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Board Gender Diversity and Innovation Strategies: Sectoral Effects on ESG Performance in Financial and Non-Financial Firms

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Abstract

This study empirically examines the joint effects of innovation strategy intensity and gender diversity in boardrooms on firms' environmental, social, and governance (ESG) performance. Drawing on the Resource-Based View and Upper Echelons Theory, we analyse a panel of financial and non-financial firms listed in the FTSE 350 on the London Stock Exchange over the period 2012–2023. Using panel regression models, we find that innovation intensity is positively associated with ESG performance across both sectors. Board gender diversity also exhibits a positive relationship with ESG performance; however, the effect is economically weaker and statistically insignificant for non-financial firms. The proportion of women employees shows sector-specific effects, being negatively related to ESG performance in financial firms but positively related in non-financial firms. While women in management positions are positively associated with ESG performance in nested models, this relationship weakens in full specifications, suggesting the influence of competing organisational factors. Notably, the presence of female executives consistently enhances ESG performance across models. Overall, the findings highlight the importance of gender diversity in senior leadership for advancing ESG outcomes and raise questions about whether conventional innovation metrics adequately capture sustainability-oriented innovation. The study offers important theoretical and managerial implications.

Keywords: innovation strategies; innovation intensity; R&D intensity; corporate governance; board gender diversity; environmental, social, and governance (ESG) performance; innovation; UK

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1. Introduction

Environmental, social, and governance (ESG) disclosure has become a major concern for a wide range of stakeholders, particularly over the past two decades. This heightened attention reflects growing stakeholder concerns about the impact of corporate activities on the environment and society. ESG provides a structured framework for understanding a firm's commitment to environmental protection, social justice, and accountable governance, thereby expanding the traditional profit-maximisation objective to incorporate broader sustainability responsibilities.

Globally, green and sustainable development has emerged as a core objective of economic transformation and public policy (Behera et al., 2024). According to the United Nations Industrial Development Organisation (UNIDO, 2023), many countries have introduced strategic policies over the last decade to promote environmentally and socially sustainable economic transformation (Y. Liu et al., 2024). As a result, stakeholder expectations regarding corporate accountability for environmental and social impacts have intensified. Firms are increasingly pressured to manage ESG-related risks across their operations and supply chains. Failure to address these risks may expose firms to legal liabilities, litigation, and increased regulatory enforcement (Xie & Lv, 2024; P. Xu et al., 2022).

ESG represents an accountability framework that integrates commercial objectives, such as profitability, with sustainable business practices to achieve long-term economic and environmental value. Consequently, ESG has become a critical consideration for organisations pursuing sustainable growth and has attracted significant attention from governments worldwide (Chen et al., 2023; Tsang et al., 2023; P. Xu et al., 2022). Given its growing influence on corporate strategy and performance, it is essential to examine the key drivers shaping firms' engagement with ESG initiatives.

Corporate governance, particularly the role of boards, plays a pivotal role in shaping ESG strategies. Bamahros et al. (2022) argue that effective boards are essential for proactively addressing ESG challenges and facilitating the cultural and strategic shifts required for sustainable transformation. Without appropriate governance structures, ESG strategies risk becoming fragmented and reactive. Albitar et al. (2023) emphasise that strong governance enhances firms' ability to meet evolving stakeholder expectations, strengthen risk resilience, and capitalise on ESG-related opportunities. Boards are therefore central to aligning ESG initiatives with corporate strategy, focusing on material issues, setting accountability mechanisms, and monitoring performance. However, prior research indicates that board involvement in ESG strategy remains underdeveloped, often positioning ESG as a compliance exercise rather than a source of competitive advantage (Albitar et al., 2023; Alkaraan et al., 2023).

The relationship between innovation strategies and ESG performance is also complex. Firms' innovative capacity is commonly reflected in research and development (R&D) expenditure and patent activity. Existing studies suggest that innovation strategies, particularly eco-innovation, can enhance ESG outcomes while supporting long-term competitiveness and corporate reputation (Duque-Grisales et al., 2020; Huang et al., 2023). Green innovation, including eco-design, resource efficiency, and waste-reduction technologies, enables firms to reduce environmental impact and align with sustainability objectives. Although initial R&D investments may temporarily reduce profitability, long-term benefits often include improved ESG performance and increased stakeholder trust. Empirical evidence from Europe and the United States shows that higher levels of R&D investment and patent production are associated with stronger ESG performance, especially environmental outcomes (Dicuonzo et al., 2022).

Despite these insights, limited research has examined the combined influence of innovation intensity strategies and boardroom gender diversity on ESG performance, particularly through a comparative analysis of financial and non-financial firms. Most existing studies assume that only sustainability-oriented innovation directly improves ESG outcomes, overlooking the potential role of broader innovation intensity (Pinheiro et al., 2024; Ahmad & Wu, 2022). This assumption is increasingly misaligned with the rapid growth of sustainable finance, where ESG considerations are incorporated into investment decisions alongside traditional financial indicators. To address this gap, the study provides UK evidence from a comparative analysis of financial and non-financial listed firms, adopting a contingency perspective to examine how innovation intensity and

corporate governance jointly influence ESG performance, while controlling for firm age and firm size.

Finally, while prior research on ESG disclosure has expanded significantly, it has largely focused on governance drivers, including board structure and demographic characteristics such as gender diversity (Tsang et al., 2023; Cheung & Lai, 2023; Martínez-Ferrero et al., 2021; Gallego-Álvarez & Pucheta-Martínez, 2022). Findings remain mixed, with some studies reporting positive effects of gender diversity on ESG outcomes (Nicolò et al., 2021; Khemakhem et al., 2023; Bhatia & Marwaha, 2022), while others identify threshold or context-dependent effects (Bananuka et al., 2022; Amorelli & García-Sánchez, 2020; De Masi et al., 2021). Recent research highlights the importance of organisational and structural contingencies in shaping this relationship, supporting the need for a contingency-based approach (García-Sánchez et al., 2020; Alkhawaja et al., 2023; Centinaio, 2024; Khidmat et al., 2022). This study contributes to the literature by examining how innovation strategies and boardroom gender diversity jointly influence ESG performance.

Consequently, the following three research questions serve as the basis for this investigation:

RQ1. *Does the intensity of companies' innovation strategies strengthen ESG performance?*

RQ2. *Does the combined influence of innovation strategies' intensity and corporate boardrooms' diversity improve ESG performance?*

RQ3. *What is the influence of industry type (financial, non-financial) and firm characteristics on the relationship between innovation strategies' intensity, corporate boardrooms' diversity, and ESG performance?*

The remainder of this study is structured as follows. Section 2 provides conceptualisation and hypotheses development. Section 3 illustrates the research design. Section 4 reports the empirical results, and Section 5 provides the conclusion.

2. Literature Review and Hypothesis Development

The Resource-Based View (RBV) (Barney, 1991) posits that a firm's ability to achieve and sustain competitive advantage depends on its possession and deployment of valuable, rare, inimitable, and non-substitutable resources. In a sustainability context, innovation-related resources, such as research and development (R&D) capabilities, technological expertise, and organisational know-how, enable firms to develop green technologies, implement sustainable practices, and strengthen ESG performance. Firms with higher R&D intensity are therefore better positioned to build sustainability-oriented capabilities that enhance long-term value creation. Larger firms, in particular, tend to possess superior financial and organisational resources, allowing them to invest more heavily in sustainability-driven innovation (López-Gamero et al., 2010). However, smaller firms may compensate for resource constraints through dynamic capabilities that allow them to respond more rapidly to changing stakeholder and regulatory pressures (Teece et al., 1997).

