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Does Board Gender Diversity Make Firms Less Greenwashed?

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ABSTRACT

This study contributes to the literature on corporate environmental responsibility by investigating the impact of female board directorship on the environmental performance of listed financial and non-financial firms in Europe from 2013 to 2022. We propose a novel proxy for greenwashing that has not yet been implemented at the firm level in financial studies. We applied panel regression estimation with fixed effects to 1300 firm-year observations. The misleading baseline results show a negative relationship between female board directorship and environmental performance. Conversely, the second layer of analysis indicates a negative relationship between our greenwashing measure and female board directorship, supporting the positive role of women on boards of directors; spurious environmental performance measures obscure this significant association. A set of robustness checks and alternative specifications (generalized least squares and two-stage least squares) confirmed the consistency of our empirical results. This study has theoretical and managerial implications by reinforcing the crucial role of women in top management positions as supporters of environmental initiatives.

JEL Classification: G21, G30, J16, M14, Q01, Q56

1 | Introduction

Adapting to climate change has become a compliance requirement for firms which are encouraged to enhance their environmental sustainability performance, mitigating the climate change risks (European Commission 2021). Investors and other stakeholders have been demanding that financial and non-financial institutions reveal their risk of exposure to climate change and the efforts made to mitigate such risks (Sutantoputra 2022). In this regard, scholars have established that the higher the level of mandatory disclosure of firms' environmental performance, the higher the level of greenwashing (Marquis et al. 2016; Gull et al. 2023; Zahid et al. 2023).

Greenwashing is a state in which there is a contradiction between the actions of an organization and the amount of commitment it claims to have toward sustainability (Walker and Wan 2012). According to the European Banking Authority's (EBA) latest report, greenwashing in the European Union (EU) is increasing, with the total number of potential cases of greenwashing expanding across all sectors, particularly in financial and banking institutions (EBA 2024). Greenwashing is a relatively new concept that has gained significant attention in the current financial (Birindelli et al. 2019; Galletta et al. 2022; Birindelli et al. 2024) and non-financial literature (Chen and Chang 2013; Seele and Gatti 2017; Yu et al. 2020; Altunbas et al. 2022; Ghitti et al. 2023). Overall, existing studies underscore the importance

of corporate communication in distorting and hiding real environmental, social, and governance (ESG) commitments, thereby constructing a positive image of a company that is environmentally friendly.

Scholars such as Zahid et al. (2023) and Birindelli et al. (2024) have empirically demonstrated how specific governance characteristics moderate the impact of greenwashing on firms' performance, thereby increasing attention to this topic.

In the context of governance dimensions analyzed by scholars, gender diversity emerges as a crucial governance dimension. Empirical evidence indicates that women tend to exercise greater caution (Faccio et al. 2016) and demonstrate heightened responsiveness to societal expectations compared to their male counterparts (Baatwah and Abdul Wahab 2023). Furthermore, McGuinness et al. (2017) found that female directors are more inclined to safeguard shareholder rights and prevent unethical practices such as earnings manipulation and fraud. Similarly, scholars including Atif et al. (2021) have posited that companies can make more informed decisions about their environmental records if they have board members who represent different stakeholder perspectives based on gender awareness.

Previous findings have established that firms with women in top management positions have a positive relationship with non-financial performance. Agnese et al. (2023) identified a positive relationship between gender-diverse boards and financial performance, while Lu and Herremans (2019) observed a positive link between gender diversity and firms' non-financial environmental performance. In addition, gender diversity can produce the following positive outcomes: better environmental disclosure (Elmagrhi et al. 2019), a reduction of carbon emissions (Lemma et al. 2023; Altunbas et al. 2022), and greater green innovation (He and Jiang 2019). These results reinforce the awareness that women are more oriented toward prioritizing community and social ties and are therefore more committed to ethical practices (Perrault and McHugh 2015); they also suggest that women can positively affect corporate social responsibility (CSR) and mitigate climate change (Altunbas et al. 2022). In contrast to the aforementioned studies, Alazzani et al. (2017), Birindelli et al. (2019), and Ramon-Llorens et al. (2020) found a non-significant, non-linear, and negative relationship between environmental performance and female directors. These controversial outcomes underscore the need for a comprehensive investigation to clarify the relationship between the two variables.

In the broader literature mentioned above, some scholars have focused on the relationship between female board members and firm greenwashing, indicating that women are less likely to participate in greenwashing activities because they tend to challenge and confirm the credibility of established green claims (Perryman et al. 2016; Lu and Wang 2021; Khan 2022). It is still unclear what defines greenwashing and what consequences it carries for companies due to a lack of a standard way to measure it. However, earlier studies have implied that women in management positions are unlikely to engage in opportunistic behaviors that lead to greenwashing. Several scholars have suggested various mechanisms for identifying cases of corporate environmental fraud. These proxies are generally grounded in standardized ratings of firms' environmental performance, as in Kassinis et al. (2022), Zahid et al. (2023), and Birindelli et al. (2024). In contrast, Ghitti et al. (2023) attempted to capture this phenomenon by examining six distinct categories based on discrepancies between ESG scores reflecting pre-commitment intentions toward sustainability and those indicating post-achievement outcomes.

Rooted in current knowledge of this topic, we investigated the impact of female board directorship on the environmental performance of listed financial and non-financial firms in Europe. Contextually, we argue for the empirical findings obtained, proposing a novel proxy for greenwashing that has not yet been implemented at the firm level in the financial literature. The methodological approach, applied to a sample of 158 listed firms for 2013–2022, is a key element of this study's novelty. The original discussion of our findings provides both empirical and theoretical justification for the controversial negative relationship between female board members and environmental performance. To confirm the consistency of our empirical evidence, we applied robustness checks and alternative specifications (i.e., generalized least squares [GLS] and two-stage least squares [2SLS]). These findings have theoretical and managerial implications, reinforcing the crucial role of women in top management as supporters of environmental initiatives. In particular, this study suggests that policymakers, regulators, and banks should re-examine their stance on board gender diversity (BGD) policies in the context of environmental performance and greenwashing in Europe. This study reveals a surprisingly negative association between BGD and environmental performance. This evidence challenges conventional beliefs and supports the view that greenwashing remains a significant obstacle to achieving sustainability (Chen and Chang 2013). This implies that current policies may require revisions to enable a thorough examination of the gender–environment nexus (OECD 2021). Furthermore, this study demonstrates that BGD is associated with a reduction in greenwashing, underscoring its importance in corporate governance (CG) to achieve actual environmental responsibility. Hence, it is essential to employ a straightforward, evidence-based approach to establish relevant financial regulations and policies.

The remainder of this article is organized as follows. Section 2 provides a literature review on gender and greenwashing issues and outlines the hypotheses. Section 3 describes the sample and methodology applied. Section 4 presents the empirical results and the robustness tests. Section 5 discusses the findings of the twofold analysis. Section 6 provides concluding remarks and outlines the theoretical and managerial implications.

2 | Theoretical Analysis and Hypotheses Development

2.1 | Legitimacy Theory

The premise of legitimacy theory is the need to demonstrate how BGD affects environmental performance and greenwashing within firms. According to this theory, companies endeavor to align their strategic and operational approaches with prevailing social norms, thereby securing societal acceptance (Suchman 1995). The alignment of these two factors has

gained relevance in CG because of increased public knowledge about environmental sustainability. The consideration of gender diversity on boards is crucial as it affects all aspects of a company's functioning. Therefore, it is expected that women on a board of directors will drive the organization to adopt the causes of gender and environment. From various perspectives, women are considered more ethical in the workplace, which may promote firm disclosure (Perrault and McHugh 2015). A holistic perspective may lead to the development of comprehensive policies to protect the natural environment. Such policies may ultimately lead to enhanced environmental performance at the organizational level, exceeding legal requirements. As such, having people of different genders on corporate boards increases a company's ability to identify and manage social aspects related to sustainability. This has created a culture of support for sustainable development initiatives (Saeed et al. 2022). Moreover, the concept of greenwashing should be examined from the standpoint of legitimacy, with particular attention to the role of gender-diverse boards. Based on legitimacy theory, such bodies would not support or engage in any form of false representation of environmental responsibilities by the organizations under their supervision. Short-term tactics for gaining recognition, such as greenwashing, as outlined by Seele and Gatti (2017), represent another avenue through which an institution can gain acceptance within its community or in the market. Nevertheless, the inclusion of women among decision-makers on a mixed-gender board is conducive to truthfulness and accountability, particularly in matters pertaining to disclosure or dishonesty surrounding sustainability issues. This reduces the prevalence of greenwashing among firms. The inclusion of female board members contributes to a more transparent, authentic approach to environmental reporting and claims because of their diverse viewpoints and ethical inclinations (Lee and Raschke 2023).

