Unveiling the Myth: A Causal Reassessment of Gender Diversity's Impact on Corporate Environmental Performance

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Abstract

This study reassesses the impact of gender diversity in corporate boards on firms' environmental performance, using a panel of 4,950 firm-year observation from Standard and Poor's (S&P) 500 companies from 2010 to 2020. Using traditional econometric techniques such as Ordinary Least Squares (OLS) and Instrumental Variables (IV), we initially find strong evidence suggesting that appointing women to corporate boards enhances environmental performance. These results remain robust across different instruments, control variables, and fixed effects specifications. However, when employing a more rigorous causal identification strategy through Staggered and Honest Difference-in-Differences (DID) methodologies, we find no significant evidence supporting a causal relationship. Instead, our findings reveal that firms tend to adopt greener practices before appointing women directors, suggesting that corporate sustainability strategies and board gender diversity evolve concurrently rather than in a causally linked manner. Our results call for a reevaluation of the existing evidence on gender diversity and environmental performance and highlight the need for more robust causal methodologies in examining corporate governance and sustainability dynamics.

Keywords: Board composition, gender diversity, environmental performance, corporate governance, causal identification.

JEL Codes: G30; G34; M14

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1. Introduction

Climate change and environmental degradation rank among the most pressing global challenges, positioning corporations as key actors in advancing sustainability initiatives. Increasingly, firms are expected to mitigate their environmental impact through Environmental, Social and Governance (ESG) strategies, with corporate boards playing a strategic role in shaping these actions (Shaukat et al., 2016). Given the rising prominence of environmental concerns in corporate governance, the composition of boards, particularly regarding gender diversity, has garnered significant academic and policy interest. Scholars and policymakers are eager to understand whether women directors and/or gender diversity contribute to more sustainable corporate practices (Biswas et al., 2018; de Villiers et al., 2011; Lu & Herremans, 2019).

This debate is particularly relevant in the context of Standard and Poor's (S&P) 500 companies, which exert substantial influence over global business practices and have a significant environmental footprint[1]. As the index comprises the 500 largest publicly traded U.S. firms (both domestic and foreign), it serves as a benchmark for corporate governance and sustainability policies worldwide (Catalyst, 2017). Understanding whether gender diversity on corporate boards drives meaningful environmental improvements is therefore crucial for policymakers, investors, and corporate stakeholders.

Corporate transparency regarding environmental performance has increased significantly in recent years, particularly among publicly traded firms such as those in the S&P 500. Companies now disclose a broad range of environmental performance indicators, including carbon emissions, energy efficiency, waste management, and climate-related risk assessments. Among these, ESG (Environmental, Social, and Governance) scores have gained particular prominence as a standardized metric for evaluating corporate sustainability efforts and many funds incorporate them into portfolio selection criteria (Kölbel et al., 2020; Amel-Zadeh & Serafeim, 2018). Moreover, ESG-driven institutional investors increasingly pressure firms to align with sustainability goals, reinforcing the importance of board composition in shaping corporate environmental strategies (Alkhawaja et al., 2023).

[1] The United States was the world's second-largest emitter of greenhouse gases in 2020, after China, with emissions reaching 5.2 billion metric tons of CO_2 equivalent (Environmental Protection Agency, 2021). A significant share of these emissions comes from publicly traded companies, particularly those in the S&P 500, which account for over 3.5 gigatonnes of CO_2 equivalent annually (Bloomberg, 2023). Although high-emission industries—such as energy, utilities, and manufacturing—make up only 15% of the index in terms of market cap, they generate nearly 70% of its carbon footprint (Carbon Disclosure Project, 2023).

Drawing on a sample of S&P 500 firms and leveraging on ESG metrics to align with the evolving research agenda, this study critically reassesses the relationship between board gender diversity and corporate environmental performance, looking to addressing key endogeneity concerns through robust empirical methodologies. Our findings challenge conventional wisdom by demonstrating that environmental improvements often precede the appointment of women directors. This supports recent evidence showing that firms under greater environmental pressure tend to increase board diversity as part of broader governance and compliance strategies, rather than as a direct driver of sustainability improvements (Dutordoir et al., 2024). Rather than assuming the existence of causal mechanisms, our findings suggest that sustainability outcomes may precede changes in board composition. It emphasizes the need for robust causal identification strategies to better understand the complex dynamics between board composition and sustainability outcomes. This study contributes to the literature at the intersection of corporate finance, governance, and sustainability by reassessing the presumed causal relationship between board gender diversity and environmental performance.

Furthermore, these insights raise questions about the justification for gender-based board quotas as a policy tool for promoting corporate sustainability. Mandatory gender quotas do not necessarily lead to improved firm outcomes and, in some cases, may even be counterproductive by constraining governance structures (Adams & Ferreira, 2009). If the relationship between women board representation and environmental performance is not causal, then diversity quotas aimed at improving sustainability outcomes may be misguided. Recent evidence indicates that the effectiveness of gender-diverse boards in sustainability efforts depends largely on regulatory frameworks and institutional conditions (Barroso et al., 2024; Alkhawaja et al., 2023). Instead of viewing board diversity as a direct driver of environmental performance, it should be understood as part of a broader governance system that influences sustainability outcomes. Nevertheless, board gender diversity remains a crucial element of sound governance, contributing to more effective oversight, richer decision-making processes, and greater stakeholder inclusivity. Policymakers should therefore prioritize regulatory measures and incentive structures that directly impact corporate environmental commitments, ensuring that diversity initiatives are grounded in governance and equity considerations rather than presumed environmental benefits lacking strong empirical support.

Beyond this specific setting, the analysis also highlights broader methodological concerns in corporate governance research. Instrumental Variable (IV) approaches, while widely used to address endogeneity, often fail to isolate true causal effects. Even after robustness checks, conventional estimates may overstate the link between board gender diversity and environmental performance. In contrast, novel Difference-in-Differences (DID) techniques offer a more credible identification strategy, reinforcing the need for advanced empirical methods in corporate governance research to avoid misleading conclusions.

The remainder of this paper is structured as follows: Section 2 reviews the theoretical and empirical literature on board gender diversity and corporate environmental responsibility. Section 3 outlines the data, methodology, and empirical strategy. Section 4 presents the empirical results, while Section 5 discusses the implications of the findings and concludes with directions for future research.

2. Literature Review: Gender Diversity and Environmental Performance

The corporate governance literature suggests that gender-diverse boards enhance decision-making by integrating a broader range of perspectives and experiences (Rao & Tilt, 2016; Triana et al., 2014; Van der Walt & Ingley, 2003). Such diversity is believed to improve deliberations, leading to more informed strategic choices, including those related to environmental sustainability. Some studies further argue that gender-diverse boards strengthen accountability to stakeholders concerned with sustainability (Birindelli et al., 2019; Liu, 2018; Lu & Herremans, 2019; Pucheta-Martínez & Bel-Oms, 2019) and are more likely to prioritize long-term sustainability over short-term financial gains (Byron & Post, 2016).

Expanding on this premise, prior research has linked female board representation with a heightened emphasis on social and environmental concerns (Liu, 2018), more effective strategic planning, the adoption of pro-environmental behaviour (Kennedy & Dzialo, 2015) and enhanced financial performance (Campopiano et al., 2023; Gabaldón et al., 2023). Gender-diverse boards have also been associated with increased investment in research and development (Triana et al., 2014), the adoption of sustainability-oriented practices, such as the use of renewable energy sources (Atif et al., 2021), and stronger ESG performance (Paolone et al., 2023; Zharfpeykan & Bai, 2025). These arguments often emphasize that female leadership is characterized by greater ethical orientation, as evidenced by their heightened concern for negative business practices such as fraud and corporate misconduct (Boulouta, 2013; Cumming et al., 2015), their willingness to promote inclusivity and sustainability as core values (Hopkins & Bilmoria, 2004) and long-term strategic thinking (Shaukat et al., 2016) Furthermore, firms with female board representation have been shown to exhibit a stronger environmental orientation, demonstrating greater commitment to sustainability initiatives and environmental responsibility (Al-Shaer & Zaman, 2016; Cook & Glass, 2018).

However, recent studies indicate that the relationship between female leadership and environmental performance is more nuanced and contingent on firm-specific factors such as industry characteristics, ownership structure, and regulatory environment (Lu & Herremans, 2019; Liu, 2018; Glass, et al., 2016). Moreover, the effectiveness of board gender diversity in driving environmental performance has been shown to depend on cultural contexts and the level of regulatory pressure faced by firms (Alkhawaja et al., 2023; Barroso et al., 2024)

Theoretical frameworks offer mixed insights into this relationship. The Behavioral Theory of the Firm (BTF) posits that board decisions, including those related to environmental policies, are influenced by cognitive biases and organizational routines (Cyert & March, 1963; Gavetti et al., 2012). Although women on boards bring diverse perspectives that promote sustainability and broader stakeholder engagement (Byron & Post, 2016; Schwab et al., 2016), their influence may be constrained by less prominent roles within the firm (Zelechowski & Bilimoria, 2004). In line with this, prior evidence shows that firms with stronger social orientations are more likely to appoint female directors—not necessarily driven by performance goals, but as part of broader symbolic or cultural commitments (Brammer et al., 2009). These patterns suggest that female directors may be appointed to firms already on a sustainability trajectory rather than initiating change themselves, raising concerns about reverse causality (Adams & Ferreira, 2009; Kirsch, 2018).

On the other hand, Social Identity Theory (SIT) (Tajfel & Turner, 1986) further elaborates on how individuals categorize themselves within social groups, influencing behavior and decision-making in organizational settings. While increased gender diversity may introduce alternative skills and experiences to corporate boards (Birindelli et al., 2019; Glass et al., 2016), women directors may also conform to dominant corporate norms, particularly in contexts where sustainability decisions are driven by broader firm strategies and shareholder interests. This perspective aligns with evidence suggesting that board diversity may reflect, rather than drive, corporate environmental commitments (Byron & Post, 2016). Empirical studies support this notion, demonstrating that environmental improvements frequently precede the appointment of female directors (Kirsch, 2018; Galbreath, 2018).

While gender-diverse boards may enhance the focus on environmental and social issues (Arora et al., 2021; Cook & Glass, 2011, 2018), these effects depend on governance structures and firm-level incentives. If both board gender diversity and environmental performance are outcomes of broader firm-level strategies rather than a direct causal relationship, then policies promoting board diversity as a mechanism for improving sustainability outcomes may warrant reconsideration (Adams & Ferreira, 2009). Given these empirical findings and theoretical perspectives, the causal relationship between board gender diversity and corporate environmental outcomes remains uncertain. Most empirical studies, including recent analyses linking gender diversity to ESG performance, rely on correlational evidence (Bear et al., 2010; Post et al., 2011; Paolone et al., 2023; Zharfpeykan & Bai, 2025), making it difficult to establish whether female directors actively drive environmental improvements or if sustainability-committed firms are simply more inclined to appoint women to their boards.