From a governance perspective, RBV can be extended to human and relational capital embedded within corporate boards. Drawing on resource dependence logic, board members contribute heterogeneous knowledge, skills, and networks that can enhance a firm's engagement with external stakeholders. In this regard, female directors provide distinctive cognitive and relational resources that facilitate stakeholder dialogue and collaboration, thereby strengthening ESG practices (M. A. Harjoto et al., 2019; Lewellyn & Muller-Kahle, 2024). Prior studies suggest that female directors tend to exhibit stronger stakeholder orientation and greater sensitivity to social and environmental concerns, whereas male directors are more often associated with shareholder-focused priorities (Wang et al., 2022; Nadeem et al., 2020). As such, board gender diversity constitutes a valuable governance resource that can shape firms' sustainability strategies and ESG outcomes (Liao et al., 2015).

The Upper Echelons Theory (UET) provides a complementary behavioural lens for understanding how board composition influences ESG performance. UET argues that organisational outcomes reflect the values, cognitive frames, and experiences of top executives and board members (Hambrick, 2007). Strategic decisions, including those related to ESG engagement, are therefore shaped by the demographic and psychological characteristics of those in senior leadership positions. Gender-diverse boards are expected to enhance decision-making quality by introducing broader perspectives, reducing groupthink, and fostering more balanced evaluations of environmental and social risks and opportunities (Carvajal et al., 2022). Consequently, UET suggests that gender diversity at the board level can influence the prioritisation and implementation of ESG initiatives by shaping how sustainability challenges are perceived and addressed.

Both RBV and UET offer a robust theoretical foundation for examining how innovation intensity and boardroom gender diversity jointly influence ESG performance. RBV highlights the strategic role of innovation and governance resources, while UET explains how board characteristics shape strategic choices related to sustainability. Integrating these perspectives enables a more nuanced understanding of how firms translate innovation capabilities and board diversity into ESG outcomes, thereby informing the hypotheses developed in this study.

2.1. Innovation Intensity Strategies and ESG Performance

Innovation intensity, commonly operationalised through research and development (R&D) investment, is widely recognised as a critical driver of firms' sustainability initiatives. R&D expenditure enables the development of environmentally friendly technologies, more efficient resource utilisation, and sustainable business models. Prior studies suggest a positive association between R&D intensity and ESG performance, as firms with stronger innovation capacity are better positioned to implement sustainability-oriented practices. For example, De Santis and Presti (2018) demonstrate that increased R&D expenditure positively influences ESG performance by fostering eco-innovation, highlighting innovation as an effective mechanism for advancing sustainable corporate practices. While the literature generally supports a link between innovation and sustainability outcomes (Ahmad & Wu, 2022), empirical findings remain inconclusive.

Although research examining the economic and financial consequences of ESG performance is extensive (Do & Kim, 2020), empirical evidence directly linking ESG performance to innovation intensity remains limited (F. Zhang et al., 2020). Existing studies have largely focused on green or eco-innovation, potentially overlooking the broader role of innovation intensity in shaping ESG outcomes (J. Xu et al., 2021). Using firm-level data finds that firms with higher R&D investment exhibit superior ESG performance, supporting the argument that innovation intensity enhances firms' sustainability capabilities. Similarly, a strong positive relationship between R&D investment, patent activity, and ESG engagement across industrial firms in Europe and the United States.

Related evidence from cross-country and sector-specific studies further supports this relationship. Ahmad and Wu (2022) show that eco-innovation contributes significantly to environmental sustainability across OECD countries, particularly in economies with higher ecological pressure. Subramanian et al. (2024) demonstrate that ESG dimensions act as necessary conditions for organisational innovation, measured through R&D expenditure, in multinational life sciences firms. At the firm level, Shahnaz and Emranul (2024) find that sustainable innovation improves ESG performance among Bangladeshi listed firms, while X. Liu et al. (2024) show that both radical innovation and incremental green innovation enhance ESG outcomes in Chinese A-share companies.

These studies suggest that innovation intensity represents a strategic capability that can strengthen ESG performance by enabling firms to respond to regulatory pressures, stakeholder expectations, and sustainability challenges. Building on this literature, and extending it to a comparative UK setting that includes both financial and non-financial firms, this study proposes the following hypothesis:

H1. *Firm innovation strategies have a significant positive effect on ESG performance of listed financial and non-financial firms in the UK.*

2.2. Corporate Boardrooms' Gender Diversity and ESG Performance

Growing awareness of environmental, social, and governance (ESG) issues has intensified public scrutiny of corporate behaviour, exposing firms to increasing stakeholder expectations, regulatory requirements, and market pressures (Brogi et al., 2022; Irawan & Okimoto, 2022). As investors, consumers, and regulators demand greater transparency and accountability, ESG disclosure has become a key mechanism through which firms signal their commitment to sustainable values (Cerciello et al., 2023; Wang et al., 2022; Ye et al., 2022). In this context, corporate governance plays a central role in shaping how ESG priorities are formulated, implemented, and monitored. Prior research highlights that the interaction between governance structures and ESG reporting is critical for addressing emerging ethical, social, and environmental challenges (Ahmad et al., 2023; Chebbi & Ammer, 2022).

Within this governance context, boardroom gender diversity has attracted increasing scholarly attention. A growing body of evidence suggests that female directors enhance ESG engagement by bringing diverse perspectives, greater stakeholder sensitivity, and stronger ethical orientation to board deliberations. For instance, Nicolò et al. (2021) find that female board representation positively influences both aggregated and individual ESG scores in European firms. However, this relationship is not uniform. The impact of female directors depends on their experience and expertise, while Cucari et al. (2018) report a negative association between female board representation and ESG disclosure in Italy. In contrast, evidence from Canada indicates a positive role of women directors in ESG-related decision-making (Khemakhem et al., 2023).

Disaggregated analyses of ESG dimensions further illustrate the value of board gender diversity. Prior studies demonstrate that female directors contribute positively to greenhouse gas reporting (Tingbani et al., 2020), anti-corruption, and gender-related disclosure transparency (Furlotti et al., 2019). UK-based evidence also suggests that gender-diverse boards strengthen corporate engagement in social initiatives and improve risk management and performance. At the same time, several studies argue that a critical mass of female directors is often required for these effects to materialise (Amorelli & García-Sánchez, 2020; De Masi et al., 2021).

Overall, international evidence consistently indicates a positive association between female board participation and ESG outcomes, although the strength and significance of this relationship remain context-dependent (Lavin & Montecinos-Pearce, 2021; Bhatia & Marwaha, 2022; Nuhu & Alam, 2024). Larger boards with greater female representation have also been shown to play a more effective role in sustainability reporting and strategic ESG decision-making (Mahmood et al., 2018; Zahid et al., 2020). Building on this literature, and extending it to a comparative analysis of financial and non-financial firms, this study proposes the following hypothesis:

H2. *Corporate boardrooms' gender diversity positively impacts ESG performance in both financial and non-financial firms.*

2.3. Moderating Role of Firm Characteristics (Size and Age)

Although firm innovation, particularly through R&D investment, has been widely recognised as a key driver of sustainability performance, there is increasing acknowledgement that this relationship is contingent on firm-specific characteristics, notably firm size. Firm size significantly shapes a firm's capacity to innovate and to implement sustainability-oriented practices. Larger firms typically possess greater financial resources, diversified portfolios, and established market positions, enabling them to invest more extensively in R&D and ESG-related initiatives. In contrast, smaller firms often face resource constraints but may demonstrate greater flexibility and adaptability in implementing innovative and sustainable practices.