In addition, legitimacy theory highlights the dynamic nature of social norms and expectations. As public awareness of the environment increases, organizations must adapt their strategies to meet societal expectations. Gender has been identified as the most significant factor affecting the process of adaptation to a new environment in most companies. Mixed-gender boards are more appropriate for transforming social values, thus offering a better reference for companies in implementing environmentally friendly policies that are in vogue with the current government policy (ECB 2023).

2.2 | Stakeholder Theory

Freeman et al. (2010) proposed stakeholder theory along with legitimacy theory, which explains how gender diversity affects environmental policies and corporate practices. According to stakeholder theory, organizations should meet the demands and expectations of all their stakeholders, such as shareholders, employees, and customers within society at large. One of these critical elements may be embodied in terms of board-level representatives of different genders because it enhances companies' ability to relate to various groups with vested interests and legitimize their actions (Webb 2004). As highlighted by Kyaw et al. (2022), the presence of diverse members on a board of directors makes for a broader range of perspectives, leading to more comprehensive decision-making processes that can encourage efficient monitoring among various stakeholders. According to our research, this aspect assumes greater significance when considering environmental and greenwashing issues. These strategic areas are subject to increasing scrutiny by stakeholders who are concerned about improving corporate responsibility and ethical behavior.

2.3 | BGD and Environmental Performance

The relationship between environmental performance and BGD has been explored in recent literature from various angles. One significant perspective is the relevant contribution of female board members to environmental initiatives within organizations. Atif et al. (2021), Ben-Amar et al. (2017), Lemma et al. (2023), and Birindelli et al. (2024) underscored the distinct behavioral patterns of female board members compared with their male counterparts, especially in the context of environmental performance and disclosure. This notion is further supported by Elmagrhi et al. (2019) and McGuinness et al. (2017), who stressed the positive influence of women on corporate boards in promoting green innovation and environmental action.

In contrast, Cook and Glass (2018) investigated the strategies employed by female directors to drive environmental actions, emphasizing diverse moral sensibilities, cognitive variations based on gender, and gender-based separation. This aligns with Cumming et al. (2015), who noted that women generally prioritize community ties and preventing harm, in contrast to men's focus on financial goals and personal achievements. Such differences contribute to ethical and cognitive diversity, which improve environmental practices. Post et al. (2011) further asserted that female leadership in administrative positions actively discourages environmentally harmful behaviors and attitudes. In a broader context, Miller and del Carmen Triana (2009) explored the connection between gender and environmental practices through social role theory and gender socialization theory. These theories propose that the agentic and communal characteristics traditionally ascribed to men and women shape their attitudes and behaviors toward the environment. Women's aptitude for exhibiting shared characteristics, such as a more significant concern for others' well-being, represents an incentive toward pro-environmental decisions. This aligns with evolutionary leadership theory, as Vugt and Ronay (2014) explained, which posits that leadership and followership behaviors evolve to address coordination problems and are significantly influenced by gender dynamics.

Finally, the notion of a "critical mass" of women on corporate boards, as proposed by Kanter (1977), is crucial for their influence to be effectively felt in decision-making, especially when it comes to environmental matters. This concept suggests that the presence of a certain number of women on boards is necessary for their perspectives to be genuinely considered, and it is only after surpassing this threshold that the positive impact of women on environmental disclosures and performance becomes noticeable (Birindelli et al. 2024). Previous studies have explored the gender–environment nexus, with a focus on financial firms (Galletta et al. 2022; Agnese et al. 2023) or specific countries and economic areas, such as the UK and the US (Atif

et al. 2021), showing mixed results on gender–environment linkages. As such, we aimed to expand the current knowledge by conducting a cross-country analysis that considers the cultural backgrounds of EU countries. Thus, we developed the following hypothesis:

Hypothesis. 1. *Board gender diversity is positively associated with listed European firms' environmental performance.*

The literature referred to above led us to formulate Hypothesis 1, which posits the existence of a positive correlation between the presence of women on corporate boards and the enhancement of environmental practices within firms. This implies that an increase in the number of women on boards in publicly traded companies is likely to result in improved environmental outcomes. This relationship also indicates that women make a unique contribution to the dynamics of the board, including different ways of addressing concerns about ethical matters, especially environmental responsibility. With the recent shift in society's perceptions and practices, especially regarding environmental concerns, organizations have become compelled to alter their strategies and behaviors to align with the public's changing views. In this context, the composition of a company's board is important. A gender-diverse board is likely to align with contemporary social norms such as diversity and inclusivity. Most importantly, social concerns are now focused on the environment, which requires various standpoints and approaches from women on corporate boards.

The participation of women in firm governance enables the consideration of different, broader views and values when making decisions; hence, the strategies adopted by an organization concerning its environment are more relevant. In addition, legitimacy theory holds that organizations should not only follow existing rules but also aim to predict future trends.

Given the growing prominence of environmental issues, businesses can meet society's evolving expectations by ensuring gender diversity on their boards. Moreover, women in senior positions within organizations are often perceived as demonstrating heightened awareness of ethical considerations and community welfare. Consequently, these individuals can steer enterprises toward sustainable development, thereby enhancing their reputation in the public sphere.

2.4 | BGD and Greenwashing

The term "greenwashing" refers to a situation in which firms give an incorrect impression of their environmental responsibility. This makes it easy for them to mask their actual conduct and make the general public doubt the genuineness of their "greenization" messages disclosed to the market (Du 2015). As defined by the Oxford English Dictionary (cited by Ramus and Montiel 2005 and Wang and Sarkis 2017), greenwashing refers to the "transmission of disinformation by an organisation to project an environmentally responsible public image." Greenwashing is the process of providing false information regarding a company's environmental strategies. This phenomenon was also defined by Baldi and Pandimiglio (2022) as the act of giving consumers less clear information about a company's environmental policies or the environmental impact of the products and services it offers. This definition emphasizes the consumer aspect, focusing on misinformation presented to consumers regarding environmental issues. Offering a more detailed definition, Delmas and Burbano (2011) described greenwashing as a mismatch between a company's actual environmental performance and the positive information it communicates about such performance. According to them, the performance itself and how it is conveyed can be either positive or negative. Greenwashing is a situation in which environmental behaviors or policies are portrayed in a positive light but which diverges from actual environmental performance. Therefore, we aimed to determine whether BGD is related to firms' environmental ratings. The research question regarding greenwashing and BGD remains in the stream of CG, especially in relation to a company's overall reputation concerning environmental sustainability.

The first stream of literature indicates that female board members reduce boards' greenwashing activities due to the broader range of perspectives and more ethical decision-making processes brought about by gender diversity (Bear et al. 2010). Perryman et al. (2016) emphasized the value of cognitive diversity on boards, which contributes to a more thorough evaluation of environmental claims and potentially reduces greenwashing. Similarly, Khan (2022) noted that gender-diverse boards are more likely to question and verify the accuracy of environmental claims.

In addition, the inclusion of women on corporate boards has been associated with more accurate and transparent environmental reporting. This proposition was corroborated by Lu and Herremans (2019) and Al-Shaer and Zaman (2016), who indicated that the inclusion of female board members enhances reporting integrity, which is crucial for reducing greenwashing. Several studies provide empirical evidence that companies with a greater proportion of women on their boards demonstrate better environmental performance and disclosure (Post et al. 2015; Naciti 2019; Lu and Wang 2021).

However, this relationship has yielded controversial results. For instance, Arayssi et al. (2016) found that in the context of US companies, a higher number of female directors might be linked to lower sustainability performance, potentially due to the challenge of managing multiple board roles or less aptitude in terms of providing misleading information regarding environmental performance. This result suggests that the effectiveness of female directors in combating greenwashing may depend on their ability to balance their responsibilities.