To address endogeneity concerns, various studies have employed Instrumental Variable (IV) techniques (Ahern & Dittmar, 2012; Atif et al. 2021, Eckbo et al., 2022). However, these methods have notably limited validity, particularly regarding the validity of commonly used instruments (Larcker & Rusticus, 2010). The use of traditional DID methods in the context of our study, without a natural treatment context derived from a specific policy intervention, presents significant limitations, as the appointment of women to corporate boards does not occur at the same point in time across all firms. Recent advances in econometrics suggest that staggered Difference-in-Differences (DID) methodologies offer a more robust causal identification approach by leveraging the staggered introduction of female board members across firms (Callaway & Sant'Anna, 2021; de Chaisemartin & D'Haultfœuille, 2022; Borusyak et al., 2022). Honest DID further mitigates concerns related to the parallel trends assumption (Rambachan & Roth, 2023), revealing that firms often enhance environmental performance before appointing female directors.

This study reassesses the relationship between board gender diversity and corporate environmental performance using a more rigorous causal identification strategy. First, we replicate traditional estimation techniques—including OLS and IV—and conduct robustness checks and placebo tests to highlight the potential misinterpretation of prior findings. These approaches often suggest a strong positive association between board gender diversity and environmental performance, yet they do not adequately address the possibility of reverse causality or firm-level characteristics that may simultaneously drive both factors. Next, we employ staggered DID and honest DID methodologies, which more effectively account for firm-specific trends and macroeconomic conditions by leveraging firms that introduce female directors at different points in time.

Our findings demonstrate that corporate environmental improvements typically precede the appointment of female directors, suggesting that environmentally-oriented firms may proactively attract diverse boards rather than gender diversity actively propelling sustainability improvements. One possible explanation is that firms prioritizing environmental performance are more attuned to stakeholder expectations and governance reforms, leading them to enhance board diversity as part of a broader strategic shift. Additionally, companies may anticipate regulatory scrutiny and improve environmental metrics before increasing gender diversity to align with evolving corporate governance standards. This aligns with the findings of Walls et al. (2012), who argue that firms with proactive environmental strategies tend to refine their governance practices, including board composition. These findings contribute to the corporate finance and governance literature by challenging the effectiveness of gender diversity policies as a tool for promoting corporate sustainability.

For policymakers, these insights indicate that while board diversity may enhance governance and accountability, its role in driving corporate environmental performance should not be overestimated. Regulatory efforts should prioritize direct incentives and industry-specific mechanisms rather than assuming that gender diversity alone drives improved sustainability outcomes (Barroso et al., 2024; Dutordoir et al., 2024). Future research should refine causal identification strategies, incorporating natural experiments and policy variations to establish more definitive conclusions. Understanding whether board diversity enhances sustainability through direct influence or merely reflects pre-existing firm priorities remains a crucial area for further investigation. In the following section, we describe our data sources, empirical strategy, and identification methods in greater detail to ensure a more accurate assessment of the causal link between gender diversity and corporate environmental outcomes.

3. Data and Descriptive Statistics

This section provides a detailed overview of our sample and key variables, focusing on board composition and environmental performance. The descriptive statistics presented here form the basis for understanding the core characteristics of the firms and these are essential for interpreting the empirical relationships between gender diversity on boards and corporate environmental outcomes, which are analyzed in the subsequent section.

3.1. *Sample and Variables*

Our dataset comprises an unbalanced panel of board-level annual data for companies listed in the S&P 500 index, sourced from BoardEx, covering the period from 2010 to 2020[2]. BoardEx provides comprehensive information on corporate boards and their respective committees, along with detailed profiles of the directors who constitute them. At the directorship level, the dataset includes academic qualifications, professional trajectories, and demographic details such as age and gender.

Our selection of board-related control variables follows prior research highlighting the importance of board characteristics in shaping corporate policies and decision making (Liu, 2018; Chen et al., 2017; Atif et al., 2021). The key gender diversity variable is defined as the number of women directors on the board (*WoB*). Additionally, we include *Nationality Mix*, which reflects the degree of internationalization and the variety of cultural backgrounds among board members[3]. Other board structure variables include *Board Size* (total number of directors), *Board Ind* (fraction of independent directors) and *Board Meetings* (total number of board meetings held during the year). *Avg Educ* is computed as the average years of education across board members, based on the International Standard Classification of Education (ISCED)[4]. Experience and age are measured as the average tenure/age of directors on corporate boards (*Avg Exper* and *Avg Age*). We also include a binary indicator for whether the board's CEO is a woman (*CEO fem*). To capture environmental governance, we construct the Environmental Committee (*Env Com*) variable, which takes a value of 1 if a board has a committee with a name containing any of the following keywords: CSR, Environmental, Sustainability, Innovation, Research, Safety, and/or Technology. This variable serves as a proxy for the company's environmental culture, under the assumption that the existence of such a committee signals a stronger commitment to sustainability[5].

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[2] This choice mitigates sample selection bias by avoiding the overrepresentation of small or privately held firms, which may have different sustainability incentives, governance dynamics, or disclosure practices. Moreover, S&P 500 firms are subject to greater investor scrutiny and regulatory compliance, ensuring more reliable and standardized environmental reporting (Clarkson et al., 2008).

[3] Prior research suggests that nationality diversity enhances decision-making by incorporating broader perspectives, fostering strategic adaptability, and strengthening firms' commitment to social responsibilities through more inclusive governance practices (Harjoto et al., 2019; Ruigrok et al., 2007).

[4] The directors in the sample possess high levels of education, with ISCED classification values ranging from 6 to 8. We assign 16 years of education to directors with an ISCED value of 6, 17 years to those with a value of 7, and 22 years to those with the highest ISCED value.

[5] Prior research has shown that firms with dedicated environmental or sustainability committees are more likely to engage in proactive environmental strategies and enhance their sustainability performance (Biswas et al. 2018; Mallin & Michelon, 2011; Peters & Romi, 2015).

We further enhance our analysis by incorporating professional networking data for each director from the BoardEx networks database[6]. Using these data, we manually link each director, in each year, to all their connections across different boards and institutions, such as associations and universities. The resulting dataset encompasses a vast array of connections across the U.S., U.K., and Europe, totaling seven million observations. This rich directorship-level information is then aggregated at the board level to construct the *Networks* variable, providing a comprehensive view of the interconnectedness of corporate boards[7].

Beyond board characteristics, we also control for firm-level attributes based on prior literature (e.g. Chen et al., 2017), incorporating financial information at the firm level by merging our dataset with Compustat. Our analysis includes firm size—proxied by the number of employees—and market value, selecting the latter as the financial metric with the fewest missing values. Additionally, to account for sectoral heterogeneity, we include industry classification following the Global Industry Classification Standard (GICS) at 4-digit level.

All data on environmental outcomes is sourced from Refinitiv Eikon, a widely used financial data platform that provides comprehensive environmental, social, and governance (ESG) metrics, frequently referenced by investors and analysts (Nicolo' et al., 2021; Pozzoli et al., 2022). ESG ratings have gained increasing relevance in capital markets, shaping investment decisions and corporate valuations as stakeholders demand greater transparency in sustainability performance (Kölbel et al., 2020; Amel-Zadeh & Serafeim, 2018).

For our study, we focus on the Environmental Pillar Score (*Env Score*), which serves as our principal dependent variable. This metric is calculated as the weighted sum of three dimensions: Resource Use, Emissions, and Environmental Innovation, with scores ranging from 0 to 100, with higher values indicating stronger environmental performance. We use *Env Score* in all our models and estimations, as it provides a more precise measure of environmental outcomes, minimizing potential biases from social and governance factors that may be directly influenced by board gender diversity. However, we also keep the *ESG Score* as an alternative dependent variable for robustness checks. This approach allows us to better isolate the

[6] Previous research has also shown that director networks significantly influence firm performance and corporate environmental strategies (Ortiz-de-Mandojana & Aragón-Correa, 2015; Owen et al., 2023)

[7] Incorporating directors' professional networks into corporate governance analysis is well-supported in academic literature. For instance, Harjoto & Wang (2020) examined the relationship between board network centrality and firms' environmental, social, and governance (ESG) performance, finding that well-connected boards positively influence ESG outcomes.

relationship between board composition and environmental performance (Chatterji et al., 2016) while assessing whether our findings extend to broader corporate sustainability performance. See Figure A in the Appendix for the distribution of *Env Score*.

Our final sample consists of 51,505 directorships (director board-years), 4,950 board-years covering 474 boards. Table 1 provides a detailed description of the study variables, including their nomenclature, type, and data source.

Table 1
Variables description

Variable	Type	Description	Source
Environmental Outcome			
ESG Score	Continuous	ESG Score	Refinitiv
Env Score	Continuous	Environmental Pillar Score weighted sum of the scores in the Resource Use, Emissions, and Environmental Innovation categories	Refinitiv
Gender diversity			
WoB	Continuous	Total number of women on board	BoardEx
Control variables			
Nationality Mix	Continuous	Proportion of board members from different nationalities within the board.	BoardEx
Board Size	Continuous	Total number of members on board	BoardEx
Board Ind	Continuous	Fraction of Independent Directors on board	BoardEx
Board Meetings	Continuous	Number of Board Meetings held in a year	BoardEx
Avg Age	Continuous	Average Age of all members on board (years)	BoardEx
Avg Educ	Continuous	Average Education level of all members on board (years)	BoardEx
Avg Exper	Continuous	Average Experience of all members on board (years)	BoardEx
Env Com	Binary	=1 if the board has an Environmental Committee; =0 otherwise	BoardEx
CEO_fem	Binary	=1 if the CEO of the board is a female director	BoardEx
Networks	Continuous	Number of connections through BoardEx	BoardEx
Firm Size	Continuous	Number of employees	CompuStat
MValue	Continuous	Total Market Value of the firm (thousand $)	CompuStat
Gind	Categorical	Industry of the Company (GIC Classification)	CompuStat

Table 1 defines the key variables used in the analysis, sourced from three main databases: BoardEx for board composition and director-level data, Refinitiv Eikon for ESG metrics, and Compustat for financial and industry data.

3.2. *Descriptive Analysis*

Table 2 presents descriptive statistics for the full sample, as well as separately for boards with and without female directors. The last column of the table shows the difference in means (and their significance) for each variable between the sub-samples of boards with women and without women.

Table 2
Descriptive Statistics

	Full Sample (n=4,950)				**With WoB (n=4,578)**		**Without WoB (n=372)**		**Diff**
Variable	**Mean**	**Std. dev.**	**Min**	**Max**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**
ESG Score	55.55	18.76	1.90	95.16	57.18	17.73	30.32	15.98	-26.86*
Env Score	48.73	27.9	0	98.55	50.80	26.99	16.62	21.29	-34.19*
WoB	2.23	1.29	0	8	2.41	1.17	-	-	-
Nationality Mix	0.15	0.19	0	0.9	0.15	0.19	0.09	0.16	-0.06*
Board Size	10.89	2.31	4	32	11.07	2.24	8.66	1.87	-2.41*
Board Ind	0.83	0.16	0	1	0.83	0.15	0.81	0.22	-0.02*
Board Meetings	8.01	3.45	1	34	8.08	3.47	7.17	3.06	-0.91*
Avg Age	62.82	3.67	42.25	82.33	62.89	3.41	61.94	5.98	-0.96*
Avg Educ	17.22	0.63	16	19.8	17.24	0.62	16.94	0.59	-0.30*
Avg Exper	12.66	4.83	0	65	12.62	4.20	13.18	9.69	0.09
Env Com	0.19	0.39	0	1	0.19	0.39	0.05	0.23	-0.14*
CEO fem	0.02	0.12	0	1	0.02	0.13	-	-	-
Networks	268.9	227.87	1.25	1946.6	279.04	230.94	143.81	132.75	-135.22*
Firm Size	50.59	128.88	0.05	2300	53.75	133.36	11.47	19.98	-42.28*
MValue	41.82	90.92	0.06	1966.1	44.54	94.13	9.53	9.48	-35.01*

Table 2 presents descriptive statistics for the full sample and the sub-samples of boards with women and without women. For each variable, the difference in means between the sub-samples (using two-sample t-tests assuming independent samples and equal variances) are reported in the last column. *Denotes statistical significance at the 1% level. Refer to Table 1 for the definitions of the variables.

