)	-25.38 (33.39)	-25.54 (33.49)	-24.92 (32.82)	-24.74 (33.44)	-26.19 (30.72)	-26.00 (30.93)
lnalpha:_cons	2.88*** (.08)	2.88*** (.079)	2.91*** (.085)	2.91*** (.084)	2.88*** (.082)	2.89*** (.083)	2.89*** (.083)	2.89*** (.084)	2.89*** (.084)	2.89*** (.083)
Observations	22534	22534	22534	22534	22534	22534	22534	22534	22534	22534

Standard errors are in parentheses; *** p<.01, ** p<.05, * p<.1

The table shows 10 analyzed models, each with a different specification, and the dependent variable indicates how many the green patents are. In all models, the coefficient of the variable *Inst Sha* indicates a positive and significant effect of IO on GI. A higher level of IO in companies is associated with a greater likelihood of investing in green technologies.

According to models 1 and 2, the presence of female directors on the board of directors has a positive impact on GI with coefficients 0.60 and 0.44, respectively. When the relationship between gender and IO is examined, the significance of female presence reduces, although the effect remains positive in some cases, even if token and mass representation are included. Thus, institutional investors who promote sustainable practices may reduce the positive effects of female presence on GI.

The result of the zero inflated binomial regression analysis clarifies that when understanding the determinants of GI, it is important to consider the excess of zeros in count data and possible interactions between variables. IO appears to be a relevant driver of GI, while women's presence is more nuanced and depends on various factors.

Discussion

The results suggest that a stronger focus should be placed on gender diversity and GI in corporations. Female directorship and GI scores are low for the sample companies, which indicates that these two areas are not priorities for many organizations. The lack of gender diversity and involvement in GI in companies is alarming as studies have demonstrated that companies that are more gender diverse and engage in GI tend to have greater financial success (Eccles et al., 2013; Yadav and Prashar, 2022; Pareek et al., 2023). Additionally, the relationship between SOEs and GI is significant and positive, which suggests that SOEs perform better in GI than their counterparts (Ali et al., 2019). Similarly, SOEs and IO have a significant interaction, which indicates that SOEs moderate the relationship between IO and GI. Therefore, IO can play a prominent role in promoting GI in SOEs, and SOEs must work with IO to maximize GI.

Based on the negative binomial regression analysis in *Table 3*, we can gain a deeper understanding of the factors that determine GI. Substantial evidence indicates that institutional shareholding and firm size have a positive and significant effect on GI, in accordance with previous research (Rong et al., 2017; Velte, 2023). Meanwhile, the negative and significant impact of leverage on GI may indicate that firms with high debt levels are less likely to invest in green technology. Furthermore, the results of this study indicate that gender diversity and GI have a positive relationship, as demonstrated by previous research (He and Jiang, 2019; Naveed et al., 2023; Benlemlih et al., 2023). It is, however, important for Chinese firms to pay greater attention to the expected positive impact of female directors on GI. As female representation on the board increases, the relationship becomes stronger. Women's token representation on the board of directors has a significant impact on GI.

However, this relationship becomes stronger with mass women representation on boards. The evidence shows that firms with a high proportion of female directors are more likely to invest in GI. Thus, female directors on boards are a powerful driver in increasing GI output, and companies should strive to create an environment of gender diversity on boards. Companies that invest in gender diversity on their boards set themselves up for long-term sustainability and success. Moreover, the interaction between female presence and IO has a positive and significant impact on GI; thus, IO positively impacts GI in firms

with more female representation (Benlemlih et al., 2023). Female representation positively impacts innovation, particularly in firms with high IO. GI is, however, heavily influenced by the firm's type of ownership and size.

The discussed results highlight the need for increased emphasis on gender diversity and GI in companies. The mass representation of women on boards contributes to improving GI. However, the positive effects of IO and firm size on GI are consistent with previous studies. Companies should prioritize these areas to improve their financial performance and contribute to a more sustainable future. To improve GI and build a beautiful common future, gender diversity and IO should be encouraged in companies, and GI needs a combination of female presence, IO, and other factors to reach its full potential.

Conclusion

This study underlines the need for a holistic approach to sustainable development that integrates diversity, ethical leadership, and innovation. In addition to achieving gender equality, companies can promote innovative and sustainable solutions by empowering women and enforcing their participation in leadership. Our results highlight the importance of IO in influencing companies to adopt green practices. GI is positively associated with IO, which demonstrates the importance of IO in promoting corporate sustainability. Thus, IO are crucial to assisting companies in creating a sustainable business model and implementing GI.

Our findings, portray corporate dynamics in a captivating manner. There is a positive correlation between female presence on board and GI, as well as between IO and GI. This impact intensifies as the female presence on board's upsurges. It is also noteworthy that female representation and IO positively interact to promote GI. By following this narrative of interconnections and influences, we gain a deeper understanding of the dynamics shaping sustainable progress within organizations. The study also highlights the moderating role of SOEs, which can amplify the relationship between IO and GI. These results suggest that promoting gender diversity and encouraging collaboration between IO and SOEs are crucial strategies for advancing GI and environmentally friendly practices. To maximize the benefits of innovation and sustainability, companies should actively strive to increase the number of women in leadership positions. Both theoretical understanding and regulatory considerations can be gained from these findings. In addition to the robustness of the results, the study's conclusion is enhanced by alternative samples and regression specifications.

By examining the influence of female present and IO on GI in Chinese A-share listed companies, this study contributes to the existing body of knowledge. A sustainable future requires diversity, ethical leadership, and innovation. For a sustainable and prosperous future, policy-makers, managers, and stakeholders need to consider these findings when formulating strategies to promote gender diversity, ethical practices, and innovation. Moreover, this study highlights the relevance of both female presence and IO in driving GI, which could provide valuable guidance on how to foster an environment that encourages ecological sustainability. For these strategies to be effective, female and IO is central as it leads to GI. Patents were used as a measure of GI, which is one of the limitations of the study. Patents alone cannot fully indicate GI, as not all innovations are patentable, and some may not result in significant advancements or marketable products. Using alternative measures will improve the feasibility of future studies. Moreover, this

data has not been disaggregated by region or intensity of regulation, which can be useful for future research.

Theoretical and practical implications

The combined impact of female board presence and IO on GI in Chinese A-share listed companies is investigated through the integration of RDT, UET, and LT. The research extends RDT by depicting how women on boards and IO contribute to GI by emphasizing external dependency and diversity of resources. LT is reinforced as GI aligns with stakeholder needs and boosts enterprise legitimacy. In contrast, UET is bolstered through findings that demonstrate how different executive traits contribute to GI.

Practically, the study found that the mass presence of female boards and involving IO can significantly lead to GI. Specifically, mass female inclusion outperforms tokenism, and interaction between IOs and SOEs is vital to maximizing GI. A significant gap in research has been bridged by the contributions, which also present practical strategies for ensuring a sustainable future.

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Availability of data and materials section. This study is based on secondary data. All the data is available on the online data stream such as Chinese Research Data Services (CRDS) & China Stock Market and Accounting Research database (CSMAR).

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