Finally, board members' individual characteristics play a role in altering greenwashing practices. Women are generally less overconfident and risk-averse than men; these traits align with lower tendencies toward misleading environmental disclosures (Faccio et al. 2016). In this sense, women's boards are less inclined to engage in opportunistic behaviors. Consequently, a board of directors with a proper representation of female members can reduce greenwashing behavior. Considering the above, we formulated the following hypothesis:

Hypothesis. 2. *Board gender diversity is negatively associated with greenwashing.*

We can posit that the presence of women on corporate boards contributes to the ethical decision-making and risk aversion that are essential to counteract greenwashing. These attributes arise from the different socialization experiences and perspectives that women often bring to leadership roles. When faced with decisions regarding environmental claims and policies, boards with gender diversity are more likely to exercise due diligence and demand accurate, honest reporting. This thorough decision-making and oversight can reduce the likelihood of a company engaging in greenwashing.

Furthermore, the presence of gender-mixed boards has the potential to significantly influence corporate culture and values, particularly in terms of fostering greater transparency and accountability. Consequently, this results in a more substantial commitment to environmental sustainability than greenwashing or any other changes made with the intention of improving public image. According to legitimacy theory, gender-diverse boards reflect more comprehensive inclusiveness and ethical standards within society and are less likely to condone practices such as greenwashing, which tend to destroy a company's reputation. The presence of women on boards of directors brings heightened levels of ethics and leads to fewer risks when making decisions. These qualities are fundamental when dealing with issues around greenwashing because there is always a strong temptation for firms to exaggerate their environmental achievements. The presence of women in boardrooms also ensures that multiple ethical standpoints are considered, thereby increasing the likelihood that companies will prioritize truthfulness in their sustainability reporting. This aligns with the increasing expectations of stakeholders, who require tangible evidence of environmental stewardship. The extant literature has emphasized the importance of ensuring gender diversity among top management to avoid reputational damage through greenwashing practices.

3 | Data and Methodology

3.1 | Data and Sample

We used a sample of 158 European firms listed on stock exchanges from 2013 to 2022. We gathered the data from Bloomberg, Refinitiv DataStream, and Eurostat. The dataset consists of 1300 firm-year observations. Tables A1 and A2 provide the correlation matrix and statistical summary, respectively.

The dataset encompasses firms from different sectors, including healthcare, financial services, industry, retail, utilities, and technology, reflecting a range of possible environmental impacts and governance in our econometric models. This cross-sector approach is fundamental to ensuring an unbiased evaluation of the impact of female directorships on environmental performance. These sectors are relevant because they include a diverse range of environmental influences and CG structures, which are critical factors in the study of greenwashing practices. We aligned the composition of the dataset to analyze the link between BGD and environmental policies.

3.2 | Regression Model Specification

We employed a fixed effects regression model to control for firm-, year-, industry-, and country-level effects as well as internal and external factors that may affect the dependent variable, thus enabling a better prediction of the independent variables' effects. We developed a separate model for each hypothesis, the first of which tested Hypothesis 1 (ENV—*Environmental performance*), while the second model tested Hypothesis 2 (*Greenwashing*). The model specifications are as follows:

$$ENV_{it} = \alpha + ß_1 * BoD_{pink_{it}} + \sum_{s}^{2} \partial_s * SG_{sit} + \sum_{c}^{3} \lambda_c * firm_{control_{cit}} + \sum_{m}^{3} \theta_m * macro_{control_{mit}} + \gamma_1 * firm_{eff} + \gamma_2 * year_{eff} + \gamma_3 * sector_{eff} + \gamma_4 * country_{eff} + \varepsilon_{it} \quad (1)$$

$$Greenwashing_{it} = \alpha + ß_1 * BoD_{pink_{it}} + \sum_{s}^{2} \partial_s * SG_{sit} + \sum_{c}^{3} \lambda_c * firm_{control_{cit}} + \sum_{m}^{3} \theta_c * macro_{control_{mit}} + \gamma_1 * firm_{eff} + \gamma_2 * year_{eff} + \gamma_3 * sector_{eff} + \gamma_4 * country_{eff} + \varepsilon_{it} \quad (2)$$

In these equations, the dependent variables are environmental performance (ENV_{it}) and the extent of greenwashing activities ($Greenwashing_{it}$) for each firm i in year t. The primary independent variable under investigation is BoD_{pink}, which denotes the proportion of female directors on the board, a factor hypothesized to impact both environmental performance and greenwashing.

We also included the social (S) and governance (G) pillar scores to support the analysis, focusing on firms' social and governance aspects. These scores, designated as SG_{sit}, reflect the performance of each firm i in these areas for year t. The model also considers firm-specific controls, including firm debt, firm size, and market-based default probability (*PD*), designated as $firm_{control\_cit}$. These variables are fundamental for understanding the financial health and scale of firm i in year t.

In addition, we integrated macroeconomic controls into the model, including the bank concentration index, inflation rate, and gross domestic product (GDP) growth, collectively referred to as $macro_{control\_mit}$. These variables provide context for the broader economic environment in which firm i operates during year t.

To ensure comprehensive analysis, the model includes fixed effects for firms ($firm_{eff}$), years ($year_{eff}$), sectors ($sector_{eff}$),

and countries ($country_{eff}$). These fixed effects help isolate the specific impact of female board directorship by controlling for the time-invariant attributes of each firm, annual economic or industry trends, and country-specific regulatory or economic factors. Finally, ε_{it} represents the error term for each firm i in year t, capturing any unexplained variance in the dependent variables, namely environmental performance and greenwashing.

3.3 | Variable Measurements

3.3.1 | Dependent Variable

We used two dependent variables in this study. The first is environmental performance ($ENV_{Performance}$), which we obtained from the Refinitiv database. The ENV pillar comprises three categories: *emissions, innovation*, and *resources*. The second variable is a proxy for greenwashing. Consistent with prior studies (Du et al. 2018; Kassinis et al. 2022; Ghitti et al. 2023) that have developed several metrics for greenwashing, we followed the perspective of Yu et al. (2020) to construct a measure of greenwashing, which we calculated as the difference between the expected environmental performance disclosed by the Bloomberg database and the actual environmental performance disclosed by Refinitiv. We calculated the greenwashing proxy using Equation (3):

$$Greenwashing_{it} = Expected\_ENV_{\text{Performance}} - Actual\_ENV_{\text{Performance}} \quad (3)$$

Unlike previous contributions (Birindelli et al. 2024), we chose not to standardize our variables because both the expected and actual ENV performance versions of the variables employed ranged from 1 to 100. Hence, their difference ranged from −1 to +1. In this case, linear transformation was not required. Standardizing these variables would not have meaningfully changed their distribution or enhanced their comparability because they were already on a similar scale. Moreover, we used the sign of our greenwashing proxy to identify greenwashing behavior ($Greenwashing_{it} > 0$).

3.3.2 | Explanatory Variables

We used the percentage of women on the board of directors (BoD Pink) as the main regressor. The BoD Pink variable allowed us to investigate the potential impact of gender diversity at the top level of corporate decision-making on environmental performance and greenwashing practices within firms. This approach aligns with the current academic focus on board diversity's role in influencing corporate strategies and policies (Brieger et al. 2019; Yarram and Adapa 2021; Afzali et al. 2022). The variable, which we obtained from the Refinitiv database, ranged from 0% to 100%. The additional variables used are the social (S) and governance (G) pillars as additional components of the ESG firm profile. According to the Thomson Reuters ESG methodology, the S score aggregates the scores of the *workforce, human rights, community*, and *product responsibility* dimensions. Likewise, the G pillar combines the scores related to the *management, shareholders*, and *CSR* dimensions. All the E, S, and G variables assumed a score between 0 and 100.

3.3.3 | Control Variables

We incorporated a range of control variables at the firm and country levels into the model to ensure a robust, holistic understanding of the factors influencing the dependent variables. Firm-level controls included measures of *firm debt, firm size*, and the *probability of default (PD) based on market values*. Our choices were informed by their proven relevance to financial research. Specifically, previous literature has shown that firm debt (Boubakri and Ghouma 2010), measured as a firm's leverage ratio, and firm size (Bhagat et al. 2015), measured as a firm's total assets, are crucial indicators of capital structure and market stature. In line with Vallascas and Hagendorff (2011) and Palmieri et al. (2024), we used the probability of default as a proxy for a firm's financial distress.