Analysis of the full sample shows that, on average, board executives possess high qualifications and significant corporate experience. The average age of around 62 years reflects the required level of professional background for board positions in our sample. Regarding board composition, the average board consists of approximately 11 directors, with an average of 2.23 women serving on these boards and 15% of members from different nationalities. Boards hold approximately 8 meetings per year. When examining environmental governance, only 19% of boards have a dedicated committee addressing sustainability issues. The mean scores are around 50, with slightly higher overall ESG scores than those for the Environmental pillar, where higher scores indicate better evaluations of a company's ESG or environmental performance.

In terms of differences between boards with and without women, a notable and significant gap is observed in the two analyzed scores, particularly in the environmental pillar, where boards without female representation score 34.19 points lower than those with at least one woman. It is also important to note that boards without women are less likely to have an environmental committee, with only 5% having one. These boards are typically smaller, associated with smaller firms, and tend to have lower profitability. Additionally, the directors on these boards have, on average, fewer network connections compared to their counterparts on boards with at least one woman. They also exhibit lower cultural diversity, with a smaller proportion of members from different nationalities, and schedule fewer annual meetings, suggesting less engagement in governance activities. When analyzing sectoral differences, Table A in the Appendix, which presents the sectoral composition of the boards, shows that companies in sectors such as Consumer Staples, Healthcare, Financials, and Utilities are more likely to have women on their boards. In contrast, boards without female representation are more commonly found in the Industrial and Information Technology sectors.

Table B in the Appendix presents the correlation matrix for all quantitative variables in the study. Given the construction of the indices and the fact that the Environmental Pillar is part of the overall ESG score, we observe a strong positive correlation between these two indicators. Additionally, both scores exhibit a positive correlation above 0.4 with the number of women on the board. There are no concerns regarding multicollinearity among the explanatory variables, as all have a VIF below 1.38, with an overall mean VIF of 1.24[8]. Lastly, the size of the board, the overall size of the company, and the average number of network connections

[8] Multicollinearity is generally considered problematic when the VIF exceeds 10, a widely accepted threshold in econometric analysis (O'Brien, 2007)

among board members also appear to be important factors influencing the environmental indicators.

To better understand how the variables of interest have evolved over time, Figure 1 illustrates the trends in the number of women on boards and the Environmental Pillar Score for each fiscal year from 2010 to 2020. To facilitate comparison between the two time series, the values have been standardized to range from 0 to 1.

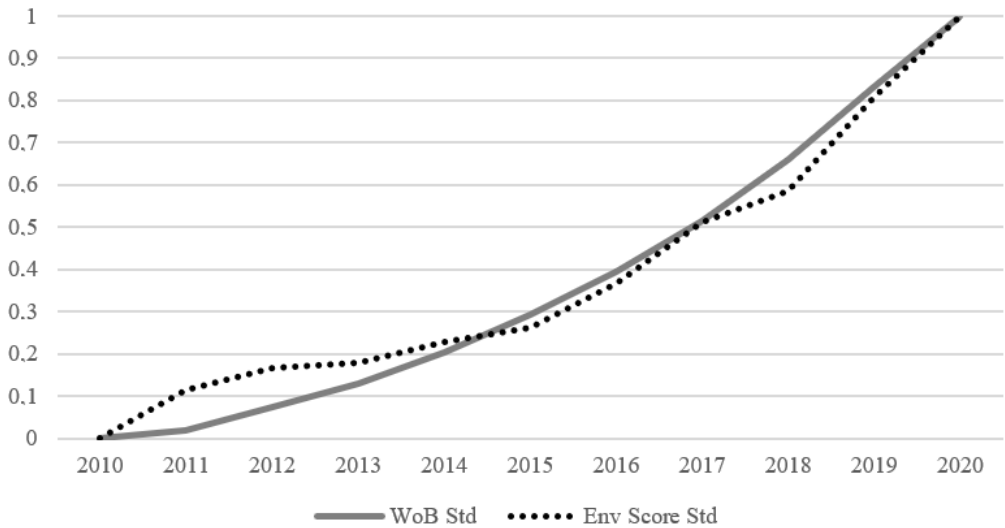

Fig. 1. Environmental Score and Women on Board by year. The Y-axis shows the standardised values and the X-axis represents the years. The figure shows the Environmental Score (dashed line) and the number of female directors on the board (bold line) over the period 2010-2020, and is based on S&P 500 firms.

Both series clearly show an upward trend over the decade studied, with the Environmental Score exhibiting more notable fluctuations. In absolute terms, the average number of women on boards has doubled over the 10-year period, rising from 1.6 in 2010 to 3.2 in 2020, with steady growth throughout. In contrast, the Environmental Score saw more substantial growth in the final three years of the period, increasing by approximately 25% from 2018 to 2020-equivalent to the growth observed from 2010 to 2017.

Figure B in the Appendix compares the Environmental Score for boards with at least one female director to those without any female directors. In each year, boards with female directors consistently show higher Environmental Scores, and this difference remains relatively stable throughout the study period.

The descriptive analysis presented in this section highlights structural differences between firms with and without female board representation, particularly in size, industry, cultural diversity and environmental commitment. However, these correlations do not establish causality, underscoring the endogeneity issue in identifying the impact of board gender diversity on corporate environmental performance. This reinforces the need for rigorous econometric methods, such as IV or DID, which we address in the next section.

4. Board Gender Composition and Environmental Outcomes

This section presents the main results of our empirical analysis. We explore the relationship between board gender diversity and corporate environmental performance using different econometric approaches. We first apply traditional estimation methods (OLS and IV) before employing staggered DID and honest DID, which offer a more rigorous causal identification strategy. This sequential approach allows us to critically assess the reliability of previous findings and question whether the observed associations truly reflect causal effects.

4.1 OLS Estimates and Robustness Checks

To assess whether our findings align with prior literature, we begin by estimating the association between board gender diversity and environmental performance using OLS regressions. While commonly employed in corporate governance research, these methods have well-known limitations in identifying causal effects. To strengthen the analysis, we also conduct a battery of robustness checks and placebo tests. However, despite their growing popularity, these complementary strategies may still fail to account for important sources of endogeneity and thus risk reinforcing misleading conclusions.

To quantify the impact of women on board on firms' environmental outcomes, we consider an equation for board i in year t as follows:

$$EnvScore_{i,t+1} = \gamma WoB_{i,t} + \beta X_{i,t} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where $EnvScore_{it}$ is the Environmental Score of board i in year t —We use the leading dependent variable because board characteristics take time to influence corporate policies — thus, the impact of gender diversity is unlikely to be immediate; $WoB_{i,t}$ is the number of females on board i in year t; X is a set of observed average characteristics of the board (such as size, age, education and tenure) associated with a vector of coefficients β; μ_i and δ_t represent board fixed effects and time effects, respectively. Finally, ε_{it}, is the error term, which is assumed to follow a normal distribution.

The main focus of this study is to estimate the impact of women on board on the environmental outcomes of the firm, γ. The key question is to find the most suitable estimation strategy for this context. If μ_i was uncorrelated with WoB_{it}, which is conditional on the observed board characteristics, γ can be consistently estimated by OLS applied to Equation (1). However, such estimates may suffer endogeneity biases resulting from the omission of unobserved variables correlated with the number of females who are part of the boardrooms. More specifically, firm-level characteristics—such as corporate culture—may simultaneously influence both the likelihood of appointing female directors and the firm's environmental initiatives (Chen et al., 2017). For example, companies with a stronger commitment to sustainability may be more inclined to appoint female directors, making it difficult to isolate the causal effect of *WoB*. If this is the case, the estimation of γ by OLS will include the true effect as well as the bias factors arising from firm heterogeneity. The inclusion of board fixed effects can mitigate these concerns or any related to other omitted firm-level characteristics that do not vary over time (Adams & Ferreira, 2009), but in our case, including board fixed effects is not feasible, as their large number relative to total observations would leave insufficient degrees of freedom for estimating other parameters, leading to inflated standard errors and potential multicollinearity.

Table 3 presents the OLS estimation results using the Environmental Score led by one period as the dependent variable. Specification (1) includes only the central independent variable of the study, *WoB*. Specification (2) incorporates relevant corporate governance variables, while specification (3) further controls for firm characteristics, industry fixed effects (4-digit GIC classification), and year fixed effects.

The OLS results indicate a positive and statistically significant association between the number of women on the board and environmental performance across all specifications[9]. When additional governance and firm-level controls are incorporated, the estimated coefficient on *WoB* decreases slightly but remains significant. These findings hold regardless of whether we use the contemporaneous *Environmental Score* or its lead by two periods. Furthermore, when the *ESG Score* is used as the dependent variable, the effects remain significant at the 1% level, though slightly smaller in magnitude (the coefficient of WoB in specification (3) is 5.02). These findings align with prior research that has documented a positive relationship between gender-diverse boards and sustainability outcomes (Byron & Post, 2016; Lu & Herremans, 2019; Paolone et al. 2023; Zharfpeykan & Bai 2024).

[9] The estimated coefficient in Specification (3) indicates that the addition of one female director is linked to a 6.04-point increase in the *Environmental Score*. Considering that the average *Environmental Score* in our sample is 48.73 (as shown in Table 2), this translates to an approximate 12% enhancement in environmental performance after the appointment of a female director.

The estimated effects of the control variables provide further valuable insights. Firms with greater market value and larger size tend to exhibit stronger environmental performance. At the board level, larger boards composed of older, more educated members, greater cultural diversity, and the presence of an environmental committee are positively associated with greener practices. Additionally, both the professional networks of board members and stronger monitoring contribute to improved outcomes. Moreover, the increased explanatory power of Model 3 highlights industry heterogeneity and supports the inclusion of fixed effects.