The moderating effect of firm size on the innovation–sustainability relationship is therefore complex and multifaceted. Several studies suggest that larger firms experience a stronger positive impact of innovation on ESG performance due to economies of scale, superior resource availability, and greater stakeholder influence. For example, Ma et al. (2024) find that R&D investments in large firms lead to significant improvements in sustainability reporting and performance, largely because such firms are better able to absorb the costs associated with sustainable innovation. In addition, larger firms are typically subject to greater public scrutiny and regulatory pressure, which further incentivises them to leverage innovation capabilities to meet ESG expectations.

Conversely, other studies indicate that firm size may exert a neutral or even negative moderating effect. Smaller firms, despite limited resources, may implement sustainability-focused innovations more rapidly due to lower bureaucratic inertia and stronger entrepreneurial orientation. Buallay et al. (2020) show that in small- and medium-sized enterprises (SMEs), R&D activities are closely linked to sustainability performance, often driven by niche market opportunities and organisational agility. By contrast, large firms may suffer from organisational inertia, bureaucratic complexity, and risk aversion, which can slow the adoption of sustainability-oriented innovations.

Despite these insights, empirical evidence examining the moderating role of firm size in the relationship between boardroom gender diversity, firm innovation, and ESG performance remains limited. Addressing this gap, the present study proposes the following hypothesis:

H3. *Firm size has a significant moderating effect on the relationship between corporate boardrooms' gender diversity, firm innovation strategies, and ESG performance in firms listed in the UK.*

Firm age influences organisational behaviour and strategic decision-making through its effects on accumulated resources, experiential learning, and risk tolerance. Older firms typically possess established routines, institutional memory, and reputational capital, which can facilitate more consistent and structured ESG practices. In contrast, younger firms often display greater agility, adaptability, and innovative capacity, enabling them to experiment with emerging ESG practices.

Older firms may benefit from long-standing relationships with key stakeholders, allowing them to leverage trust and credibility in ESG reporting and implementation. Conversely, younger firms may capitalise on technological advances and evolving sustainability trends to pursue ESG objectives more innovatively. Prior studies show that governance characteristics—such as board diversity, CEO duality, and ownership structure—significantly influence ESG performance. In particular, gender-diverse boards are associated with stronger ESG disclosure and environmental stewardship due to broader perspectives and enhanced ethical oversight (García-Sánchez et al., 2019).

Empirical evidence suggests that mature firms often adopt more conservative governance approaches that emphasise risk management and regulatory compliance. Buallay et al. (2020) find that older firms exhibit higher ESG scores, supported by structured governance frameworks and greater financial stability. By contrast, younger firms may adopt entrepreneurial governance models that support innovative ESG strategies but face constraints related to limited resources and short-term performance pressures.

Amran et al. (2015) further argue that firm age strengthens the effectiveness of governance mechanisms in shaping ESG practices through organisational learning and institutionalisation. Older firms are more likely to embed ESG practices within formal governance systems, supported by economies of scale, stakeholder credibility, and financial resources. Younger firms, while flexible and adaptive, often lack the regulatory expertise, reporting capabilities, and governance maturity required for sustained ESG performance. Consistent with prior literature (Abdi et al., 2022; Yin et al., 2022), this study therefore examines the moderating role of firm age in the relationship between corporate governance, innovation intensity, and ESG performance.

H4. *Firm age has a significant moderating effect on the relationship between gender diversity, firm innovation, and ESG performance in firms listed in the UK.*

3. Methodology

This study employs an ex post facto research design to examine how changes in the independent variables are associated with variations in the dependent variable. Under this approach, existing data are analysed to identify correlations and potential cause–effect relationships without manipulating any variables.

The sample comprises FTSE 350 firms publicly listed on the London Stock Exchange (LSE). The FTSE 350 includes companies across multiple industries and ownership structures, offering a comprehensive representation of the UK corporate landscape. Compared with smaller samples, FTSE 350 firms provide broader sectoral coverage, enhancing the generalisability of the findings across diverse corporate contexts.

Given the longitudinal nature of the dataset, panel regression techniques are used to estimate the models. Panel methods are appropriate because they allow the study to control for unobserved firm-level heterogeneity that may otherwise bias the results. The empirical analysis adopts a comparative approach between financial and non-financial firms in the UK, enabling sectoral differences to be examined explicitly. The selection of the panel estimator (e.g., fixed effects versus random effects) is guided by the nature of the data and formal diagnostic testing, ensuring that time-invariant unobserved characteristics and potential correlation with explanatory variables are appropriately addressed. In addition, robust inference procedures are applied to account for potential heteroskedasticity and serial correlation in the error structure.

The study period covers 2012 to 2023 (11 years). This window is selected because it coincides with major regulatory and market developments shaping ESG practices in the UK and reflects the progression of ESG integration into corporate strategy, driven by domestic regulation and international commitments. Key milestones include the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, which introduced non-financial reporting requirements and strengthened transparency on environmental and social matters. The UK's adoption of the EU Non-Financial Reporting Directive (NFRD) in 2017 further reinforced ESG disclosure obligations and encouraged the incorporation of ESG issues into strategic decision-making. Finally, the 2015 Paris Agreement intensified global commitments to reduce carbon emissions, influencing corporate sustainability agendas throughout the study period.

To address potential endogeneity concerns, including reverse causality, omitted variable bias, and simultaneity, several mitigation strategies are employed. First, key independent variables are lagged to reduce the likelihood of contemporaneous feedback from ESG performance. Second, firm fixed-effects models are used to control for time-invariant unobserved heterogeneity. Third, the inclusion of year fixed effects and a comprehensive set of control variables helps capture common macroeconomic and regulatory shocks. Finally, robustness checks using alternative model specifications are conducted to assess the stability of the results. Together, these approaches enhance the credibility of the empirical findings and support cautious causal interpretation.