For country-level controls, we considered variables that reflect the economic environment surrounding firms. These included the *bank concentration index* (Ratti et al. 2008), which is a proxy for competitiveness within the banking sector; the *inflation rate*, which signals economic stability; and the *GDP growth rate*, which is indicative of overall economic growth (Kim et al. 2011; Hao et al. 2022; Li et al. 2023). By incorporating these firm-specific and macroeconomic factors into the model, we aimed to isolate the influence of BGD on environmental performance and greenwashing, ensuring a more precise and reliable analysis.

3.3.4 | Instrumental Variables

To address endogeneity issues, we selected the following instrumental variables (IVs) from the Eurostat database. The first is the *gender equality index*, which has an aggregate score ranging from 1 to 100 and captures the state of gender equality. This variable is a measure of culture and represents people's perceptions of gender issues, especially regarding the participation of women in leadership positions, such as boards of directors. The second is the *pink parliament*, which is a benchmark for the share of women in national parliaments and governments (Barasinska and Schäfer 2018; Belaounia et al. 2020; Palvia et al. 2020). This index can determine the extent of opportunity or threat to women's leadership and thus the likelihood of female directors being on a board. We also used the *gender pay gap* and *gender employment gap*, which are determined as the difference between the gender wage gap and the gender employment gap of men and women aged between 20 and 64 years, as a percentage of the average gross hourly wage of male employees and the employment rate gap (Ahmed et al. 2023; Mia et al. 2023). We selected these variables because, although they might influence women's careers (e.g., the number of women on a board), they do not directly impact a firm's sustainability performance. Finally, as a factor that may affect the availability of qualified female directors in board positions, we employed the *female education rate*

to gauge the proportion of women in the population who have successfully completed tertiary studies, such as degrees from universities or higher technical institutions (Berger et al. 2013). Table 1 displays the descriptions and sources of the variables used in the estimations.

3.4 | Robustness Checks

We identified the absence of multicollinearity among regressors by implementing a variance inflation factor (VIF) (Imbens and Wooldridge 2009). We addressed potential endogeneity issues

TABLE 1 | Variables description.

Variable name	Description	Source
Dependent variables		
ENV performance	Score representing environmental performance	*Refinitiv*
Greenwashing	A measure indicating the level of greenwashing activities	*Authors' elaboration (Refinitiv, Bloomberg)*
Independent variables		
BoD Pink	The ratio of female directors to total directors on the board	*Refinitiv*
SOC pillar	Score reflecting the firm's social performance	*Refinitiv*
GOV pillar	Score reflecting the firm's governance quality	*Refinitiv*
Controls variables (firm-based and country-based)		
Firm debt	Leverage of the firm, indicating the proportion of debt in the firm's capital structure	*Refinitiv*
Firm size	The logarithm of the firm's market capitalization used as a control for the firm's scale	*Refinitiv*
Default probability	Market-based default probability indicates financial health	*Bloomberg*
Bank concentration index	Concentration of the banking sector, accounting for market competition levels	*BankScope*
Inflation rate	Annual inflation rate, accounting for the stability of the economic environment	*Eurostat*
GDP growth	The growth rate of the GDP reflects overall economic growth	*Eurostat*
Instrumental variables		
Pink Parliament	Indicator measuring the proportion of women in national parliaments and national governments	*Eurostat*
Gender equality index	Composite indicator that assumes values ranging from 1 to 100. A score of 100 would mean that a country had reached full equality between women and men	*Eurostat*
Gender pay gap	The indicator measures the difference between male and female paid employees' average gross hourly earnings as a percentage of male paid employees' average gross hourly earnings	*Eurostat*
Gender employment gap	Indicator measuring the difference between the employment rates of men and women aged 20 to 64	*Eurostat*
Female education rate	The indicator measures the share of the female population who have successfully completed tertiary studies (e.g., university, higher technical institution, etc.)	*Eurostat*

Note: This table lists the key variables used in the study, including dependent, independent, control, and instrumental variables, along with their respective sources.

in the second instance by employing a 2SLS approach with IVs (2SLS-IV) (Granger 1969; Wintoki et al. 2012), which are *Pink_Parliament, Gender_Equality_Index, Gender_Pay_Gap, Gender_Employment_Gap*, and *Female Education Rate*. We chose these variables based on their ability to influence the proportion of female directors on a board (BoD Pink) (*relevance criteria*), while not being directly correlated with our dependent variables (*exclusion criteria*), which included environmental performance and greenwashing activities. To ensure the validity of our IVs, we first performed the baseline regression by adding the IVs identified as regressors and then conducted a first-stage *F*-test and the Stock-Yogo test to validate our results (Stock et al. 2002). These tests evaluated the strength of the relationship between our IVs and BoD Pink (the main regressor). Identifying strong relationships is fundamental to the effectiveness of the 2SLS approach.

Furthermore, we used the Cragg–Donald test to assess and confirm the absence of endogeneity in the final model (Cragg and Donald 1993). This test verified that our model was correctly specified and that the IVs adequately addressed the endogeneity concerns. Finally, we used the Hansen J and Durbin–Wu–Hausman tests to check for over-identification and verify that errors were not correlated with our chosen IVs (Durbin 1954; Wu 1973; Hausman 1978).

Recognizing the potential for heteroskedasticity, we re-estimated the 2SLS model using the Arellano coefficient estimation. This step addressed any issues of non-constant variance in the error terms of our regression models, thus ensuring more reliable and robust results (Arellano and Bover 1995). In addition to the 2SLS model, we employed the GLS model, which served as an additional check, focusing on the consistency of our main regressor (*BoD Pink*) and solving cross-sectional correlation problems. Using GLS, we aimed to confirm the results of our 2SLS analysis and add robustness to our conclusions.

Finally, we investigated the possible existence of the lagged effects of *BoD Pink* on our dependent variables to determine whether the impact of female board representation on environmental performance and greenwashing is immediate or progresses over time.

4 | Empirical Results

4.1 | Baseline Results

The baseline results in Table 2 show the relationship between BGD (BoD Pink) and the environmental performance of listed European firms, revealing a consistent negative association in contrast to Atif et al. (2021), Ben-Amar et al. (2017), Lemma et al. (2023), and Birindelli et al. (2024). The baseline model indicates a statistically significant negative relationship ($\beta = -0.105$, p-value < 0.05) that shrinks in size but remains present even when accounting for other variables such as firm-specific and macroeconomic factors as well as sector and country-fixed effects. The evidence does not support Hypothesis 1—which predicts a positive association between BGD and environmental performance—because it presents an opposite link ($\beta = -0.089$, p-value < 0.01). Our findings differ from those of Elmagrhi et al. (2019) and Lu and Herremans (2019), who demonstrated that board composition has complex implications for firms' corporate environmental strategies. This result suggests the need for further investigation into this controversial nexus.

Table 3 presents the results obtained using the greenwashing proxy. The coefficient of BGD (BoD Pink) across the different models consistently exhibits a statistically significant, negative relationship with our greenwashing measure in financial and non-financial European listed firms. Based on a significant coefficient in the baseline model ($\beta = -0.176$, p-value < 0.01), the findings suggest that the presence of women on a board is correlated with a decrease in greenwashing activities, thus confirming Hypothesis 2. These outcomes are consistent with the empirical findings of previous studies (Post et al. 2015; Naciti 2019; Lu and Wang 2021), which highlight that female directors are less likely to engage in opportunistic behaviors that could lead to greenwashing (Bear et al. 2010; Perryman et al. 2016) and are more accurate and transparent in terms of environmental reporting (Al-Shaer and Zaman 2016; Lu and Herremans 2019). Even after controlling for firm-specific and macroeconomic factors, a negative and significant relationship persists, including two-way sector and country fixed effects. Legitimacy theory, which supports our hypotheses, implies that diverse boards may enhance a firm's legitimacy by conforming to social norms and stakeholder expectations. This denotes a commitment to real environmental practices rather than engaging in greenwashing (Seele and Gatti 2017). This negative association indicates that gender-diverse boards may be more effective at aligning corporate behavior with legitimate expectations of environmental responsibility, possibly because of their diverse perspectives and business vision, leading to more rigorous oversight and ethical standards (Eagly and Johannesen-Schmidt 2001; Faccio et al. 2016). The robustness of this relationship across the model specifications reinforces the consistency of our findings and underscores the potential role of BGD in mitigating greenwashing practices.