Table 3. Traditional Estimation Results: OLS and IV estimates - Dependent Variable: *EnvScore (lead)*

	OLS Estimation			**IV Estimation: 2nd Stage**		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
WoB	**9.699*****	**6.921*****	**6.038*****	**8.001****	**5.915****	**6.776*****
	(0.310)	**(0.344)**	**(0.365)**	**(3.206)**	**(2.928)**	**(2.195)**
Nationality Mix		16.66***	12.88***	13.55***	12.84***	13.13***
		(1.886)	(1.931)	(2.229)	(2.114)	(2.034)
Board Size		1.465***	1.600***	1.264**	1.621***	1.474***
		(0.209)	(0.202)	(0.599)	(0.543)	(0.436)
Board Ind		6.751***	10.87***	10.73***	10.88***	10.82***
		(2.207)	(2.279)	(2.292)	(2.281)	(2.278)
Board Meetings		0.236**	0.565***	0.526***	0.567***	0.550***
		(0.111)	(0.117)	(0.132)	(0.129)	(0.123)
Avg Age		0.693***	0.815***	0.860***	0.813***	0.832***
		(0.119)	(0.119)	(0.142)	(0.132)	(0.127)
Avg Educ		3.082***	3.593***	3.359***	3.608***	3.505***
		(0.607)	(0.600)	(0.721)	(0.701)	(0.662)
Avg Exper		-0.133	-0.151*	-0.105	-0.154	-0.134
		(0.088)	(0.091)	(0.119)	(0.115)	(0.105)
Env Com		4.816***	4.073***	3.270**	4.123***	3.771***
		(0.914)	(0.902)	(1.576)	(1.518)	(1.278)
Networks		0.022***	0.022***	0.021***	0.022***	0.022***
		(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
FirmSize			0.023***	0.022***	0.024***	0.023***
			(0.004)	(0.005)	(0.005)	(0.005)
MValue			0.039***	0.037***	0.039***	0.038***
			(0.004)	(0.005)	(0.005)	(0.005)
Constant	28.61***	-93.52***	-117.4***	-109.1***	-111.5***	-110.5***
	(0.785)	(12.02)	(11.77)	(12.53)	(12.55)	(12.31)
Industry FE	×	×	Yes	Yes	Yes	Yes
Year FE	×	×	Yes	Yes	Yes	Yes
Observations	4,381	4,381	4,115	4,115	4,115	4,115
R-squared	0.188	0.285	0.406	0.401	0.406	0.405

Table 3 reports the OLS and IV estimates. Columns (1)–(3) show OLS regressions with varying control variables and fixed effects. Columns (4)–(6) present the second-stage IV results, using different instruments: relative exposure of male directors to female peers outside their own board (Column 4), the female-to-male participation ratio (Column 5), and both instruments combined (Column 6). Robust standard errors are shown in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively. Variable definitions are in Table 1.

To demonstrate that even robustness tests and placebo tests, which have become increasingly popular in quantitative research (i.e. Eggers et al. 2024), cannot always be considered reliable strategies for validating results-particularly in contexts with severe endogeneity and reverse causality concerns- we perform a series of robustness tests that are commonly used in the literature (Harjoto et al. 2019; Atif et al. 2021; Tunyi et al 2023; Harakeh et al. 2023). The results can be found in Table C in the Appendix. Regresion (1) excludes from the sample boards with a female CEO; (2) replaces WoB by the number of female independent directors (3) employs the ratio of women on the board in relation to its size (*Gender Ratio*) instead of the absolute *WoB* as the independent variable; (4) replaces *WoB* by the Blau Index, regularly used in the literature (He & Jiang, 2019) as a measure of gender diversity[10], which ranges from 0 (no diversity) to 1 (maximum diversity); (5) substitutes *WoB* with the number of men on board (*MoB*). Finally, (6) is a placebo test assigning a *falsified WoB* for each firm. More specifically, we randomly assign to each board-year observation a value between 0 and 8 to resemble the proportions for each segment in the original variable *WoB*.

Regressions (1) through (4) show that the OLS estimated coefficient remains robust across different specifications. Additionally, both the coefficient of *MoB* and the coefficient of the *falsified WoB* in Regressions (5) and (6) are not statistically significant, suggesting that the baseline results are not purely driven by random variation. However, given the inherent limitations of OLS, robustness tests, and placebo assignments in this context, these results do not eliminate concerns of endogeneity and reverse causality. Instead, they reinforce the need for more rigorous causal identification strategies, which we address in subsequent sections using IV and DID methodologies.

4.2. IV Estimates

To address endogeneity concerns, we employ IV estimation, which leverages exogenous variation in board gender diversity to improve causal identification. We use two instrumental variables as a source of exogenous variation in *WoBs*. The chosen instruments must be correlated with the proportion of women directors on the board but remain exogenous to the firm's environmental performance, conditional on the observed board characteristics.

[10] It was calculated as *1- ∑Pi2*, where *P* is the proportion of individuals in a category (fraction of female and male directors), and *i* is the number of categories (two in this case) (Blau, 1977). This index takes into account both the number of gender categories and the evenness of the distribution of board members among them.

To construct the first instrument, we build on Adams & Ferreira (2009), who argue that one barrier to female board appointments is their limited network connections. They hypothesize that male directors with greater exposure to female colleagues are more likely to facilitate the appointment of women to their own boards. Their proposed instrument measures the fraction of male directors on a board who also serve on other boards with at least one female director, an approach later adopted by Levi et al. (2014) and Chen et al. (2017).

Following this rationale, we refine this instrumental variable by computing, at the board level, the average relative connections of male directors to female directors, excluding connections within their own board. Specifically, for each male director in each year, we calculate the proportion of their total connections that are with female directors outside their current board, then aggregate these values at the board level.

Our instrument improves upon existing measures (Adams & Ferreira, 2009) in two key ways. First, it strengthens the exogeneity condition by incorporating connections beyond corporate boards, such as professional associations and educational institutions, reducing potential correlation with environmental performance. Second, it accounts for the extent of exposure, distinguishing between male directors with a single female connection and those with multiple board-level interactions with women. This enhancement provides a more precise proxy for the influence of male directors' networks on female board appointments.

The second instrument follows Chen et al. (2017) and exploits variation in the female-to-male labor force participation ratio at the state level. The argument is that firms headquartered in states with a higher ratio of female-to-male labor force participation are expected to have greater access to qualified female board candidates, increasing the probability of appointing women to boards. Accordingly, firms headquartered in these states are expected to have a higher proportion of female directors. Using data from the U.S. Census Bureau, we construct this instrument as the ratio of female-to-male labor force participation in the state where the firm is headquartered[11]. We find that both instruments are positively and significantly correlated with the number of females on board[12].

[11] The female (male) participation ratio is determined as the percentage of the non-institutional female (male) population in the civilian workforce

[12] To validate the first instrument and strengthen the robustness of our approach, we replicate Adams & Ferreira (2009)'s IV using our sample. The correlation between the replicated IV and *WoB* is 0.24, while our proposed instrument exhibits a stronger correlation of 0.33 with *WoB*.

Returning to the technical details, we estimate Equation (1) together with the following first-stage equation, in a two-stage least squares (2SLS) framework:

$$WoB_{i,t} = \alpha_0 IV_{i,t} + \alpha_1 X_{i,t} + \mu_i + \delta_t + v_{it} \tag{2}$$

where WoB is replaced in Equation (1) by the predicted values resulting from the OLS model that estimates Equation (2), separately for each of the instruments. Table D in the Appendix presents the first-stage regression results where the dependent variable is number of women on board. Table 3 reports the second-stage IV regression results where each column corresponds to one of the instruments previously defined – (4) uses male directors' exposure to women, (5) the female to male participation ratio and (6) includes both instruments.

The IV estimates yield similar coefficients for WoB compared to the OLS estimates with Fixed Effects (specification (3) in Table 3) and they remain statistically significant. The results of the second stage are very similar regardless of the instrument used, although the coefficient is more significant using the first instrumental variable. Indeed, the results remain unchanged when using both instruments simultaneously. Furthermore, the Sargan overidentification test (Chi-sq(1) P-val = 0.9793) indicates that the instruments are valid, i.e., uncorrelated with the error term.

The results of the first stage (Table D in the Appendix) indicate that both instruments used (the exposure of male directors to women and the female to male participation ratio) indeed have a highly significant predictive power for the number of females on board, even after netting out the impacts of other included explanatory variables and fixed effects.

The credibility of these findings depends on the validity of the instrumental variables used in the estimation. Regarding the relevance condition, Stock et al. (2002) suggest that an instrument is considered weak if the F-statistic falls below 10. In our analysis, the F-statistics for both instruments exceed this threshold, indicating strong instrument relevance. However, the exclusion restriction remains a more challenging assumption, requiring that the instruments influence environmental performance only through their effect on board gender composition. This assumption is inherently untestable. Moreover, even if these instruments mitigate some endogeneity concerns, they do not fully eliminate potential omitted variable bias or dynamic selection effects.

These findings are consistent with previous literature, where similar IV approaches have also identified a positive relationship between board gender diversity and environmental performance. Prior studies have similarly confirmed the strength of these instruments under the relevance condition. However, the exclusion restriction remains a critical concern, highlighting the need for further robustness analysis to ensure the reliability of this relationship.

4.3. Staggered DID and Honest DID

A critical contribution of this study is the rigorous reassessment of the assumed causal relationship between board gender diversity and corporate environmental performance. To address endogeneity concerns and enhance the robustness of our findings, we implement a Staggered DID methodology, which represents a significant methodological improvement over conventional approaches. Furthermore, we apply the Honest DID framework to validate the parallel trends assumption and ensure the reliability of our inferences.

4.3.1 Staggered DID

Traditional DID models compare the outcomes for two similar groups with and without the treatment but that would otherwise be subject to similar influence from the trending variables. Therefore, it increases the likelihood that any difference in the changes in outcomes before and after the treatment between the two groups is due to the impact of the treatment rather than the difference between the two groups prior to treatment. The drawback of the traditional DID approach is the assumption of a uniform treatment time across all units.

More aligned with the context of our study, the staggered DID approach (Chaisemartin & D' Haultfœuille (2022), Callaway & Sant'Anna (2021), Borusyak et al., (2022)) extends the traditional DID to allow for the treatment adoption to occur at different points in time. In our set up, it allows women to enter the boards for the first time (that is, their transition from control to treated) at different points in time. The estimation methodology by Borusyak et al. (2022) has sizable advantages over alternative robust estimators, such as Chaisemartin & D' Haultfœuille (2022) or Callaway & Sant'Anna (2021); firstly, in this framework, random sampling is not required, and the standard errors are efficient even in the case of heteroscedasticity and serial correlation of error terms.

In practice, to carry out this methodology, the analysis sample must contain only companies in which we can observe the transition from having no women (control) to having one or more (treatment). Therefore, we need to exclude from the sample those companies that already had at least one woman in 2010. Once the company becomes part of the treated group, it remains so throughout the entire period. Another difference of this methodology from traditional DID is that, in addition to the never-treated, in each period it uses those that have not yet been treated as the control group[13]. Since this DID analysis does not allow for treatment decay, we further eliminate those in which women leave the board at any time after being treated (these represent only 3.6% of the treated). We end up with a sample of 882 panel observations for 84 companies, of which 81 become treated at some point after 2010, and 3 were never-treated. Based on this sample we estimate the following two panel regressions:

$$Static: \quad EnvScore_{i,t} = \tau^{static} D_{i,t} + \mu_i + \delta_t + \varepsilon_{it} \tag{3}$$

$$Dynamic: \quad EnvScore_{i,t} = \sum_{h=-a}^{b} \tau_h \, 1\left[K_{i,t} = h\right] + \mu_i + \delta_t + \varepsilon_{it} \tag{4}$$

Equation (3) corresponds to the static specification, where $D_{i,t}$ is an indicator variable that equals one when at least one woman joins the board in period t, and 0 otherwise. It includes a single treatment indicator with τ^{static} capturing the Average Treatment Effect (ATE). The static model presents limitations when there are few never-treated units as in the case of our study. Therefore, we additionally use the dynamic specification provided by equation (4), where the set $1\left[K_{i,t} = h\right]$ captures the lead/lag indicator variables tracking the number of years $K_{i,t} = t - E_i$ since the year when at least one woman joins the board, E_i. The treatment effects for each horizon as well as the pre-trend coefficients are captured by τ_h. The constants in the sum refer to the periods pre- and post-treatment included ($a \geq 0, b \geq 0$).