Model Specification

Model 1: Corporate Governance, Innovation Intensity, and ESG Model

$$ESG_{it} = \gamma_1 + \propto_2 PCT_WB_{it} + \propto_3 PCT_WEMP_{it} + \propto_4 PCT_WMGT_{it} + \propto_5 NFEXEC_{it} + \propto_6 BoD_{Age_{it}} + \propto_7 goodwill_{ta\ it} + \propto_8 RoA + \propto_9 Ino_Int_{it} + \propto_{10} PE_Ratio_{it} + \propto_{11} RET_{SHF_{it}} + \mu_{it}$$

Model 2: Corporate Governance, Innovation Intensity, and ESG—Contingency Model 1

$$ESG_{it} = \gamma_1 + (\propto_2 PCT_{WB_{it}} + \propto_3 PCT_{WEMP_{it}} + \propto_4 PCT_{WMGT_{it}} + \propto_5 NFEXEC_{it}) * firm_{Size_{it}} + \propto_6 BoD_{Age_{it}} + \propto_7 goodwill_{ta\ it} + \propto_8 RoA + (\propto_{10} Ino_Int_{it}) * firm_Size + \propto_{11} PE_Ratio_{it} + \propto_{12} RET_{SHF_{it}} + \mu_{it}$$

Model 3: Corporate Governance, Innovation Intensity, and ESG—Contingency Model 2

$$ESG_{it} = \gamma_1 + (\propto_2 PCT_WB_{it} + \propto_3 PCT_WEMP_{it} + \propto_4 PCT_WMGT_{it} + \propto_5 NFEXEC) * firm_Age + \propto_6 BoD_{Age_{it}} + \propto_7 goodwill_{ta\ it} + \propto_8 RoA + (\propto_6 Ino_Int_{it}) * firm_Age_{it} + \propto_9 PE_Ratio_{it} + \propto_{10} RET_{SHF_{it}} + \mu_{it}$$

Table 1 shows definitions of the variables underlying this study.

Table 1. Definition of variables.

Variables	Mnemonic	Definition/Estimation
ESG Score	ESG_Score	Environmental, social, and governance (ESG) factors help to measure the sustainability and social impact of business activities. The firms' ESG scores were extracted from the FTSE 350 listed companies' published annual financial report since 2012 to 2023
Innovation intensity	Ino_Int	R&D expenditure and patents are typical proxies for innovation input and output. R&D investment is a representation of a firm's technological knowledge. According to previous studies (F. Zhang et al., 2020), innovation performance is also measured by R&D/Total Assets Ratio
PCT_WB	PCT_WB	Percentage of women on the board
NFEEXEC	NFEEXEC	Number of females executives
PCT_WEMP	PCT_WEMP	Percentage of females in the organisation
PCT_WMGT	PCT_WMGT	Percentage of females in management
Return on Asset	ROA	Return on Asset is the company's ability to make a profit.
Financial Leverage	Gearing	Ratio between total liabilities/total assets

Table 1. *Cont.*

Variables	Mnemonic	Definition/Estimation
Return on Capital Employed	ROCE	This helps investors see through growth forecasts, being a very useful tool in calculating the efficiency and profitability of capital investments in the company, and for identification of those areas which are central for the maintenance and growth of resources and performance.
Goodwill to Total Asset	(gdwill_ta)	Goodwill, the present value of the anticipated excess earnings discounted over a certain number of years.
Total Asset	Assets	Total Assets
Firm Age	F.AGE	Number of years from listing date till 2023.

4. Results and Discussion

4.1. Descriptive Statistics

Table 2 reports the descriptive statistics for financial and non-financial firms. On average, non-financial firms exhibit higher ESG scores than financial firms, although variability is greater among non-financial firms, as reflected in higher standard deviations. Measures of board gender diversity (percentage of women on boards, in management, and among employees) are broadly comparable across sectors, with slightly higher averages observed in financial firms. Financial firms also display a higher mean number of female executives, consistent with stronger governance and regulatory expectations in the sector.

Table 2. Descriptive statistics.

	Mean	Max	Min	Std. Dev.	Mean	Max	Min	Std. Dev.
	Non-Financial Firms				**Financial Firms**			
ESG	0.486	0.763	0.235	0.099	0.4257	0.753	0.2443	0.054
PCT_WB	0.268	0.75	0.062	0.108	0.286	0.555	0.083	0.06
PCT_WEMP	0.362	0.82	0.03	0.144	0.425	0.679	0.197	0.05
PCT_WMGT	0.25	0.6792	0.02	0.096	0.254	0.67	0.09	0.045
NFEXEC	3.341	16	2	2.125	4.131	14	2	1.216
BOD_AGE	57.617	70	40	3.134	57.728	64.67	51.14	1.423
Ino_Int	−0.224	1036.179	−2516.88	66.325	0.459	296.921	−696.898	28.812
TOTAL_ASSETS	12.361	901.342	−62.455	39.385	10.701	271.256	−98.896	24.879
Firm_AGE	62.255	139	−1	46.002	59.222	150	4	45.456
ROA	8.336	311.172	−65.096	20.553	4.422	70.967	−49.854	10.363
GEARING	89.7	990.262	0	123.381	35.793	939.334	0	113.384
GOODWILL_ASSETS	0.158	0.802	0	0.159	0.041	0.489	0	0.067
PE_RATIO	41.334	10,060	0.0601	268.523	13.415	192	1.78	13.595
RET_SHF	19.081	442.59	−705.546	43.54	8.179	100.743	−88.233	15.59

Innovation intensity and firm size show substantial dispersion in both samples, indicating heterogeneity in R&D engagement and asset scale. Financial performance indicators (ROA, gearing, and returns) exhibit greater volatility among non-financial firms, reflecting sectoral differences in risk profiles and operating structures. Overall, the descriptive statistics suggest meaningful variation across firms and sectors, supporting the suitability of panel regression analysis.

4.2. Correlation Metrics Analysis

Table 3 presents the pairwise correlations between the main variables. Overall, the correlations are moderate in magnitude, suggesting no immediate concerns regarding multicollinearity. Board gender diversity variables, particularly women in management and the number of female executives, are positively correlated with ESG performance in both sectors, with slightly stronger associations observed in financial firms. However, these correlations are interpreted cautiously, as they do not imply causality.

Table 3. Pearson correlation.

	ESG	PCT_WB	PCT_WEMP	PCT_WMGT	NFEXEC	BOD_AGE	Ino_Int	TASSET	FAGE	ROA	lev	GW_AST	PE_RATIO	RET_SHF
Financial firms														
ESG	1													
PCT_WB	0.31	1												
PCT_WEMP	0.21	−0.03	1											
PCT_WMGT	0.17	0.14	0.28	1										
NFEXEC	0.39	0.24	0.18	0.22	1									
BOD_AGE	0.53	0.34	0.14	0.21	0.25	1								
Ino_Int	−0.08	0.03	0	−0.02	0.08	−0.04	1							
TASSET	−0.11	−0.04	−0.1	−0.1	−0.04	−0.11	0.02	1						
AGE	−0.04	0.03	−0.18	−0.11	−0.02	0.01	0.01	−0.07	1					
ROA	−0.11	−0.03	−0.23	−0.17	−0.07	−0.16	0.01	0.03	−0.02	1				
GEARING	0.44	0.15	0.05	0.15	0.24	0.23	0.02	0.01	−0.06	−0.03	1			
GWILL_AST	0.19	0.13	−0.48	−0.29	−0.04	0.03	0	−0.02	0.07	0.19	0.12	1		
PE_RATIO	0.14	−0.06	0.03	0.06	0.02	0.14	0.09	−0.05	−0.05	0.05	0.1	0.06	1	
RET_SHF	0.09	0.04	−0.21	−0.15	−0.02	−0.02	0	0.11	−0.12	0.53	0.17	0.28	0.11	1
	ESG	PCT_WB	PCT_WEMP	PCT_WMGT	NFEXEC	BOD_AGE	Ino_Int	TASSET	FAGE	ROA	lev	GW_AST	PE_RATIO	RET_SHF
Non-financial firms														
ESG	1													
PCT_WB	0.32	1												
PCT_WEMP	−0.07	0.16	1											
PCT_WMGT	0.09	0.3	0.54	1										
NFEXEC	0.27	0.33	0.17	0.28	1									
BOD_AGE	0.27	0.01	−0.2	−0.09	0.06	1								
R_D	−0.01	−0.01	−0.02	0.02	0	0	1							
TASSET	−0.04	−0.01	−0.01	−0.01	−0.04	−0.03	0.01	1						
AGE	0.24	−0.01	−0.07	−0.04	0.1	0.16	−0.04	−0.07	1					
ROA	−0.1	0.02	0.07	0.02	−0.08	−0.18	0	−0.01	−0.07	1				
GEARING	0.16	0.06	0.03	0.06	0.15	0.02	0.02	−0.01	0.13	−0.08	1			
GWILL_AST	−0.14	0.03	−0.03	−0.07	−0.07	−0.05	0.03	0.02	0	−0.03	−0.06	1		
PE_RATIO	−0.01	0.04	−0.03	−0.04	0	0.08	0	0.01	−0.02	−0.03	−0.02	0	1	
RET_SHF	−0.02	0	0.1	0.06	−0.05	−0.1	0	0.04	0.02	0.33	0.06	0	−0.03	1