4.2 | Robustness Analyses

In our study, we incorporated the lagged variables of BoD Pink (ranging from 1 to 4 years prior) to examine the potentially delayed effects of female board representation on the dependent variables, namely, environmental performance (ENV performance) and greenwashing (Table 4).

First, BoD Pink had a highly negative correlation with greenwashing (−0.215, $p < 0.01$) and ENV performance (−0.126, $p < 0.01$), indicating that women on a board reduce the level of greenwashing activities and hence the environmental performance score. Looking at the 1-year lagged results, BoD Pink had no significant influence on greenwashing ($\beta = 0.006$, p-value > 0.1) or environmental performance ($\beta = -0.011$, p-value > 0.1). This pattern persisted for two years, and even though there was no significant relationship with greenwashing ($\beta = -0.129$, p-value > 0.1) or environmental performance ($\beta = -0.126$, p-value > 0.1), it would be worthwhile investigating this further. In addition, the 3-year lag of BoD Pink did not have any meaningful effect on the decrease in pollution activities ($\beta = -0.029$, p-value > 0.1) or environmental practices ($\beta = -0.013$, p-value

TABLE 2 | Female board directorship and environmental performance.

Variables	Baseline	Controls model	Two-ways and country FE
BoD Pink	−0.105**	−0.092***	−0.089***
	(0.052)	(0.031)	(0.031)
SOC score		0.530***	0.532***
		(0.046)	(0.046)
GOV score		−0.243***	−0.242***
		(0.057)	(0.057)
Firm debt		1.371	1.542
		(1.169)	(1.164)
Firm size		−2.794***	−2.759***
		(0.685)	(0.692)
Default probability		−0.432***	−0.405***
		(0.134)	(0.130)
Bank concentration index		−0.125**	−0.119**
		(0.050)	(0.048)
Inflation rate		0.221*	0.248*
		(0.132)	(0.133)
GDP growth		−0.048	−0.052
		(0.046)	(0.046)
Constant term	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Sector fixed effect	No	No	No
Country fixed effect	No	No	Yes
Observations	1300	1300	1300
R^2	0.007	0.499	0.503
Adjusted R^2	−0.125	0.429	0.432
F statistic	7.929***	126.012***	104.603***

Note: This table presents the results of the regression analysis examining the impact of female board directorship on environmental performance, incorporating various model specifications, including firm controls, macroeconomic controls, and fixed effects for the sector and country. This table outlines the coefficients for key variables across different model setups, providing clarification on their statistical significance and the robustness of the findings. Robust t-stat in parenthesis.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

> 0.1). In addition, the 4-year lag of BoD Pink revealed that it was not significantly related to either reducing pollution activities ($\beta = -0.095$, p-value > 0.1) or environmental practices ($\beta = -0.061$, p-value > 0.1). These results suggest that the influence of female board representation on environmental outcomes and greenwashing does not consistently manifest in different years.

As part of our robustness analysis, we investigated the impact of board composition and the social (SOC) and governance (GOV) pillars on greenwashing, examining their lagged forms to assess both the immediate and delayed impacts of these factors (for further details, refer to Table 5).

For BoD Pink, the results showed a consistently significant, negative relationship with greenwashing across all models (−0.182***, −0.104**, −0.207***, and −0.120**). This finding indicates a robust association between increased female board representation and decreased greenwashing activity.

We analyzed the SOC and GOV pillars by focusing on their ESG profiles. Generally, the SOC pillar had a significant positive

TABLE 3 | Female board directorship and Greenwashing measure.

Variables	Baseline	Controls model	Two-ways and country FE
BoD Pink	−0.176***	−0.181***	−0.178***
	(0.052)	(0.032)	(0.031)
SOC pillar		0.530***	0.532***
		(0.047)	(0.047)
GOV pillar		−0.242***	−0.241***
		(0.059)	(0.058)
Firm debt		1.428	1.614
		(1.157)	(1.151)
Firm size		−2.838***	−2.799***
		(0.657)	(0.663)
Default probability		−0.437***	−0.407***
		(0.135)	(0.131)
Bank concentration index		−0.115**	−0.108**
		(0.053)	(0.052)
Inflation rate		0.408***	0.438***
		(0.145)	(0.145)
GDP growth		−0.058	−0.062
		(0.047)	(0.047)
Constant term	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Sector fixed effect	No	No	No
Country fixed effect	No	No	Yes
Observations	1300	1300	1300
R^2	0.018	0.494	0.498
Adjusted R^2	−0.112	0.422	0.427
F statistic	21.480***	123.262***	102.507***

Note: This table displays the regression results evaluating the relationship between female board directorship and greenwashing, using various model specifications such as firm controls, macroeconomic controls, and two-way sector and country fixed effects. This table offers a comprehensive view of the coefficients for the key variables across different models, emphasizing their statistical significance and demonstrating the robustness of these findings. Robust t-stat in parenthesis.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

relationship with greenwashing ($\beta = 0.584$, p-value < 0.01), suggesting that higher social performance scores are associated with increased greenwashing. However, the lagged effects of SOC pillars yielded mixed results. Neither the 1-year nor 4-year delays indicated significance ($\beta = 0.007$ and 0.008, respectively). Nevertheless, there was a positive effect of $\beta = 0.045$ for the 2-year lag, but it was not significant because p-value > 0.1. Interestingly, there was a negative correlation at three years ($\beta = -0.064$, p-value < 0.05); thus, higher social performance may decrease greenwashing in the future.

As for the governance factor, the current effect had a negative and significant correlation with greenwashing ($\beta = -0.485$, p-value < 0.01 and $\beta = -0.554$, p-value < 0.01), denoting that better governance is associated with less greenwashing. Lagged effects for this category were inconclusive; none of the 1- or 2-year lags significantly impacted it ($\beta = 0.017$ and -0.010). However, there was a positive relationship observed between them at three years ($\beta = 0.078$, p-value < 0.1) while non-significant at four years ($\beta = 0.069$), which means that governance's influence over time may be different when it comes to greenwashing.

TABLE 4 | Female board directorship lag effects.

Variables	Greenwashing	Greenwashing	ENV performance	ENV performance
BoD Pink	−0.215***	−0.015	−0.126***	0.022
	(0.047)	(0.069)	(0.048)	(0.069)
lag (BoD Pink, 1)		−0.006		−0.011
		(0.107)		(0.105)
lag (BoD Pink, 2)		−0.129		−0.126
		(0.084)		(0.083)
lag (BoD Pink, 3)		−0.029		−0.013
		(0.068)		(0.066)
lag (BoD Pink, 4)		−0.095		−0.061
		(0.071)		(0.070)
Firm debt	1.672	0.164	1.613	0.230
	(1.548)	(2.217)	(1.553)	(2.162)
Firm size	−6.015***	−5.821***	−5.973***	−5.764***
	(0.839)	(1.026)	(0.864)	(1.034)
Default probability	−0.858***	−0.643**	−0.853***	−0.612**
	(0.193)	(0.294)	(0.190)	(0.279)
Bank concentration index	−0.147**	−0.189**	−0.157***	−0.177***
	(0.059)	(0.075)	(0.056)	(0.068)
Inflation rate	0.434**	0.676***	0.247	0.357**
	(0.181)	(0.197)	(0.171)	(0.182)
GDP growth	−0.054	−0.138**	−0.044	−0.105*
	(0.058)	(0.056)	(0.057)	(0.055)
Constant term	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	1300	707	1300	707
R^2	0.237	0.201	0.230	0.196
Adjusted R^2	0.131	−0.007	0.124	−0.013
F statistic	50.611***	12.815***	48.719***	12.418***

Note: This table presents the analysis results on the lag effects of female board directorship on greenwashing and environmental performance. The table includes various lag periods of the BoD Pink variable to explore its time-delayed impact. Additional firm-specific and macroeconomic variables are also included to control for other influential factors. This table provides clarifications to the immediate and delayed effects of board gender diversity on firm behaviors and environmental outcomes, highlighting the importance of considering time dynamics in corporate governance studies. Robust t-stat in parenthesis.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

When performing robustness checks, the coefficient for BGD (BoD Pink) remained negative and statistically significant across the different model specifications. These findings reinforce the hypothesis that BGD is negatively associated with greenwashing in listed European firms (Table 6). The GLS model—which addresses issues of heteroskedasticity, serial correlation, and cross-sectional correlation—demonstrated a negative relationship ($\beta = -0.094$, p-value < 0.01), confirming the findings under standard conditions and suggesting that this relationship is not biased.