The estimation of the static DID specification in equation (3) results in an ATE of 11.07 (significant at the 1% level). The effect appears to be of high magnitude compared to the IV results, which suggests a potential bias that could be partially attributed to the limited number of boards that are never-treated in our sample.

Moreover, the results from the staggered DID dynamic imputation are pesented in Table 4. This table reports estimates of the response of Environmental Scores and pre-trend coefficients, using specification (4) with a = b = 6. For better visual inspection, Figure 2 plots the estimated τ_h from Table 4. Together with the point estimates, 95% confidence intervals are shown using standard errors clustered by board.

[13] Figure C in the Appendix shows the frequencies of treated and control board-observations by year.

Table 4. DID Dynamic Imputation Results

	Pre-Treatment Coefficients		*Post-Treatment Coefficients*	
Horizon (h)	τ_{-h}	**Std. Error**	τ_h	**Std. Error**
0			2.670**	1.058
1	3.494*	1.799	5.348***	1.541
2	0.842	1.747	9.385***	1.988
3	-1.433	1.951	14.128***	2.510
4	-2.109	2.250	14.885***	2.899
5	-1.126	1.913	17.645***	3.214
6	-1.593	1.854	17.410***	3.398

This table presents the Staggered DID imputation results based on 882 panel observations. It reports pre-treatment and post-treatment effects of female board entry, along with standard errors, for each period. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively.

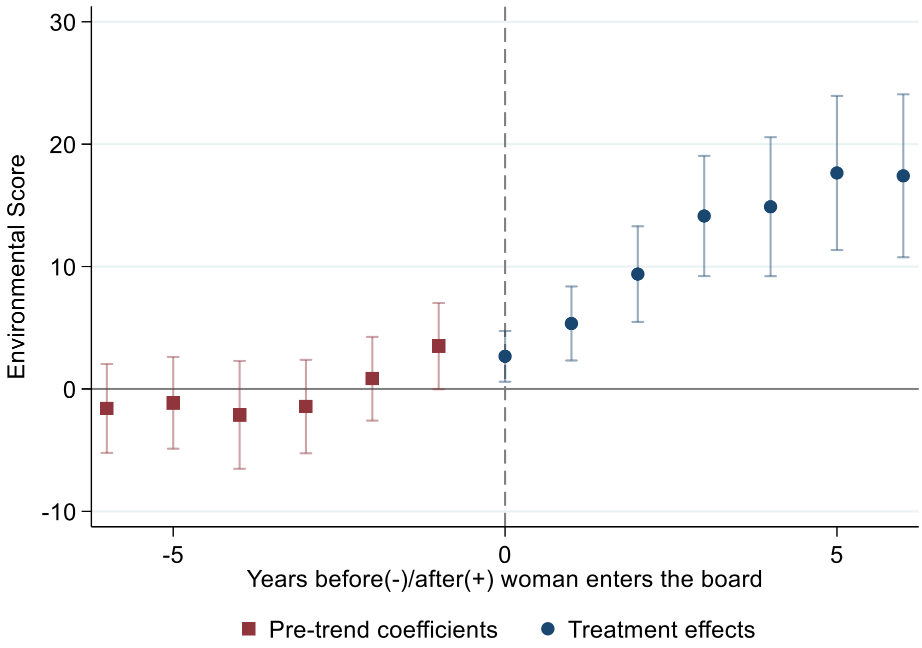

Figure 2. Staggered DID on Women Entrance – Dynamic Specification and Pre-trends. The Y-axis displays changes in the Environmental Score, while the X-axis indicates periods relative to the treatment, with the event horizon set to 6. Pre-treatment effects (squares) and post-treatment effects (circles) are shown for each period, along with 95% confidence intervals (bands).

The DID dynamic specification results indicate positive and significant effects in all post-treatment periods, with the period immediately following treatment exhibiting a magnitude of 5.35 (significant at the 1% level), translating into an approximate 11% increase in Environmental Scores. However, a crucial finding emerges when examining the pre-treatment coefficients. While most of them remain statistically non-significant, the period immediately preceding treatment shows a significant and positive coefficient (3.49), highlighting a clear upward trend in environmental performance before the appointment of female directors. This pattern strongly suggests that firms were already on a trajectory of improving sustainability practices before incorporating women into their boards.

4.3.2 Honest DID

To further assess whether this trend would have persisted without treatment, we conducted an Honest DID analysis following the methodology of Rambachan & Roth (2023). This approach enabled us to construct a counterfactual scenario that reflects the likely trajectory of environmental scores in the absence of female board appointments. Figure 3 visually illustrates the robustness of the Honest DID analysis.

(A) Honest DID *M* = 0.05

(B) Extrapollation Parallel Trend

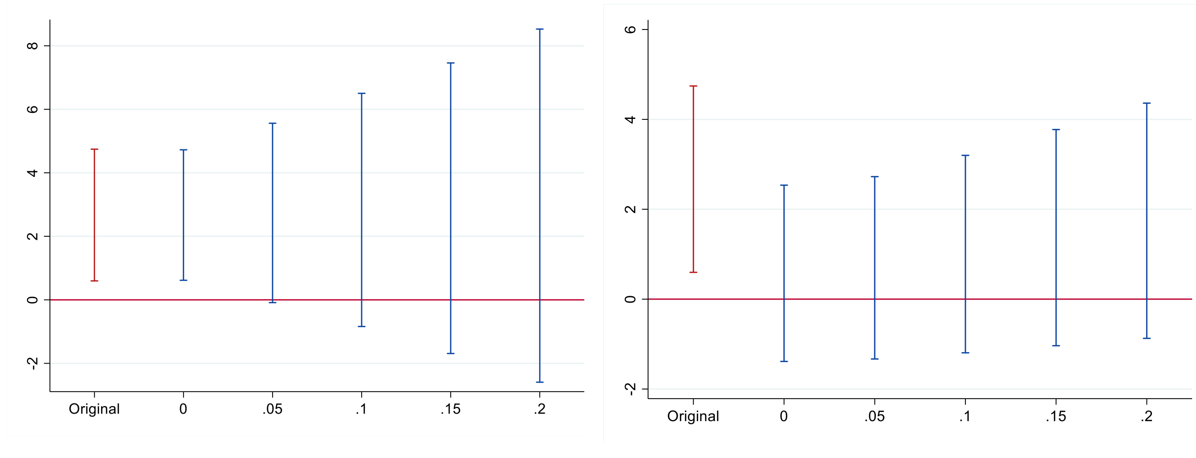

Figure 3. Honest DID - *M* and Extrapolation Coefficient Parallel Trend. Panel A presents the maximum pre-treatment deviation *(M=0.05)* that would still allow the post-treatment coefficient to remain significant. Panel B shows the extrapolation of the parallel trend in the absence of treatment

Panel A presents the maximum pre-treatment deviation *(M=0.05)* that would still allow the post-treatment coefficient to remain significant. This means that, even if environmental performance had deviated by 5% more in the pre-treatment period, the post-treatment effect would still hold. This highlights the sensitivity of the results and provides a threshold for potential deviations. Panel B shows the extrapolation of the parallel trend in the absence of treatment, where the estimated environmental score trajectory follows a steady increase even before the appointment of women to corporate boards. The extrapolated post-treatment trend aligns closely with the actual observed values, suggesting that the environmental improvements would have likely occurred regardless of board gender composition.

Numerically, the minimal gap between the extrapolated and actual environmental scores in the post-treatment period reinforces the argument that the observed association between board gender diversity and environmental performance is not causal. Instead, the findings suggest that firms were already engaging in sustainability initiatives before appointing female directors. These results challenge previous interpretations that link gender-diverse boards to environmental improvements and highlight the need to account for pre-existing corporate sustainability commitments when analyzing the impact of board composition on environmental outcomes.

We conducted additional tests to assess the robustness of our findings. Specifically, we replicated the DID analysis using the overall *ESG Score* (see Appendix – Figure D). To rule out the possibility that our results are driven by firms already signaling environmental commitment, we excluded from the sample those corporations that had established an environmental committee prior to the appointment of female directors. Across all specifications, the estimates consistently indicate a violation of the parallel trends assumption during the pre-treatment period. Furthermore, the treatment effects are not significantly different from zero when projecting the post-treatment trend via linear extrapolation of the pre-treatment trajectory. Taken together, these results suggest that firms begin adopting greener practices before appointing women to their boards. Thus, the observed correlation between board gender diversity and environmental outcomes may not reflect a causal relationship, but rather concurrent developments within broader environmental and diversity strategies.

Finally, given that the original treatment group is relatively small—limited to firms that move from zero to one woman on the board—it could be argued that, during the analysis period, firms without any female directors are not representative of the broader population. To address this concern and ensure that our DID results are not driven by sample composition, we conduct an additional robustness check using an alternative treatment definition. Specifically, we redefine treated firms as those transitioning from one female director to more than one. This broader definition increases the number of treated observations to 2,326 panel entries, representing over half of the firms included in the OLS and IV analyses. Figure E in the Appendix presents the results of this alternative DID specification. The pre-trend results are even more pronounced—although also less precise, as indicated by wider confidence intervals. All pre-treatment periods are now significantly different from zero, reinforcing the evidence that environmental improvements precede the increase in board gender diversity. Post-treatment effects, by contrast, show no significant changes, further supporting the interpretation that the entry of additional women on the board does not drive subsequent improvements in environmental performance.

To shed light on the strong pre-treatment trend observed in our estimates, we investigate whether the creation of environmental committees might be driving the upward trajectory in environmental performance prior to the appointment of female board members. However, our data do not support this explanation. Among the firms in our sample, environmental committees are rarely established before the entry of women into the board. In most cases, the creation of such committees coincides with or occurs after the appointment of the first or second female director. This suggests that the rise in environmental scores preceding female board appointments is unlikely to be explained by formal governance structures alone.

Interestingly, when environmental committees are present, they consistently include female directors, who often constitute the majority of their members. This observation reinforces the idea that women play a central role in shaping firms' sustainability agendas once on the board, but it also underscores that their presence is not the initial trigger for firms' environmental improvements.

Several alternative explanations may account for the pre-trend. First, it is possible that firms undergoing a broader strategic shift toward sustainability—driven by stakeholder pressure, reputational concerns, or ESG-focused investor engagement—simultaneously enhance their environmental practices and diversify their boards as part of a coordinated effort to align with evolving governance norms. Second, companies anticipating future regulatory or market expectations may proactively adjust both their environmental and governance profiles. Lastly, it is plausible that firms with improving environmental performance become more attractive to female candidates, thereby endogenously linking sustainability progress with board gender diversity. Investigating these potential mechanisms represents a promising avenue for future research, particularly to disentangle whether board diversification acts as a signal, a consequence, or a facilitator of sustainability-oriented strategies.

In conclusion, this study underscores the importance of applying rigorous causal identification methods when evaluating corporate governance practices. Policymakers and practitioners should be cautious when advocating for board gender diversity as a direct mechanism for improving corporate environmental performance. While diversity remains an essential governance objective, its role in shaping sustainability outcomes may be more reflective of underlying firm characteristics rather than a causal driver of change. By leveraging advanced econometric methodologies, this research contributes to a more nuanced understanding of the intersection between gender diversity and corporate sustainability, highlighting the importance of robust causal inference in empirical corporate finance studies.