Board age shows a positive correlation with ESG performance in financial firms, while the association is weaker in non-financial firms, indicating possible sectoral differences in governance experience and regulatory orientation. Innovation intensity exhibits a weak negative correlation with ESG performance in financial firms and a weaker or mixed association in non-financial firms, suggesting that the relationship between innovation and ESG may depend on sectoral context and innovation focus rather than indicating a direct trade-off.

Firm size and profitability display weak negative correlations with ESG performance in both samples, while leverage shows a positive association with ESG, particularly among financial firms. These relationships are modest and preliminary, and their interpretation is deferred to the multivariate regression analysis, where firm-specific heterogeneity and control variables are explicitly accounted for.

Overall, the correlation analysis provides initial insights into the associations among key variables, while underscoring the need for regression-based analysis to draw more robust inferences.

The results of the Variances Inflation Factor (VIF) Test are illustrated in Table 4. The VIF is a technique used to assess the existence of multicollinearity. Typically, the highest VIF value is considered an indicator of the severity of multicollinearity among the predictors. A VIF value greater than 10 suggests that multicollinearity significantly impacts the accuracy of the regression coefficient estimates obtained by least squares. As revealed in Table 3, none of the variables show VIF values >2 which implies that the occurrence of multicollinearity is strongly unlikely in the regression model.

Table 4. Variances Inflation Factor (VIF) Test.

	VIF (Financial Firms)	VIF (Non-Financial)
C	2.922	5.39
PCT_WB	2.101	1.626
PCT_WEMP	3.55	2.901
PCT_WMGT	1.82	1.71
NFEXEC	3.11	2.81
Ino_Int	2.01	1.918
BoD_AGE	2.72	2.02
ROA	3.25	3.00
GEARING	3.10	2.81
GWILL_AST	1.92	1.61
PE_RATIO	2.51	2.41
RET_SHF	1.16	1.14
Firm_Age	1.72	1.53
Firm Size	2.00	1.92

4.3. Results of Regression Analysis (Financial Firms)

The results of the regression analysis regarding financial firms (Nested Models vs. Full Model) are depicted in Table 5. Positive and highly significant results (0.179, $p = 0.000$) confirm that board gender diversity enhances ESG performance. Older boards (BoD_AGE), leverage, and goodwill positively impact ESG, while ROA and shareholder returns have weak negative effects. Negative and highly significant results (-0.146, $p = 0.000$) suggest that a higher proportion of women employees is associated with lower ESG performance. There are positive and significant results (0.0679, $p = 0.032$), suggesting that women in management roles improve ESG outcomes. Positive and highly significant results (0.0064,

$p = 0.000$) indicate that female executives play a key role in ESG initiatives. Surprisingly, Intensity (R_D) has no significant impact on ESG performance (0.0001, $p = 0.091$).

Table 5. The results of the regression analysis: Financial Firm, Nested Models vs. Full Model.

	Nested Model					Full Model
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
C	0.030 * (0.051) {0.552}	0.0452 (0.053) {0.3912}	−0.028 (0.052) {0.586}	−0.0267 (0.050) {0.528}	−0.0227 (0.0517) {0.6607}	0.0629 * (0.0511) {0.2183}
PCT_WB	0.179 *** (0.024) {0.000}					0.1532 (0.0244) {0.000}
PCT_WEMP		−0.146 (0.030) {0.000}				−0.1133 * (0.0293) {0.0001}
PCT_WMGT			0.0679 * (0.0317) {0.032}			0.0259 (0.0304) {0.3931}
NFEXEC				0.0064 *** (0.1227) {0.000}		0.00655 * (0.00115) {0.000}
Ino_Int					0.0001 (0.000) {0.091}	−0.0001 (0.000) {0.0287}
BoD_AGE	0.006 (0.000) {0.000}	0.0075 (0.000) {0.000}	0.0073 (0.000) {0.000}	0.0072 (0.0009) {0.000}	0.0075 (0.000) {0.000}	0.0056 (0.0008) {0.000}
ROA	−0.0003 (0.0002) {0.0905}	−0.0005 (0.000) {0.0105}	−0.0003 (0.0002) {0.0360}	−0.0003 (0.000) {0.0608}	−0.0004 (0.000) {0.0119}	−0.00004 (0.000) {0.0105}
GEARING	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}
GWILL_AST	0.170 ** (0.022) {0.000}	0.135 * (0.024) {0.000}	0.198 * (0.023) {0.000}	0.1917 (0.0217) {0.000}	0.1832 * (0.0221) {0.000}	0.1330 (0.0237) {0.000}
PE_RATIO	0.0002 (0.000) {0.0467}	0.0002 (0.000) {0.1199}	0.0002 (0.000) {0.153}	0.00016 (0.000) {0.1058}	0.0002 (0.0001) {0.096}	0.0002 (0.000) {0.0502}
RET_SHF	−0.0002 (0.0001) {0.0398}	−0.0002 (0.000) {0.115}	−0.0001 (0.0001) {0.297}	−0.0002 (0.0001) {0.1029}	0.000 (0.0001) {0.5997}	0.00001 (0.0001) {0.3777}
R^2	0.538	0.523	0.514	0.528	0.514	0.569
Adj R^2	0.493	0.476	0.466	0.482	0.466	0.524
S.E of regression	0.038	0.039	0.039	0.0389	0.039	0.037
F-statistic	11.849	11.145	10.721	11.374	10.688	12.690
Prob(F-Statistic)	0.0000	0.00	0.000	0.000	0.000	0.0000
Durbin Watson	1.765	1.74	1.74	1.8	1.7	1.8
Log likelihood	1851.1	1831.5	1867.9	1883.9	1856.1	1915.5

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

Regarding the Full Model (Comprehensive Analysis of ESG Determinants), the results show that PCT_WB remains positive and significant (0.1532, $p = 0.000$), reinforcing the importance of board gender diversity. PCT_WEMP remains negative and significant (−0.1133, $p = 0.0001$), confirming the counterintuitive relationship. PCT_WMGT becomes insignificant (0.0259, $p = 0.3931$), suggesting that managerial gender diversity alone does

not drive ESG. NFEXEC remains positive and significant (0.00655, $p = 0.000$), underscoring the role of female executives in ESG success. R&D Intensity is slightly negative (−0.0001, $p = 0.0287$), reinforcing that financial firms do not rely on R&D for ESG improvements. Model Fit: Highest among all models is ($R^2 = 0.569$, F-stat = 12.690, $p = 0.000$), confirming its robustness. The regression results confirm that board gender diversity and female executives significantly enhance ESG performance, while the effect of women in management varies. Surprisingly, a higher percentage of women employees correlates with lower ESG outcomes, suggesting potential industry-related constraints. R&D investments do not significantly impact ESG in financial firms, as their sustainability efforts focus on governance and regulatory compliance rather than technological innovation. The full model (Model 6) provides the best explanatory power, highlighting the interplay between gender diversity, firm characteristics, and ESG outcomes.