The use of a 2SLS regression with IVs such as the *pink parliament, gender equality index, gender pay gap*, and *female education rate* serves to support the claim by addressing potential endogeneity concerns. This method indicates that the negative correlation

TABLE 5 | The effect of lagged social and governance pillars on greenwashing.

	Greenwashing			
BoD Pink	−0.182***	−0.104**	−0.207***	−0.120**
	(0.034)	(0.048)	(0.042)	(0.060)
SOC pillars	0.584***	0.581***		
	(0.048)	(0.068)		
lag (SOC, 1)		0.007		
		(0.034)		
lag (SOC, 2)		0.045		
		(0.035)		
lag (SOC, 3)		−0.064**		
		(0.033)		
lag (SOC, 4)		0.008		
		(0.037)		
GOV pillars			−0.485***	−0.554***
			(0.066)	(0.103)
lag (GOV, 1)				0.017
				(0.051)
lag (GOV, 2)				−0.010
				(0.047)
lag (GOV, 3)				0.078*
				(0.046)
lag (GOV, 4)				0.069
				(0.047)
Firm debt	1.280	0.408	1.896	0.144
	(1.147)	(1.512)	(1.457)	(2.035)
Firm size	−3.507***	−3.245***	−4.209***	−3.665***
	(0.637)	(0.759)	(0.816)	(0.995)
Default probability	−0.457***	−0.216	−0.743***	−0.460
	(0.137)	(0.220)	(0.180)	(0.282)
Bank concentration index	−0.114**	−0.127**	−0.142**	−0.173**
	(0.054)	(0.064)	(0.057)	(0.075)
Inflation rate	0.410***	0.500***	0.426**	0.535***
	(0.146)	(0.152)	(0.172)	(0.178)
GDP growth	−0.061	−0.096**	−0.050	−0.085
	(0.048)	(0.048)	(0.055)	(0.053)
Constant term	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	1300	707	1300	707
R^2	0.476	0.450	0.318	0.298
Adjusted R^2	0.402	0.305	0.222	0.113
F statistic	129.135***	38.046***	66.262***	19.757***

(Continues)

TABLE 5 | (Continued)

Note: This table details analyzing the lagged effects of social and governance (S-G) scores on greenwashing. It explores the impact of current and past (lagged) S-G scores on greenwashing, incorporating various lag periods to assess the temporal dynamics of these relationships. The table includes coefficients for BoD Pink, the SOC, and GOV pillar scores, and their respective lagged values. This analysis is complemented by firm-specific and macroeconomic control variables, providing a more nuanced understanding of the factors influencing greenwashing in firms. The results highlight the significance of both immediate and delayed impacts of social and governance factors on greenwashing activities. Robust t-stat in parenthesis.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

between BoD Pink and greenwashing remained statistically significant when endogeneity bias was removed ($\beta = -0.121$, p-value < 0.01 in the 2SLS model and $\beta = -0.121$, p-value < 0.05 with the addition of Arellano and Bover's method for heteroskedasticity).

The consistency of the negative coefficient of BoD Pink across these robustness estimation techniques, together with the IV approaches, provides a robust empirical basis for the claim that greater gender diversity on corporate boards is associated with lower greenwashing levels. This finding is consistent with the principles of legitimacy theory, which posits that gender-diverse boards are more likely to adhere to social and ethical norms and expectations, thereby reducing their propensity to engage in greenwashing behavior.

To test the validity of the implemented IVs, we initially included them in the baseline regression analysis. This enabled us to ascertain the statistical significance of our estimation and obtain a preliminary validation of the relevance of the instruments. Table 7 presents the results of the analysis, indicating no statistically significant impact on environmental performance or greenwashing as the dependent variables in the models. The lack of correlation strengthens the validity of the IVs employed in the 2SLS model.

Finally, we ascertained the absence of multicollinearity through the VIF (Table A3) and the strength of our IVs using the first-stage F-Test (Table A4). As demonstrated in Table A5, the final model exhibited (1) the absence of endogeneity, (2) no correlation between the IVs and the error term, and (3) the absence of over-identification problems, as verified by the Hansen J and Durbin–Wu–Hausman tests. These tests confirmed the reliability of the IVs used in the analysis. The results of the Hansen J test (p-value = 0.0766) indicate that the IVs did not significantly violate the over-identification restrictions at conventional levels of significance. This suggests that the IVs used in the model were valid and did not correlate with the error term in the regression equation. Similarly, the Durbin–Wu–Hausman test (p-value = 0.9673) provides further evidence of the validity of the

TABLE 6 | The GLS, 2SLS, and 2SLS models with Arellano robustness estimation.

Greenwashing			
	GLS model	**2SLS model**	**2SLS model & Arellano**
BoD Pink	−0.094***		
	(0.034)		
Predicted BoD Pink		−0.121*	−0.121**
		(0.064)	(0.061)
Firm debt	1.135**	−1.342**	−1.342**
	(0.572)	(0.575)	(0.527)
Firm size	−5.926***	6.055***	6.055***
	(0.296)	(0.297)	(0.319)
Default probability	−1.329***	1.332***	1.332***
	(0.161)	(0.161)	(0.246)
Bank concentration index	−0.057*	0.021	0.021
	(0.035)	(0.026)	(0.027)
Inflation rate	0.220	0.051	0.051
	(0.180)	(0.188)	(0.209)
GDP growth	0.029	−0.055	−0.055
	(0.083)	(0.083)	(0.087)
Pink Parliament	−0.068		
	(0.058)		
Gender equality index	0.024		
	(0.170)		
Gender pay gap	−0.181**		
	(0.077)		
Gender employment gap	−0.222*		
	(0.126)		
Female education rate	−0.125		
	(0.130)		
Constant term	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	1300	1300	1300
R^2	0.256	0.256	0.256
Adjusted R^2	0.252	0.252	0.252
F statistic	63.623***	63.623***	63.623***

Note: This table presents the results from different econometric models used to analyze greenwashing, including the Generalized Least Squares (GLS), Two-Stage Least Squares (2SLS), and 2SLS with Arellano robustness estimation. This table compares the effectiveness of these methods in capturing the impact of board gender diversity and other variables on greenwashing. The GLS model is used for its ability to handle heteroskedasticity or autocorrelation in the data. The 2SLS models, both standard and with Arellano robustness, are employed to address potential endogeneity issues, with the latter providing more robust error estimates.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 7 | Regression of instrumental variables on dependent variable.

	ENV	GREENW
Constant	79.780***	103.536***
	(12.330)	(12.670)
Parliament	−0.058	−0.102
	(0.110)	(0.111)
Gender equality index	−0.142	−0.293
	(0.198)	(0.197)
Gender gap	−0.106	−0.059
	(0.119)	(0.126)
Gender employment gap	0.490	0.416
	(0.353)	(0.380)
Educational female rate	0.392	0.110
	(0.267)	(0.268)
Firm fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Observations	1300	1300
F statistic	1337.45***	1369.53***

Note: This table presents the results of the robustness checks to verify that our instrumental variables are not statistically significant for the main dependent variables (ENV—environmental pillar) and (GREENW—proxy of greenwashing). Robust *t*-stat in parenthesis.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

instruments by indicating no systematic difference between the estimates obtained from the IVs and the ordinary least squares (OLS) regression.

Furthermore, to ensure objectivity and avoid potentially biased conclusions that could compromise the reliability and robustness of our findings, we conducted the Stock et al. (2002) test to assess the strength of the instruments in the IV regressions. The results in Table A5 confirm the strength and reliability of the estimates. Additionally, we conducted a Pesaran CD test for cross-sectional dependence to examine the impact of female board directorship on environmental performance and greenwashing levels across firms, sectors, and countries; this test is useful for identifying potential economic, political, and social factors that may simultaneously influence firms and therefore the study's results.

5 | Discussion

In light of the growing importance attributed to the gender–environment nexus (OECD 2021), the baseline results presented in Table 2 challenge the prevailing expectations and existing literature (Ben-Amar et al. 2017; Atif et al. 2021; Lemma et al. 2023; Birindelli et al. 2024). Our findings indicate a significant negative association (−0.105**) between environmental performance and BGD. The rejection of Hypothesis 1 requires a detailed explanation of the reasons for the discrepancy between our results and current knowledge in the field.