5. Discussion and Conclusion

This study reassesses the assumed causal link between gender diversity on corporate boards and firms' environmental performance using a comprehensive dataset of S&P 500 companies from 2010 to 2020. Unlike prior research that suggests a positive impact of female board representation on corporate sustainability outcomes, our findings challenge this notion by demonstrating that environmental improvements often precede the appointment of women to boards.

By employing a rigorous empirical framework—including OLS, IV, staggered DID, and Honest DID—our analysis provides robust evidence that the observed correlation between board gender diversity and environmental performance does not imply causation. Instead, our results indicate that firms already engaged in sustainability strategies are more likely to appoint female directors, suggesting that corporate environmental commitment and board gender diversity evolve concurrently rather than through a direct causal link.

Our findings have significant policy implications, particularly for initiatives that promote gender diversity on corporate boards as a mechanism to enhance firms' environmental responsibility. While increasing female representation in corporate leadership remains a critical governance goal, justifying such policies primarily on environmental grounds may be misguided. Regulatory efforts that mandate gender quotas with the expectation of driving sustainability outcomes should reconsider their underlying assumptions. Instead, policies aimed at improving corporate environmental performance should focus on strengthening sustainability incentives, regulatory frameworks, and stakeholder engagement mechanisms rather than relying on board composition alone.

Instead, effective regulatory interventions should prioritize direct mechanisms that incentivize firms to adopt sustainable practices. These include linking executive compensation to environmental targets, enforcing standardized ESG disclosure frameworks, mandating third-party sustainability audits, and leveraging market-based instruments such as green bonds and carbon pricing. Strengthening stakeholder engagement and shareholder activism can also drive corporate accountability for environmental commitments. By focusing on these targeted strategies, policymakers can enhance corporate sustainability outcomes without relying on indirect governance mechanisms such as board diversity mandates. This does not imply that gender diversity on boards is irrelevant; rather, its value lies in improving governance, decision-making quality, and stakeholder representation, rather than directly driving corporate sustainability outcomes. Policymakers should therefore ensure that diversity-promoting regulations are grounded in governance and equity rationales rather than presumed environmental benefits that lack robust causal support.

We advocate for continued research into the mechanisms through which board composition affects corporate behavior and outcomes, particularly in the context of sustainability. Future research should explore the broader strategic, institutional, and organizational factors that drive both trends simultaneously. One key avenue for further investigation is understanding the mechanisms through which board members—regardless of gender—contribute to sustainability strategies. If gender-diverse boards do play a role in shaping environmental policies, it is crucial to determine whether this influence operates through enhanced stakeholder engagement, stronger corporate governance, or shifts in long-term strategic planning. Investigating these channels would provide a more nuanced perspective on how board dynamics affect sustainability efforts rather than merely focusing on compositional diversity.

Additionally, research should explore the characteristics of firms that both improve environmental performance and appoint female directors. If sustainability-oriented companies are more likely to pursue diverse leadership as part of a broader ESG strategy, this would suggest that board diversity may be a consequence rather than a cause of sustainability efforts. A related question is whether female appointments trigger a self-reinforcing dynamic, whereby the visibility of prior findings linking gender diversity and environmental performance encourages firms to further engage with both. Initial appointments – potentially motivated by governance or reputational concerns—could help strengthen internal sustainability agendas. Investigating whether such dynamics arise endogenously or in response to external pressures could shed light on the longer-term effects of board composition on corporate behavior.

Finally, the role of institutional and market-driven forces—such as regulatory frameworks, investor expectations, and societal shifts—deserves greater attention. Future studies should examine how firms respond to ESG-driven institutional demands and whether gender diversity on boards emerges as part of a broader adaptation to these conditions rather than as an independent determinant of environmental performance. By shifting the research focus towards these underlying mechanisms, scholars can contribute to a more rigorous and policy-relevant understanding of corporate governance and sustainability.

APPENDIX

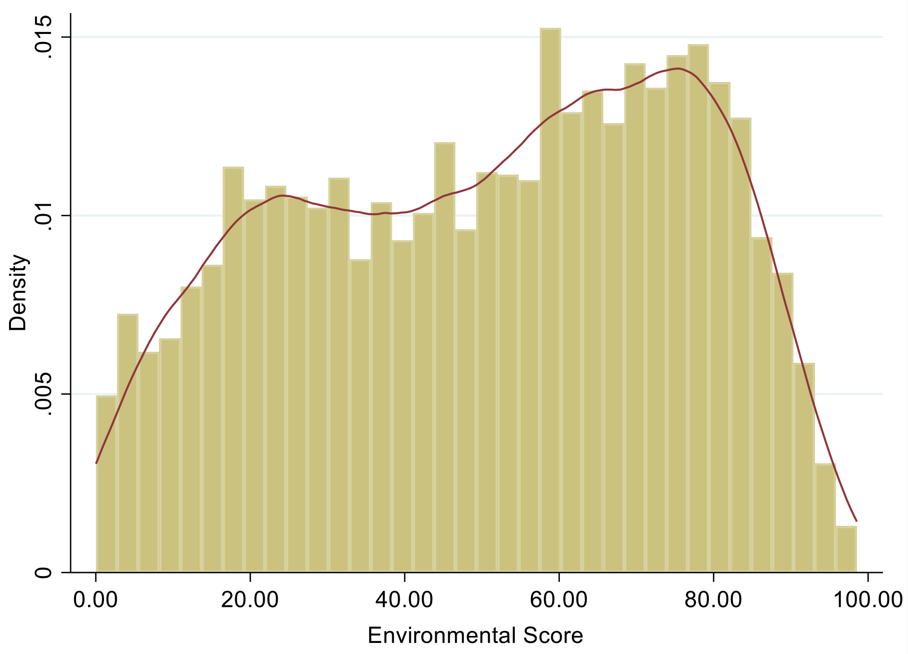

Figure A. Distribution of Environmental Scores.
This figure displays the distribution of firms' Environmental Scores based on the full sample. The histogram shows the empirical density, while the smoothed line represents a kernel density estimate. The distribution is right-skewed, with most observations concentrated between 40 and 85.

Table A
Industry composition (GIC Two-digit) - frequencies

	Full Sample	**With WoB**	**Without WoB**
Energy	4.91	4.85	5.65
Materials	5.35	5.53	3.23
Industrial	13.27	12.76	19.62
Consumer Discretionary	11.35	11.01	15.59
Consumer Staples	7.03	7.30	3.76
Health Care	12.57	13.02	6.99
Financials	13.62	14.66	0.81
Information Technology	14.73	13.85	25.54
Communication	4.53	4.11	9.68
Utilities	6.28	6.79	0
Real Estate	6.36	6.14	9.14

This table reports the industry distribution of firms in the full sample, as well as separately for firms with and without female board representation (*WoB*). Industry classification is based on the Global Industry Classification Standard (GICS) at the two-digit level. The percentages reflect the share of firms in each industry category.

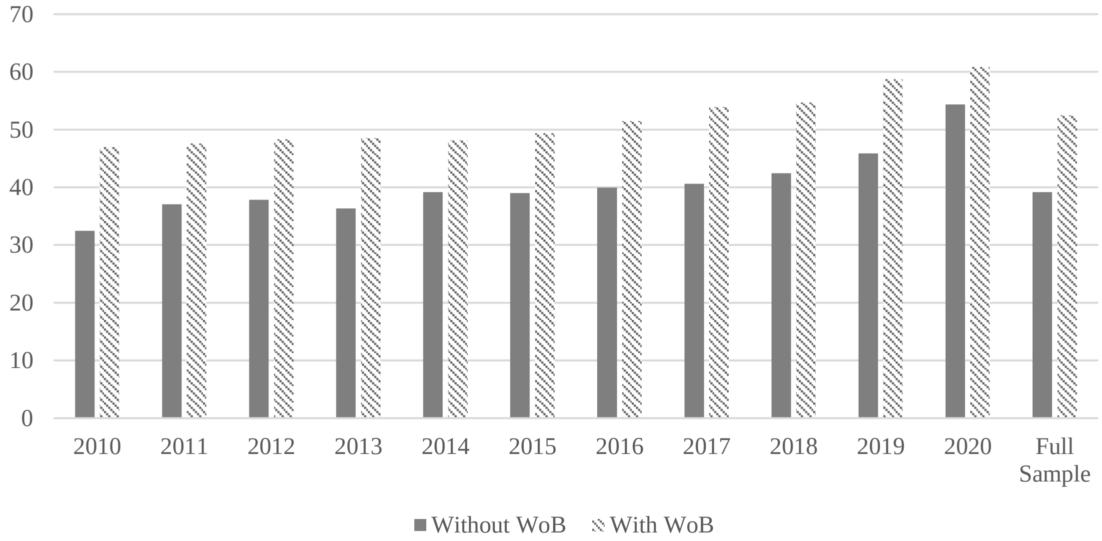

Figure B. Average Environmental Scores Over Time by Board Gender Diversity.
This figure displays the average Environmental Score of firms with and without women on boards (WoB) from 2010 to 2020, as well as for the full sample. The Y-axis reports the Environmental Score, and the X-axis represents the year. Solid bars correspond to firms without female board members, while hatched bars represent firms with at least one woman on the board.

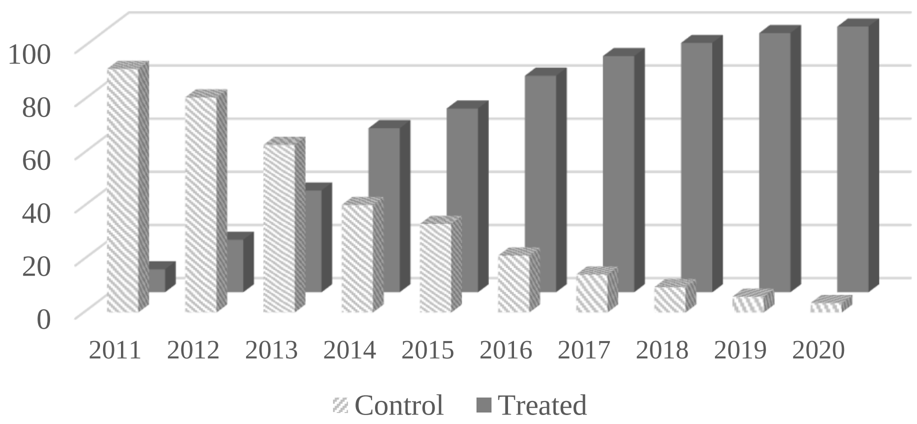

Figure C. Annual Distribution of Treated and Control Firms.
This figure shows the frequency distribution of treated and control firms by year, from 2011 to 2020. The Y-axis indicates the number of observations per group, while the X-axis represents the year. Solid bars correspond to treated firms—those that appointed a female director—whereas hatched bars indicate control firms, which did not experience board gender changes during the same period.