Table 6 illustrates the results of the moderating effect of firm age and firm size on ESG performance.

The results reveal that a higher percentage of women on the board, in management, as employees, and as executives positively impacts ESG performance. This effect is consistent across firm sizes. The influence of board gender diversity on ESG performance varies with firm age, with older firms (46–60 years) showing a positive relationship. Larger firms with more women on the board and in management show better ESG performance. Firms with higher debt levels indicate a higher corporate boardroom commitment to ESG practices. Goodwill (GWILL_AST) is positive and significant, suggesting that intangible assets like reputation drive ESG improvements. The moderating effects of firm age and size on the relationship between R&D and ESG are insignificant, indicating that R&D investments in non-financial firms do not strongly contribute to ESG improvements. Board gender diversity is a key driver of ESG performance, especially in older and larger firms. However, younger firms with more women in leadership positions show weaker ESG outcomes, suggesting potential challenges in integrating sustainability strategies at earlier stages. While financial factors like leverage and goodwill support ESG improvements, profitability and shareholder returns present trade-offs. R&D does not significantly impact ESG, highlighting that its effectiveness depends on how firms align innovation with sustainability goals.

Table 6. The moderating effect of firm age and firm size on ESG performance (financial firms).

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
C	0.240659 0.02779 0.000	0.0624 (0.057) {0.2744}	0.0125 (0.0565) {0.8250}	0.0312 (0.058) {0.5913}	0.1507 (0.0448) {0.0008}
BoD_AGE	0.0023 (0.000) {0.000}	−0.0066 (0.0001) {0.000}	0.0065 (0.000) {0.000}	0.0063 (0.0009) {0.000}	0.0047 (0.0008) {0.000}
ROA	−0.0001 (0.0002) {0.766}	−0.0004 (0.0002) {0.0211}	−0.0004 (0.0002) {0.0428}	−0.0004 (0.000) {0.0364}	−0.0001 (0.000) {0.0291}
GEARING	0.0002 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}
GWILL_AST	0.0873 (0.0158) {0.000}	0.1967 * (0.049) {0.000}	0.2241 (0.048) {0.000}	0.2147 (0.0479) {0.000}	0.0419 (0.0192) {0.0288}

Table 6. *Cont.*

	Model 1	Model 2	Model 3	Model 4	Model 5
PE_RATIO	−0.0002 (0.000) {0.6754}	−0.0002 (0.000) {0.0231}	0.0002 (0.000) {0.0508}	0.0001 (0.000) {0.0098}	−0.0001 (0.0001) {0.5040}
RET_SHF	−0.0004 (0.000) {0.000}	−0.0002 (0.000) {0.2609}	−0.0001 (0.0001) {0.4938}	−0.0002 (0.0001) {0.3873}	−0.000 (0.0001) {0.0496}
Moderating coefficients					
	PCT_WB	PCT_WEMP	PCT_WMGT	NFEXEC	Ino_Int
Fage < 15 yrs	−0.2406 0.02779 0.0000	−0.0951 (0.0173) {0.000}	−0.1639 ** (0.0352) {0.000}	−0.0086 ** (0.0019) {0.000}	−0.0021 (0.0018) {0.2501}
Fage 16–30 yrs	−0.067 ** (0.0162) {0.000}	−0.0496 ** (0.0201) {0.0138}	−0.08837 (0.0347) {0.0112}	−0.0045 ** (0.0023) {0.0326}	−0.0021 (0.0018) {0.1318}
* Fage 30–45 yrs	−0.0727 (0.0163) {0.000}	−0.0448 ** (0.0199) {0.0252}	−0.0919 ** (0.0386) {0.0174	−0.0042 * (0.0022) {0.0594}	−0.0020 (0.0017) {0.2489}
Fage 46–60 yrs	0.0130 ** (0.0197) {0.512}	0.0087 * (0.0196) {0.6552}	0.0064 * (0.0.376) {0.0174}	−0.0019 ** (0.0022) {0.4370}	−0.0020 (0.0018) {0.2574}
Fage > 60 yrs	−0.0726 ** (0.0163) {0.000}	−0.0722 (0.0191) {0.0002}	−0.1254 (0.0347) {0.000}	−0.00576 ** (0.0019) {0.0037}	−0.0025 (0.0018) {0.1635}
Firm size > sample average	0.2239 (0.0234) {0.000}	−0.0084 (0.0393) {0.8315}	0.1916 (0.0424) {0.000}	0.0102 (0.003) {0.0007}	−0.81083 (3.0396) {0.3012}
Firm size < sample average	0.2298 (0.0234) {0.000}	−0.0002 (0.0370) {0.9961}	0.2104 (0.044) {0.000}	0.0109 (0.0028) {0.000}	0.0021 (0.0018) {0.2497}
R^2	0.608	0.561	0.551	0.552	0.520
Adj R^2	0.566	0.515	0.503	0.505	0.469
S.E of regression	0.032	0.037	0.038	0.038	0.034
F-statistic	14.691	12.129	11.59	11.659	10.183
Prob(F-Statistic)	0.0000	0.000	0.000	0.000	0.000
Durbin Watson	2.073	1.91	1.9	1.9	1.9

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

4.4. Results of Regression Analysis (Non-Financial Firms)

The regression results provided analyse the determinants of ESG (environmental, social, and governance) performance for non-financial companies. In Model 1, the Percentage of Women on the Board (PCT_WB) has a positive and significant (0.241, $p = 0.000$) effect on ESG indicating that a higher percentage of women on the board is associated with better ESG performance. In Model 2, the Percentage of Women Employees (PCT_WEMP) has a positive and significant (0.0514, $p = 0.000$) effect, indicating that a higher percentage of women employees is associated with better ESG performance. In Model 3, the Percentage of Women in Management (PCT_WMGT) has a positive and significant (0.0440, $p = 0.0465$) effect, indicating that women in management roles contribute to better ESG performance. In Model 4, the Number of Female Executives (NFEXEC) has a positive and significant (0.0098, $p = 0.000$) effect on ESG performance, indicating that female executives positively influence ESG performance. In Model 5, innovation strategies' intensity, R&D intensity, does not significantly influence ESG performance in non-financial companies, similar to the results for financial firms. However, this result is surprising, as non-financial companies