Following the implementation of several CG reforms (Enriques and Volpin 2007), European firms may exhibit distinctive governance dynamics that diverge considerably from those observed in the US and UK, which have been more frequently investigated. Amorelli and García-Sánchez (2021) observed that the association between environmental performance and BGD varies according to the geographic area under study.

Although most of the existing literature indicates a positive correlation, some scholars have identified a non-linear relationship (Birindelli et al. 2019) and even a negative association (Ramon-Llorens et al. 2020) in specific contexts, including in financial firms and European studies. Specifically, European countries tend to implement more rigorous regulations pertaining to CG (Dallas and Pitt-Watson 2016) and compliance with environmental standards (Löfstedt and Vogel 2001; Mooneeapen et al. 2022). EU regulations on CG principles can influence the manner in which companies operate and make decisions, thereby enabling them to compete in the market while aligning with drivers of environmental sustainability. In this context, a board's role, including gender diversity composition, may interact with these regulations differently than in regions or countries with less stringent environmental standards, as Chiaramonte et al. (2024) demonstrated. For instance, stringent environmental regulations may prompt a board to prioritize compliance over innovative environmental strategies, which might not immediately enhance a firm's environmental performance (DeMenno 2023).

Additionally, the cultural backgrounds of EU member states can influence the dynamics of board operations and decision-making processes (Lu and Wang 2021). As evidenced in the literature (Lewellyn and Muller-Kahle 2020; Tyrowicz et al. 2020; Mohsni et al. 2021), European corporate culture may place different expectations on board members, influencing the manner in which gender diversity translates into corporate actions and business strategies. For instance, the cultural norms in European firms that prioritize risk aversion or a particular style of consensus-building may influence the operation and decision-making processes of gender-diverse boards with respect to environmental performance (Eagly and Johannesen-Schmidt 2001; Faccio et al. 2016). European firms also tend to prioritize short-term financial performance over long-term environmental strategies. Consequently, corporate boards may be incentivized to make choices that are not immediately reflected in environmental performance metrics (Demirag 1995; Kordsachia et al. 2022). For example, in the post-COVID-19 era, public grants, such as the *European Recovery and Resilient Facility Plan* promoted by the European Commission—provide incentives for short-term environmental investments. When these grants are combined with short-term compensation mechanisms for managers, they may result in a board of directors prioritizing short-term objectives over long-term strategies (Liu et al. 2023). Based on previous arguments, the extant literature suggests that the implementation of environmental strategies in European firms that are subject to the influence of board decisions may diverge from that observed in other regions or countries. Even if gender-diverse boards in Europe are inclined toward positive environmental

strategies, the effectiveness of these strategies in practice may be affected by operational, cultural, or regulatory factors unique to the European context and the composition of European boards of directors (García Martín and Herrero 2020).

The findings presented in Table 3, which align with Hypothesis 2, indicate that the level of greenwashing practiced by European listed firms is negatively associated with the proportion of female board members. The baseline model shows a statistically significant, negative coefficient (−0.176***) for BGD (BoD Pink), suggesting that the increased presence of women on boards is associated with a reduction in greenwashing activities. These results are particularly noteworthy considering the discussion presented above, in which BGD appears to negatively impact environmental performance. This primary outcome led us to develop Hypothesis 2, which postulates that gender-diverse boards may be less inclined to engage in greenwashing practices, thereby facilitating more realistic but seemingly lower environmental performance. Our findings indicate that boards with diverse gender compositions are more likely to make ethical decisions. Datta et al. (2021) argued that the presence of women on boards may help bring in more ethical views and ensure more reporting practices. Similarly, Nadeem (2022) found that women on boards of directors increase their level of financial reporting disclosures.

Due to their ethical and transparent approaches, boards with gender diversity are less likely to engage in greenwashing practices. Instead, these firms tend to prioritize the implementation of environmental strategies, even if such strategies do not immediately result in improvements in a firm's environmental performance metrics (Nuber and Velte 2021). Consequently, *pink boards* may encourage robust stakeholder engagement and responsiveness (Byron and Post 2016; Smulowitz and Smulowitz 2024). This includes heightened sensitivity to stakeholders' environmental concerns, leading to more authentic environmental practices and reduced reliance on greenwashing as a means of projecting a false image of environmental stewardship. Consistent with this view, another subliterature stream empirically supports this idea, demonstrating that gender-diverse boards may be more vigilant and responsive to regulatory compliance, including more prominent adherence to environmental standards (Elmagrhi et al. 2019). This vigilance can naturally lower the propensity to engage in greenwashing activities because compliance requires an accurate representation of environmental performance (De Masi et al. 2021).

Additionally, integrating women into boards of directors fosters transparency and reinforces a prudent approach to corporate environmental practices, thereby reducing the inclination toward greenwashing strategies and opportunistic behaviors. Eagly and Johannesen-Schmidt (2001) and Faccio et al. (2016) showed that female board members often display increased risk aversion. This tendency may influence a company's approach to environmental claims. Specifically, women's risk aversion may lead to a more careful evaluation of environmental statements, ensuring that they are substantiated. The hypothesis is that BGD contributes to long-term strategic outlooks (Datta et al. 2021; Mohsni et al. 2021). This long-term perspective is crucial for understanding board decisions, particularly regarding environmental policies. Boards with diverse gender representation tend to discourage short-term deceptive practices such as greenwashing. These practices are incongruous with the pursuit of long-term sustainability goals and have the potential to negatively affect a company's reputation.

6 | Conclusions, Implications, and Limitations

This study presents a comprehensive analysis of the influence of female board directorship on the environmental performance of listed financial and non-financial firms in Europe from 2013 to 2022. The findings and implications of this study contribute significantly to the existing literature on corporate environmental responsibility. In particular, this study introduces a novel proxy for firm greenwashing that has not been previously explored at this level in financial studies. Our empirical analysis initially revealed a misleading negative correlation between female board directorship and environmental performance, which corroborates the empirical evidence provided by Ramon-Llorens et al. (2020) in the European context. Nevertheless, a more detailed examination using our greenwashing metric yielded divergent outcomes. This indicates the positive impact of female directors on environmental performance, which may be attributed to their potential role in reducing greenwashing practices. This evidence underscores the need for accurate measurement tools to assess the true impact of board composition on environmental strategies, particularly considering the growing importance of gender and environmental issues for policymakers and international organizations (OECD 2021; European Commission 2022).

Our results show a negative association between BGD and environmental performance in European companies, suggesting the influence of unique regional dynamics and policies. European firms subjected to more stringent regulations might focus more on legal and operational compliance than on innovation and adaptation to current trends in environmental strategies. Strong cultural influences in European countries could also shape how gender diversity impacts environmental performance, emphasizing short-term financial returns and possibly overshadowing long-term environmental goals. The results demonstrate a negative correlation between the gender diversity of boards of directors and the environmental performance of European companies. This implies that unique regional dynamics and policies influence this relationship. Therefore, we can posit that European firms, which are subjected to more stringent regulations, may direct their attention toward matters of legal compliance and operational conformity (rather than innovation and adaptation) among the prevailing trend of environmental strategies. It is also possible that strong cultural influences in European countries shape how gender diversity affects environmental performance. This could result in a focus on short-term financial returns, which may overshadow long-term environmental goals. Our findings also indicate that an increase in female representation on boards of directors is associated with reduced greenwashing. This evidence suggests that gender-diverse boards in Europe may be more inclined to prioritize ethical decision-making and transparent managerial practices, which could result in business actions with a reduced environmental impact and a greater focus on mitigating climate change (Altunbas et al. 2022). The boards represented in our sample seem to have adopted long-term strategic environmental

policies, moving away from superficial short-term environmental claims. The analysis yields evidence of the dual impact of BGD. The presence of women on a board has a negative impact on an organization's immediate environmental performance; however, it has a positive effect on reducing greenwashing. This offers a novel understanding of the relationship between CG and environmental policy in the European context, supporting the existing literature that has emphasized differential effects on European countries (Ramon-Llorens et al. 2020; Amorelli and García-Sánchez 2021). These findings have significant implications for policymakers and practitioners, emphasizing a firm's need to provide fair, clear, and non-misleading information on sustainability (EBA 2019). This study underscores the need for policymakers to advocate for long-term, ethical, and environmentally conscious strategies as well as for greater board diversity regarding CG issues. From this perspective, policies should be devised to align corporate actions with environmental sustainability given the distinct interaction between board composition and European environmental performance. For business practitioners, the results suggest integrating this novel evidence (or perspective) into their advisory roles, recognizing the unique European context. The promotion of sound governance, including gender diversity issues, ensures that companies can effectively manage the risks inherent in the operating environment and identify and capitalize on the opportunities presented. As highlighted in the *Sustainability Committees: Structure and Practices* by the International Finance Corporation (World Bank), this goal requires developing and implementing a sustainability policy and plan that is progressively tailored to align with the strategic directives of boards of directors.