Table B
Correlation Matrix

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1. ESG Score	1														
2. Env Score	0.862*	1													
3. WoB	0.497*	0.439*	1												
4. Nationality Mix	0.157*	0.167*	0.060*	1											
5. Board Size	0.285*	0.334*	0.434*	0.103*	1										
6. Board Ind	0.139*	0.104*	0.131*	0.026	0.081*	1									
7. Board Meetings	0.115*	0.145*	0.162*	0.055*	0.149*	0.019	1								
8. Avg Age	0.076*	0.056*	-0.021	-0.149*	0.101*	0.040*	0.003	1							
9. Avg Educ	0.137*	0.143*	0.049*	0.119*	0.025	0.056*	0.039*	0.030*	1						
10. Avg Exper	0.056*	0.063*	-0.034	-0.051	0.097*	-0.007	-0.050	0.402*	-0.019	1					
11. Env Com	0.190*	0.193*	0.191*	0.074*	0.125*	0.019	0.128*	0.043*	0.150*	-0.015	1				
12. CEO fem	0.073*	0.068*	0.154*	-0.026	0.055*	0.016	0.023	-0.026	0.010	0.001	0.024	1			
13. Networks	0.256*	0.268*	0.163*	0.117*	0.159*	0.018	0.112*	-0.089*	0.169*	-0.057	0.098*	0.047*	1		
14. Firm Size	0.227*	0.232*	0.185*	0.039	0.185*	-0.020	-0.003	-0.067*	0.008	0.017	-0.006	0.034	0.134*	1	
15. MValue	0.270*	0.259*	0.208*	0.086*	0.137*	0.024	0.020	-0.014	0.098*	-0.006	0.015	0.002	0.189*	0.346*	1

This table present the pairwise correlations with $n = 4{,}508$; Statistical significance is indicated by * at the 5% level. Refer to Table 1 for the definition of the variables.

Table C
Robustness and Placebo Tests – Dependent Variable*: EnvScore (lead)*

	(1)	(2)	(3)	(4)	(5)	(6)
WoB	5.983***					
	(0.375)					
WoB Independent		5.932***				
		(0.387)				
Gender Ratio			0.543***			
			(0.038)			
Blau Index				62.109***		
				(3.122)		
MoB					0.203	
					(0.226)	
Falsified WoB						0.125
						(0.229)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (4 dig)	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,054	4,115	4,115	4,115	4,115	4,115
R-squared	0.406	0.397	0.396	0.419	0.366	0.365

This table reports the OLS estimation results of a series of robustness and placebo tests using specification (3) from Table 3 as the baseline model. Robust standard errors are shown in parentheses, and significance level is indicated by *** for the 1% level. For brevity, only the coefficients of the main independent variable in each specification are reported. Column (1) excludes female CEOs from the sample. Columns (2) to (4) replace the WoB variable with, respectively, the number of independent female directors, the gender ratio, and the Blau Index. Column (5) uses the number of men on the board (MoB) instead of WoB. Column (6) presents a placebo test that randomly assigns the number of female directors across firms.

Table D
IV Estimation Results – First-Stage

	Dependent Variable: *Women on Board* (WoB)		
Instrumental Variable	(1)	(2)	(3)
Exposure of male directors to females	1.914***		1.832***
	(0.273)		(0.272)
Female to Male participation ratio		4.860***	4.713***
		(0.586)	(0.590)
Controls	Yes	Yes	Yes
Industry FE (4dig)	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	4,115	4,115	4,115
Cragg-Donald (CD) Wald F-statistic	48.84	68.98	57.55
Stock and Yogo weak ID test critical values at 10% IV size	16.38	16.38	19.93
J-statistic for overidentification	-	-	0.582

Table D presents the first-stage IV results, where the dependent variable is the number of females on the board (WoB). All models include the same controls and fixed effects as in specification (3) of Table 3. For brevity, the estimated coefficients of control variables are not reported. Column (1) instruments WoB with male directors' exposure to female peers, Column (2) uses the Female-to-Male participation ratio, and Column (3) combines both instruments. Robust standard errors are in parentheses, and statistical significance is indicated by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

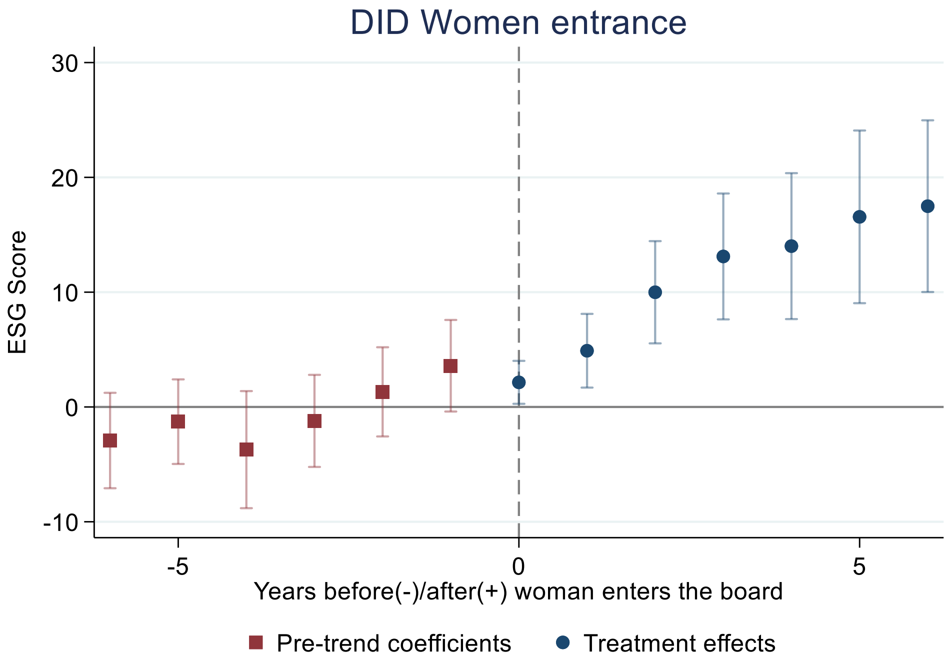

Figure D. Staggered DID on Women Entrance Dynamic Specification. The Y-axis displays changes in the ESG Score, while the X-axis indicates periods relative to the treatment, with the event horizon set to 6. Pre-treatment effects (squares) and post-treatment effects (circles) are shown for each period, along with 95% confidence intervals (bands).

Figure E. Staggered DID Alternative Treatment Definition Dynamic Specification.
This figure presents the dynamic DID estimates using an alternative treatment definition: firms that transition from one to more than one woman on the board. The Y-axis shows changes in the Environmental Score, and the X-axis plots the event time relative to the year of treatment (year 0). Pre-treatment coefficients (squares) and post-treatment effects (circles) are shown for each period along with 95% confidence intervals (bands).

Declaration of generative AI and AI-assisted technologies in the writing process
During the preparation of this work, the authors used *ChatGPT-4* in order to assist with language refinement, structure improvement, and clarity enhancement of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

REFERENCES

Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics*, *94*(2), 291–309. https://doi.org/10.1016/J.JFINECO.2008.10.007

Ahern, K. R., & Dittmar, A. K. (2012). The changing of the boards: The impact on firm performance of mandated female board representation. *Quarterly Journal of Economics*, *127*(1), 137–197. https://doi.org/10.1093/qje/qjr049

Alkhawaja, A., Hu, F., Johl, S., & Nadarajah, S. (2023). Board gender diversity, quotas, and ESG disclosure: Global evidence. *International Review of Financial Analysis*, 90, 102823. https://doi.org/10.1016/j.irfa.2023.102823

Al-Shaer, H., & Zaman, M. (2016). Board gender diversity and sustainability reporting quality. *Journal of Contemporary Accounting & Economics*, *12*(3), 210–222. https://doi.org/10.1016/j.jcae.2016.09.001

Amel-Zadeh, A., & Serafeim, G. (2018). Why and how investors use ESG information: Evidence from a global survey. *Financial Analysts Journal*, *74*(3), 87–103. https://doi.org/10.2469/faj.v74.n3.2

Arora, S., & Organizational, A. P.-G. B. (2021). Inclusivity and empowerment—Grow and let grow. *Journal of Organizational Effectiveness*, 41(1), 21–30. https://doi.org/10.1002/joe.22136

Atif, M., Hossain, M., Alam, M. S., & Goergen, M. (2021). Does board gender diversity affect renewable energy consumption? Journal of Corporate Finance, 66, 101665. https://doi.org/10.1016/j.jcorpfin.2020.101665

Barroso, R., Duan, T., Guo, S. (Sarina), & Kowalewski, O. (2024). Board gender diversity reform and corporate carbon emissions. *Journal of Corporate Finance*, 87, 102616. https://doi.org/10.1016/j.jcorpfin.2024.102616

Bear, S., Rahman, N., & Post, C. (2010). The impact of board diversity and gender composition on corporate social responsibility and firm reputation. *Journal of Business Ethics*, *97*(2), 207-221. https://doi.org/10.1007/s10551-010-0505-2

Birindelli, G., Iannuzzi, A. P., & Savioli, M. (2019). The impact of women leaders on environmental performance: Evidence on gender diversity in banks. *Corporate Social Responsibility and Environmental Management*, *26*(6), 1485–1499. https://doi.org/10.1002/csr.1762

Biswas, P.K., Mansi, M., Pandey, R. (2018). Board composition, sustainability committee and corporate social and environmental performance in Australia. *Pacific Accounting Review* 30(4), 517–540. https://doi.org/10.1108/PAR-12-2017-0107

Blau, P. M. (1977). Inequality and Heterogeneity: A Primitive Theory of Social Structure. *New York: Free Press.*

Borusyak, K., Jaravel, X., & Spiess, J. (2022). Revisiting event study designs: Robust and efficient estimation. *The Review of Economic Studies*, Volume 91, Issue 6, November 2024, Pages 3253–3285. https://doi.org/10.1093/restud/rdae007

Boulouta, I. (2013). Hidden connections: The link between board gender diversity and corporate social performance. *Journal of Business Ethics*, *113*(2), 185–197. https://doi.org/10.1007/s10551-012-1293-7

Brammer, S., Millington, A., & Pavelin, S. (2009). Corporate reputation and women on the board. *British Journal of Management*, *20*(1), 17–29. https://doi.org/10.1111/j.1467-8551.2008.00600.x

Byron, K., & Post, C. (2016). Women on boards of directors and corporate social performance: A meta-analysis. *Corporate Governance: An International Review, 24*(4), 428–442. https://doi.org/10.1111/corg.12165

Callaway, B., & Sant'Anna, P. H. C. (2021). Difference-in-Differences with multiple time periods. *Journal of Econometrics*, *225*(2), 200–230. https://doi.org/10.1016/j.jeconom.2020.12.001

Campopiano, G., Gabaldón, P., & Gimenez-Jimenez, D. (2023). Women directors and corporate social performance: An integrative review of the literature and a future research agenda. *Journal of Business Ethics, 182*(3). https://doi.org/10.1007/s10551-021-04999-7

Catalyst. (2017). Women CEOs of the S&P 500.