are typically more R&D-intensive, and R&D is often linked to environmental innovation. However, while R&D is often associated with innovation and sustainability, its impact on ESG performance depends on how firms allocate their R&D resources and integrate sustainability into their innovation strategies. An evaluation of the control variables reveal that BoD_AGE is positive and significant across all models. Older boards are associated with better ESG performance. This suggests that the experience and stability of older board members contribute to stronger governance and sustainability practices. Older boards may have a better understanding of long-term risks and opportunities, enabling them to prioritise ESG initiatives effectively. Return on Assets (ROA) is consistently negative and significant across models. This indicates a trade-off between short-term financial performance and long-term sustainability investments. Firms prioritising profitability may allocate fewer resources to ESG initiatives, which require long-term commitments and may not yield immediate financial returns. Gearing (Leverage) is positive and significant across all models. This may reflect the increased stakeholder scrutiny faced by highly leveraged firms, prompting them to adopt stronger ESG practices to mitigate risks and maintain stakeholder trust. Leveraged firms may also use ESG initiatives as a way to enhance their reputation and access capital. The Goodwill to Assets Ratio (GWILL_AST) coefficient is negative and significant across models. This contrasts with financial firms, where goodwill had a positive relationship with ESG performance. In non-financial companies, goodwill may reflect intangible assets like brand value or intellectual property, which do not necessarily translate into strong ESG practices. The Price-to-Earnings Ratio (PE_RATIO) coefficient is negative and significant in some models. This suggests that investors may prioritise financial performance over ESG initiatives in non-financial companies. Firms with high valuations may focus on meeting short-term financial targets rather than investing in long-term sustainability. The Return to Shareholders (RET_SHF) coefficient is not significant in most models, as illustrated in Table 7.

Table 7. The results of the regression analysis: Non-Financial Firms, Nested Models vs. Full Model.

	Nested Models					**Full Model**
C	0.0755 * (0.0328) {0.0021}	0.147 (0.033) {0.000}	0.1594 (0.034) {0.000}	0.1322 (0.0326) {0.000}	0.1767 (0.0429) {0.0000}	0.0683 * (0.0301) {0.0235}
PCT_WB	0.241 *** (0.0186) {0.000}					0.2019 (0.0283) {0.000}
PCT_WEMP		0.0514 (0.0153) {0.000}				0.0275 * (0.018) {0.1282}
PCT_WMGT			0.0440 * (1.9922) {0.0465}			−0.0125 (0.0285) {0.6613}
NFEXEC				0.0098 *** (0.0009) {0.000}		0.0054 * (0.0012) {0.000}
R_D					−0.0000 (0.000) {0.6785}	−0.00001 (0.000) {0.7230}
BoD_AGE	0.006 (0.000) {0.000}	0.0055 (0.001) {0.000}	0.0054 (0.000) {0.000}	0.0055 (0.000) {0.000}	0.0054 (0.000) {0.000}	0.0059 (0.0000) {0.000}

Table 7. *Cont.*

	Nested Models					Full Model
ROA	−0.0003 (0.0002) {0.000)	−0.0003 (0.000) {0.0021}	−0.0003 (0.0002) {0.0028}	−0.0003 (0.000) {0.0006}	−0.0004 (0.000) {0.0004}	−0.00004 (0.000) {0.0105}
GEARING	0.0000 (0.000) {0.000)	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}
GWILL_AST	−0.0569 ** (0.0111) {0.000)	−0.0648 * (0.011) {0.000}	−0.0622 * (0.0117) {0.000}	−0.0589 (0.0115) {0.000}	−0.0542 * (0.0179) {0.0026}	−0.0547 (0.0154) {0.000}
PE_RATIO	−0.0002 (0.000) {0.0752)	−0.0002 (0.000) {0.1141}	−0.0002 (0.000) {0.1132}	−0.0001 (0.000) {0.0812}	−0.000 (0.0001) {0.0176}	−0.0002 (0.000) {0.0024}
RET_SHF	0.0002 (0.0000) {0.1965)	−0.0002 (0.974) {0.114}	−0.0001 (0.0001) {0.1810}	0.000 (0.0001) {0.0859}	0.000 (0.0001) {0.1455}	0.00001 (0.0001) {0.3247}
R^2	0.538	0.382	0.376	0.402	0.336	0.383
Adj R^2	0.416	0.324	0.317	0.345	0.257	0.307
S.E of regression	0.0814	0.083	0.083	0.082	0.085	0.0829
F-statistic	7.560	6.586	6.411	7.132	11.518	12.690
Prob(F-Statistic)	0.0000	0.00	0.000	0.000	0.000	0.0000
Durbin Watson	2.00	2.0	2.0	2.0	1.9	2.0
Log likelihood	1851.1	1831.5	1867.9	1883.9	1856.1	1915.5

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

Table 8 illustrates the results of the moderating effect of firm age and firm size on ESG performance.

As shown in Table 8, across models, younger firms (<15 years) with more women on the board, in management, or as executives tend to have lower ESG performance. This negative effect weakens slightly for firms aged 16–45 years but remains significant. Firms aged 46–60 years show a positive relationship between gender diversity and ESG performance, while firms >60 years return to a negative relationship. Regardless of size, firms with more women on the board, in management, or as executives tend to have better ESG performance. The positive effect is consistent across large and small firms, suggesting gender diversity is a strong driver of ESG performance. In regards to innovation strategies' intensity, Table 8 shows that firm age and size do not significantly moderate the R&D–ESG relationship in financial firms. This suggests that financial firms focus more on digital transformation and regulatory compliance rather than on traditional R&D for ESG improvements.

Table 8. The moderating effect of firm age and firm size on ESG performance (non-financial firms).

	Model 1	Model 2	Model 3	Model 4	Model 5
C	0.240659 0.02779 0.000	0.0624 (0.057) {0.2744)	0.0125 (0.0565) {0.8250)	0.0312 (0.058) {0.5913)	0.1507 (0.0448) {0.0008)
BoD_AGE	0.0023 (0.000) {0.000)	−0.0066 (0.0001) {0.000}	0.0065 (0.000) {0.000}	0.0063 (0.0009) {0.000}	0.0047 (0.0008) {0.000}
ROA	−0.0001 (0.0002) {0.766)	−0.0004 (0.0002) {0.0211}	−0.0004 (0.0002) {0.0428}	−0.0004 (0.000) {0.0364}	−0.0001 (0.000) {0.0291}