By contrast, for practitioners in the banking sector, this study suggests the importance of considering these dynamics in terms of risk assessment and lending decisions, as gender-diverse boards may influence environmental strategies and compliance. Similarly, banking practitioners should adapt their lending practices to align with the needs of firms that adhere to ethically driven governance structures.

The limitations of this study relate to its focus on European countries for only one decade. Further research should address these limitations by extending the observation period and conducting a comparative analysis with the US, thereby providing a more comprehensive global perspective. Additionally, we used only listed firms, overlooking potential differences in the impact of environmental performance on unlisted companies. Furthermore, scholars should investigate the mediating mechanisms through which gender diversity influences environmental performance, such as organizational culture and decision-making processes. This would facilitate a more detailed understanding of the relationships under study. Moreover, the roles of regulatory frameworks and cultural influences should be incorporated into the analysis, thereby enhancing the relevance and implications of the present study.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix

TABLE A1 | Correlation matrix.

	GREENW	Bod Pink	SOC	GOV	Lev	Mkt	PD	Bank Conc	Inf	GDP g	Parl	Gend Eq Index	Gen Gap	Educ
GREENW	1***	0.06	−0.65	0.42	0.02	0.46	0.11	0.02	−0.03	−0.02	0.05	0.05	0.06	0.08
Bod Pink	0.06	1***	0.05	0.08	−0.1	0.05	−0.05	−0.03	0.25	−0.04	−0.06	0.12	−0.28	0.05
SOC	−0.65	0.05	1***	−0.38	−0.03	−0.28	−0.14	−0.08	0.03	−0.01	−0.1	0.03	−0.02	−0.01
GOV	0.42	0.08	−0.38	1***	0.03	0.33	−0.02	−0.01	0.01	−0.03	−0.08	0.01	0.04	−0.03
Lev	0.02	−0.1	−0.03	0.03	1***	−0.02	0.01	0.07	−0.01	−0.07	0.07	−0.12***	−0.2	−0.09
Mkt	0.46	0.05	−0.28	0.33***	−0.02	1***	−0.18	−0.01	0.01	−0.01	0.02	0.04	0.01	0.07
PD	0.11	−0.05	−0.14	−0.02	0.01	−0.18	1***	0.01	−0.05	0.00	0.03	−0.02	0.02	0.00
Bank Conc	0.02	−0.03	−0.08	−0.01	0.07*	−0.01	0.01	1***	−0.12	0.06	0.43	−0.38	−0.23	−0.23
Inf	−0.03	0.25	0.03	0.01	−0.01	0.01	−0.05	−0.12	1***	0.03	−0.13	0.3	−0.07	0.22
GDP g	−0.02	−0.04	−0.01	−0.03	−0.07**	−0.01	0.00	0.06*	0.03	1***	0.04	0.03	0.01	0.05
Parl	0.05	−0.06	−0.1	−0.08	0.07	0.02	0.03	0.43	−0.13	0.04	1***	−0.19	−0.2	0.15
Gend Eq Index	0.05	0.12	0.03	0.01	−0.12	0.04	−0.02	−0.38	0.3	0.03	−0.19	1***	0.43	0.87
Gen Gap	0.06	−0.28	−0.02	0.04	−0.2	0.01	0.02	−0.23	−0.07*	0.01	−0.2	0.43	1***	0.38
Educ	0.08	0.05	−0.01	−0.03	−0.09	0.07	0.00	−0.23	0.22	0.05	0.15	0.87	0.38	1***

Note: This table presents a correlation matrix that outlines the relationships between various variables used in the study. This matrix includes the dependent variables ENV and Greenwashing alongside key independent and control variables such as BoD Pink, SOC, GOV, and others. The matrix provides a quantitative view of these variables' interrelatedness, highlighting potential correlations or inverse relationships.

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

TABLE A2 | Statistical summary.

Statistic	ENV	GREENW	BoD Pink	SOC	GOV	LEV	MKT	PD	Bank_conc	INF	GDP_g	Pink_ Parliament	Gend_Eq_Index	Gen_Gap	Female_Educ
Min	24.81	−97.32	0.00	14.04	17.86	0.00	5.371	0.08	35.79	−1.140	−11.33	23.00	53.30	4.20	22.90
1st Qu.	44.19	−63.57	22.22	38.60	57.14	15.94	8.707	0.69	45.28	0.480	0.00	29.50	67.45	9.40	41.10
Median	54.26	10.84	30.77	45.61	62.50	28.98	9.655	13.21	62.51	1.230	1.71	32.00	72.70	14.93	46.90
Mean	55.52	19.20	30.42	47.90	61.81	28.73	9.656	20.53	60.01	1.856	1.25	35.11	71.40	14.64	43.58
3rd Qu.	65.12	41.86	40.00	56.14	67.86	40.18	10.625	24.37	66.37	2.290	2.44	38.60	76.80	19.80	49.40
Max	97.67	53.28	66.67	91.23	85.71	104.73	12.650	28.20	96.57	10.000	24.37	69.60	83.90	29.80	56.40

Note: This table provides a statistical summary of the key variables used in the study, offering a comprehensive overview of their distribution characteristics. This summary includes basic statistics such as minimum, first quartile, median, mean, third quartile, and maximum values for each variable, including ENV, GreenW, BoD Pink, SOC, GOV, and several others.

TABLE A3 | Variance inflation factor (VIF).

BoD Pink	SOC	GOV	Bank Debt	Bank Size	Default probability	Bank concentration index	Inflation	GDP growth
1.087	1.273	1.261	1.067	1.222	1.141	1.027	1.086	1.009

Note: This table displays the variance inflation factor (VIF) values for key variables, including BoD Pink, SOC, GOV, LEV, MKT, PD, Bank_Conc, INF, and GDP_g. These VIF values are crucial for assessing multicollinearity among the regression models' variables, ensuring the estimated coefficients' reliability and validity.

TABLE A4 | Hausman Test.

Hausman Test	
Chi-square	28.397
Degrees of freedom	5
p-value	0.411

Note: This table presents the results of the Hausman Test conducted in the study. The test includes a chi-square statistic, degrees of freedom, and the associated *p*-value. The Hausman Test is used to determine the appropriateness of using fixed effects versus random effects in the panel data analysis, based on the assumption of whether individual effects are correlated with the regressors.

TABLE A5 | Cragg-Donald, First Stage *F*-Test, and Hansen J and Durbin–Wu–Hausman Tests for overidentification, Stock-Yogo, and Pesaran CD-Test.

Cragg-Donald		**First Stage *F*-Test**		**Overidentification Test (1)**	
Cragg-Donald Test	0.6561	First Stage *F* Test	63.5304	Hansen *J* Test	31.343
p-value	0.9987	Degrees of Freedom	7; 1291	Degrees of Freedom	1
		p-value	0.000	*p*-value	0.0766
Overidentification Test (2)		**Stock-Yogo**		**Pesaran CD-Test**	
Durbin–Wu–Hausman	0.93963	Stock-Yogo Test	46.42	Pesaran CD Test	41.26
Degrees of Freedom	5	*p*-value	0.000	*p*-value	0.3869
p-value	0.9673				

Note: This table details the results of the Cragg-Donald and First Stage *F*-Tests. The Cragg-Donald statistic and *p*-value assess the instrumental variables' strength in the 2SLS regression. The First Stage *F*-Test, along with its *F*-value, degrees of freedom, and *p*-value, evaluates the joint significance of the instrumental variables in the first stage of the 2SLS estimation. The Hansen *J* test is useful in identifying that our errors are not correlated with the instrumental variables. These tests are critical for validating the effectiveness of the instrumental variables in the econometric model. Similarly, the Durbin–Wu–Hausman test is valuable for further evaluating the validity of instrumental variables (IVs) and the presence of endogeneity in the regression model.