Chatterji, A. K., Durand, R., Levine, D. I., & Touboul, S. (2016). Do ratings of firms converge? Implications for managers, investors, and strategy researchers. *Strategic Management Journal, 37*(8), 1597–1614. https://doi.org/10.1002/smj.2407

Chen, J., Leung, W.S., Goergen, M., (2017). The impact of board gender composition on dividend payouts. *Journal of Corporate Finance*. 43, 86–105. https://doi.org/10.1016/j.jcorpfin.2017.01.001

Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, Organizations and Society, 33*(4-5), 303-327. https://doi.org/10.1016/j.aos.2007.05.003

Cook, A., & Glass, C. (2011). Leadership change and shareholder value: How markets react to the appointments of women. *Human Resource Management*, *50*(4), 501–519. https://doi.org/10.1002/HRM.20438

Cook, A., & Glass, C. (2018). Women on corporate boards: Do they advance corporate social responsibility? *Human Relations*, *71*(7), 897–924. https://doi.org/10.1177/0018726717729207

Cumming, D., Leung, T. Y., & Rui, O. M. (2015). Gender diversity and securities fraud. *Academy of Management Journal*, 58(5), 1572–1593. https://doi.org/10.5465/amj.2013.0750

Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall.

de Chaisemartin, C., & D'Haultfœuille, X. (2022). Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: A survey. *The Econometrics Journal, 26*(3), C1–C30. https://doi.org/10.1093/ectj/utac017

de Villiers, C., Naiker, V., & van Staden, C. J. (2011). The effect of board characteristics on firm environmental performance. *Journal of Management*, *37*(6), 1636–1663. https://doi.org/10.1177/0149206311411506

Dutordoir, M., Schoubben, F., Struyfs, K., & Torsin, W. (2024). Environmental pressure and board gender diversity: Evidence from the European Union Emission Trading System. *Business Strategy and the Environment*, 33(5), 3911–3935. https://doi.org/10.1002/bse.3686

Eckbo, B. E., Nygaard, K., & Thorburn, K. S. (2022). Does mandatory board gender-balancing reduce firm value? *Journal of Financial Economics, 143*(3), 614-641. https://doi.org/10.1016/j.jfineco.2022.01.001

Eggers, A. C., Tuñón, G., & Dafoe, A. (2024). Placebo Tests for Causal Inference. *American Journal of Political Science*, *68*(3), 1106–1121. https://doi.org/10.1111/ajps.12818

Gabaldón, P., Gimenez-Jimenez, D., & Campopiano, G. (2023). Women directors and sustainability: A contribution of networking activities. In *Research Handbook on Corporate Governance and Ethics*. https://doi.org/10.4337/9781800880603.00017

Galbreath, J. (2018). Is board gender diversity linked to financial performance? The mediating mechanism of CSR. *Business & Society*, *57*(5), 863–889. https://doi.org/10.1177/0007650316647967

Gavetti, G., Greve, H. R., Levinthal, D. A., & Ocasio, W. (2012). The behavioral theory of the firm: Assessment and prospects. *Academy of Management Annals*, 6(1), 1–40. https://doi.org/10.1080/19416520.2012.656841

Glass, C., Cook, A., & Ingersoll, A. R. (2016). Do Women Leaders Promote Sustainability? Analyzing the Effect of Corporate Governance Composition on Environmental Performance. *Business Strategy and the Environment*, *25*(7), 495–511. https://doi.org/10.1002/bse.1879

Harjoto, M. A., Laksmana, I., & Yang, Y. (2019). Board nationality and educational background diversity and corporate social performance. *Corporate Governance: The International Journal of Business in Society*, *19*(2), 217–239. https://doi.org/10.1108/CG-04-2018-0138

Harjoto, M. A., & Wang, Y. (2020). Board of directors network centrality and environmental, social and governance (ESG) performance. *Corporate Governance: The International Journal of Business in Society*, *20*(6), 965–985. https://doi.org/10.1108/CG-10-2019-0306

Harakeh, M., Leventis, S., El Masri, T., & Tsileponis, N. (2023). The moderating role of board gender diversity on the relationship between firm opacity and stock returns. *The British Accounting Review*, *55*(1), 100955. https://doi.org/10.1016/j.bar.2022.101145

He, X., & Jiang, S. (2019). Does gender diversity matter for green innovation? *Business Strategy and the Environment*, *28*(7), 1341–1356. https://doi.org/10.1002/bse.2319

Hopkins, M. M., & Bilimoria, D. (2004). Care and Justice Orientations in Workplace Ethical Dilemmas of Women Business Owners. *Group & Organization Management*, *29*(4), 495-516. https://doi.org/10.1177/1059601103257424

Kennedy, E. H., & Dzialo, L. (2015). Locating gender in environmental sociology: Theoretical frames and empirical approaches. *Sociology Compass*, 9(10), 920–929. https://doi.org/10.1111/soc4.12303

Kirsch, A. (2018). The gender composition of corporate boards: A review and research agenda. *The Leadership Quarterly*, 29(2), 346–364. https://doi.org/10.1016/j.leaqua.2017.06.001

Kölbel, J. F., Heeb, F., Paetzold, F., & Busch, T. (2020). Can sustainable investing save the world? Reviewing the mechanisms of investor impact. *Organization & Environment, 33*(4), 554–574. https://doi.org/10.1177/1086026620919202

Larcker, D. F., & Rusticus, T. O. (2010). On the use of instrumental variables in accounting research. *Journal of Accounting and Economics, 49*(3), 186–205. https://doi.org/10.1016/j.jacceco.2009.11.004

Levi, M., Li, K., Zhang, F., (2014). Director gender and mergers and acquisitions. *Journal of Corporate Finance*. 28, 185–200. https://doi.org/10.1016/j.jcorpfin.2013.11.005

Liu, C. (2018). Are women greener? Corporate gender diversity and environmental violations. *Journal of Corporate Finance, 52*, 118–142. https://doi.org/10.1016/j.jcorpfin.2018.08.004

Lu, J., & Herremans, I. M. (2019). Board gender diversity and environmental performance: An industries perspective. *Business Strategy and the Environment*, *28*(7), 1449–1464. https://doi.org/10.1002/bse.2326

Mallin, C., & Michelon, G. (2011). Board reputation attributes and corporate social performance: An empirical investigation of the US best corporate citizens. *Accounting and Business Research, 41*(2), 119-144. https://doi.org/10.1080/00014788.2011.550740

Nicolo', G., vZampone, G., Sannino, G. and De Iorio, S. (2021), Sustainable corporate governance and non-financial disclosure in Europe: does the gender diversity matter?, *Journal of Applied Accounting Research*,Vol.23 No.1, pp.227-249. https://doi.org/10.1108/JAAR-04-2021-0100

O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality & Quantity*, 41(5), 673-690. https://doi.org/10.1007/s11135-006-9018-6

Ortiz-de-Mandojana, N., & Aragón-Correa, J. A. (2015). Boards and Sustainability: The Contingent Influence of Director Interlocks on Corporate Environmental Performance. *Business Strategy and the Environment*, 24(6), 499–517. https://doi.org/10.1002/bse.1833

Owen, A. L., Temesvary, J., & Wei, A. (2023). Board of Directors' Networks, Gender, and Firm Performance in a Male-Dominated Industry: Evidence from U.S. Banking. *Journal of Banking & Finance* https://doi.org/10.1016/j.jbankfin.2023.107333

Paolone, F., Pozzoli, M., Cucari, N., & Bianco, R. (2023). Longer board tenure and audit committee tenure. How do they impact environmental performance? A European study. *Corporate Social Responsibility and Environmental Management*, 30(1), 358–368. https://doi.org/10.1002/csr.2359

Peters, G. F., & Romi, A. M. (2015). The association between sustainability governance characteristics and the assurance of corporate sustainability reports. *Auditing: A Journal of Practice & Theory*, *34*(1), 163-198. https://doi.org/10.2308/ajpt-50849

Post, C., Rahman, N., & Rubow, E. (2011). Green Governance: Boards of Directors' Composition and Environmental Corporate Social Responsibility. *Business & Society*, *50*(1), 189-223. https://doi.org/10.1177/0007650310394642

Pozzoli, M., Pagani, A., & Paolone, F. (2022). The impact of audit committee characteristics on ESG performance in the European Union member states: Empirical evidence before and during the COVID-19 pandemic. *Journal of Cleaner Production* 371, 133411. https://doi.org/10.1016/j.jclepro.2022.133411

Pucheta-Martínez, M. C., & Bel-Oms, I. (2019). What have we learnt about board gender diversity as a business strategy? The appointment of board subcommittees. *Business Strategy and the Environment*, *28*(2), 301–315. https://doi.org/10.1002/bse.2226

Rambachan, A., & Roth, J. (2023). A more credible approach to parallel trends. *The Review of Economic Studies*, *90*(5), 2555–2591. https://doi.org/10.1093/restud/rdad018

Rao, K., & Tilt, C. (2016). Board Composition and Corporate Social Responsibility: The Role of Diversity, Gender, Strategy and Decision Making. *Journal of Business Ethics*, *138*(2), 327–347. https://doi.org/10.1007/s10551-015-2613-5

Ruigrok, W., Peck, S. I., & Tacheva, S. (2007). Nationality and gender diversity on Swiss corporate boards. *Corporate Governance: An International Review, 15*(4), 546–557 https://doi.org/10.1111/j.1467-8683.2007.00587.x

Schwab, A., Werbel, J. D., Hofmann, H., & Henriques, P. L. (2016). Managerial Gender Diversity and Firm Performance: An Integration of Different Theoretical Perspectives. *Group and Organization Management*, *41*(1), 5–31. https://doi.org/10.1177/1059601115588641

Shaukat, A., Qiu, Y., & Trojanowski, G. (2016). Board attributes, corporate social responsibility strategy, and corporate environmental and social performance. *Journal of Business Ethics, 135*(3), 569–585. https://doi.org/10.1007/s10551-014-2460-9

Stock, J. H., Wright, J. H., & Yogo, M. (2002). A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments. *Journal of Business & Economic Statistics*, *20*(4), 518–529. https://doi.org/10.1198/073500102288618658

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behavior. In S. Worchel & W. G. Austin (Eds.), *Psychology of intergroup relations* (pp. 7–24). Chicago: Nelson-Hall.

Triana, M. del C., Miller, T. L., & Trzebiatowski, T. M. (2014). The double-edged nature of board gender diversity: Diversity, firm performance, and the power of women directors as predictors of strategic change. *Organization Science*, *25*(2), 609–632. https://doi.org/10.1287/orsc.2013.0842

Tunyi, A. A., Areneke, G., Tob-Ogu, A., & Khalid, S. (2023). Doing more with more: Women on the board and firm employment. *Journal of Business Research, 154,* 113385 https://doi.org/10.1016/j.jbusres.2022.113385

Van der Walt, N., & Ingley, C. (2003). Board Dynamics and the Influence of Professional Background, Gender and Ethnic Diversity of Directors. *Corporate Governance: An International Review*, *11*(3), 218–234. https://doi.org/10.1111/1467-8683.00320

Walls, J. L., Berrone, P., & Phan, P. H. (2012). Corporate governance and environmental performance: is there really a link? *Strategic Management Journal*, 33(8), 885-913. https://doi.org/10.1002/smj.1952

Zharfpeykan, R., & Bai, Y. (2025). Board gender diversity and corporate environmental, social and governance performance: Evidence from New Zealand listed firms. *Pacific Accounting Review*. *(Forthcoming)*

Zelechowski, D. D., & Bilimoria, D. (2004). Characteristics of Women and Men Corporate Inside Directors in the US. *Corporate Governance*, *12*(3), 337–342. https://doi.org/10.1111/j.1467-8683.2004.00374.x