Table 8. *Cont.*

	Model 1	Model 2	Model 3	Model 4	Model 5
GEARING	0.0002 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}	0.0001 (0.000) {0.000}
GWILL_AST	0.0873 (0.0158) {0.000}	0.1967 * (0.049) {0.000}	0.2241 (0.048) {0.000}	0.2147 (0.0479) {0.000}	0.0419 (0.0192) {0.0288}
PE_RATIO	−0.0002 (0.000) {0.6754}	−0.0002 (0.000) {0.0231}	0.0002 (0.000) {0.0508}	0.0001 (0.000) {0.0098}	−0.0001 (0.0001) {0.5040}
RET_SHF	−0.0004 (0.000) {0.000}	−0.0002 (0.000) {0.2609}	−0.0001 (0.0001) {0.4938}	−0.0002 (0.0001) {0.3873}	−0.000 (0.0001) {0.0496}
	Moderating coefficients				
	PCT_WB	PCT_WEMP	PCT_WMGT	NFEXEC	Ino-Int
Fage < 15 yrs	−0.2406 0.02779 0.0000	−0.0951 (0.0173) {0.000}	−0.1639 ** (0.0352) {0.000}	−0.0086 ** (0.0019) {0.000}	−0.0021 (0.0018) {0.2501}
Fage 16–30 yrs	−0.067 ** (0.0162) {0.000}	−0.0496 ** (0.0201) {0.0138}	−0.08837 (0.0347) {0.0112}	−0.0045 ** (0.0023) {0.0326}	−0.0021 (0.0018) {0.1318}
* Fage 30–45 yrs	−0.0727 (0.0163) {0.000}	−0.0448 ** (0.0199) {0.0252}	−0.0919 ** (0.0386) {0.0174	−0.0042 * (0.0022) {0.0594}	−0.0020 (0.0017) {0.2489}
Fage 46–60 yrs	0.0130 ** (0.0197) {0.512}	0.0087 * (0.0196) {0.6552}	0.0064 * (0.0.376) {0.0174}	−0.0019 ** (0.0022) {0.4370}	−0.0020 (0.0018) {0.2574}
Fage > 60 yrs	−0.0726 ** (0.0163) {0.000}	−0.0722 (0.0191) {0.0002}	−0.1254 (0.0347) {0.000}	−0.00576 ** (0.0019) {0.0037}	−0.0025 (0.0018) {0.1635}
Firm size > sample average	0.2239 (0.0234) {0.000}	−0.0084 (0.0393) {0.8315}	0.1916 (0.0424) {0.000}	0.0102 (0.003) {0.0007}	−0.81083 (3.0396) {0.3012}
Firm size < sample average	0.2298 (0.0234) {0.000}	−0.0002 (0.0370) {0.9961}	0.2104 (0.044) {0.000}	0.0109 (0.0028) {0.000}	0.0021 (0.0018) {0.2497}
R^2	0.608	0.561	0.551	0.552	0.520
Adj R^2	0.566	0.515	0.503	0.505	0.469
S.E of regression	0.032	0.037	0.038	0.038	0.034
F-statistic	14.691	12.129	11.59	11.659	10.183
Prob(F-Statistic)	0.0000	0.000	0.000	0.000	0.000
Durbin Watson	2.073	1.91	1.9	1.9	1.9

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

5. Conclusions

This study examines the combined influence of innovation intensity strategies and boardroom gender diversity on ESG performance. It investigates the influence of gender diversity and firm innovation in UK financial and non-financial firms over the period 2012–2023. For both financial and non-financial firms, the relationship between innovation intensity and ESG performance is positive and significant, but the magnitude of the coefficient for financial firms suggests that this effect is very negligible and not significant

for non-financial firms. For both financial and non-financial firms, innovation strategies, R&D intensity has a positive and significant relationship with ESG performance, but the magnitude of the coefficient for financial firms suggests that this effect is very negligible and not significant for non-financial firms. However, as I have stated, this may be due to the integration of R&D in green investment. However, the results are not conclusive. Pinheiro et al. (2024) in his study found that higher ESG performance is observed in companies that invested more in research and development. Furthermore, the results of Shahnaz and Emranul (2024) also lend credence to the positive effect of innovation on environmental, social, and governance (ESG) performance.

The percentage of women on the board has a positive and significant relationship with ESG performance, for both financial and non-financial firms. This result is consistent (Pucheta-Martínez et al., 2019, Arayssi et al., 2019; Khemakhem et al., 2023). However, the magnitude of the coefficient for financial firms suggests that this effect is very negligible and not significant for non-financial firms. The percentage of women employees has a negative effect on ESG performance in financial firms. Unlike financial firms, the percentage of women employees has a positive relationship with ESG performance in non-financial firms. For both financial and non-financial firms, the percentage of women in management has a positive relationship with ESG performance in the Nested models. Further, these relationships become insignificant in the full model, suggesting that other factors may overshadow the influence that women in management could have on ESG. In both financial and non-financial firms, the number of female executives has a positive relationship with ESG performance across models.

For both financial and non-financial firms, the results for firms with a younger age range (Fage < 15 yrs, 16–30 yrs, 30–45 yrs), across all gender diversity variables, show that more gender diverse boards tend to have lower ESG performance. Firms with ages between the range of 46–60 years, with more women on the board, achieve better ESG performance. This may be due to their greater organisational maturity and ability to effectively utilise diverse leadership for sustainability goals.

For both financial and non-financial firms, larger firms and smaller firms alike benefit from gender diversity in leadership and management roles. This highlights the universal importance of gender diversity in driving ESG performance, regardless of firm size. For both financial and non-financial firms, neither firm size nor firm age moderators have any significant effect on the relationship between innovation intensity and ESG performance.

5.1. Theoretical Implications

Our study adopts the Nested vs. Full Model methodology; by demonstrating that certain gender diversity effects become insignificant in the full model, our results suggest the presence of additional corporate-specific or external factors that mediate these relationships. This methodological contribution emphasises the need for comprehensive models that account for confounding variables when studying ESG performance determinants.

The results of this study support the assumptions underlying RBV, stakeholder theory, and UET, which suggest that diverse boards and leadership teams are better equipped to address the needs of various stakeholders and leverage external resources for sustainability initiatives. However, the negative relationship between gender diversity at the employee level and ESG performance in financial firms challenges the assumption that gender diversity uniformly enhances ESG outcomes. This highlights the need for context-specific theories that account for sectoral differences and organisational dynamics.

5.2. Managerial Implications

Findings of this study highlight the importance of gender diversity in leadership roles for driving ESG initiatives. Firms should implement policies to increase the representation of women on boards and in executive roles, such as setting diversity targets, mentoring programs, and inclusive hiring practices. The results suggest that companies with a high level of boardroom diversity strengthen innovation strategies' intensity and leverage external resources for sustainability initiatives.

By distinguishing between financial and non-financial firms, our study uncovers the magnitude and significance of this relationship, providing a better understanding of gender diversity's role in corporate sustainability. Unlike prior research, our study highlights the divergence in the impact of female employees on ESG performance. While financial firms exhibit a negative relationship, non-financial firms show a positive correlation. This novel insight suggests that industry-specific factors influence how gender diversity at different levels of the corporate hierarchy translates into business innovation strategies' intensity and ESG. As reveal by this study, the lack of a significant relationship between innovation strategies and ESG performance challenges the innovation-driven sustainability theory, which posits that innovation is a key driver of environmental and social sustainability. This suggests that traditional innovation strategies, R&D metrics, may not adequately capture sustainability-focused innovation, particularly in financial firms.

5.3. Limitations of the Study and Suggestions for Future Research

Findings of this study remain within the context of large UK companies; the study also has limitations due to the sample selection FTSE350.

Our study focuses only on two firm-specific moderators—firm size and firm age—and this limits our understanding of the role of other firm moderators. Importantly, in the consideration of the measure for innovation for non-financial companies, the study has not incorporated the patent rights of the companies. The lack of significance of innovation intensity in driving ESG performance raises questions about the adequacy of traditional metrics for capturing sustainability-focused innovation. Future research should develop and validate new metrics that better align with ESG goals. Future research may explore this further.

Future studies may adopt a single theory or combination of the theories adopted by this study or other theoretical lenses to address the research questions of this study in different countries and settings. Future studies may adopt a case study approach or difference-in-differences (DID) methodology to explore the same research variables employed by this study, to adopt or adapt our research model.

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