

Female CEO and ESG Performance

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Abstract

This study examines whether female CEOs influence firm's ESG performance using a sample of 1,722 non-financial firms listed on the Taiwan Stock Exchange (TWSE) and the Taipei Exchange (TPEX) during 2016~2024. Drawing on upper echelons theory, together with insights from sociology and organizational behavior suggesting that female leaders tend to exhibit greater risk aversion, stronger ethical orientation, higher stakeholder concern, and more collaborative leadership styles, this study predicts that female executives are more likely to promote ESG-related initiatives. However, critical mass theory and tokenism suggest that female CEOs may face greater organizational constraints, limiting their ability to translate these leadership characteristics into firm-level ESG outcomes. Using correlation analysis and multiple regression estimations, the empirical results show that firms led by female CEOs, female vice CEOs, or both exhibit significantly higher overall ESG performance and stronger environmental, social, and governance performance. In contrast, when a female CEO simultaneously serves as board chair (CEO duality), overall ESG performance declines, primarily because of weaker governance performance, although environmental performance remains significantly stronger.

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1. Introduction

Board gender diversity refers to the degree of balance between female and male members on a firm's board of directors, capturing the gender composition of board structure. It is generally argued that gender diversity broadens the range of perspectives and decision-making participation, thereby improving corporate governance quality and enhancing the comprehensiveness of board deliberation. Managerial gender diversity denotes the proportion of female and male leaders within a firm's top management team. This concept emphasizes the diversity effects arising from gender differences across managerial levels and suggests that gender balance plays a critical role in shaping managerial styles, decision-making processes, implementation effectiveness, and overall organizational culture. Both board gender diversity and managerial gender diversity reflect a firm's inclusiveness in gender representation and constitute a concrete manifestation of equal opportunity in human rights within organizational settings.

In many advanced economies, particularly in Europe, board gender diversity has become a central corporate governance issue and has been increasingly promoted through regulatory and policy initiatives. For example, the European Union introduced guidelines on board gender balance in 2012. In June 2022, the European Parliament adopted an agreement requiring listed firms in the EU to ensure that, by the end of June 2026, at least 40% of non-executive director positions or 33% of total board seats are held by women. Similar policies in countries such as Norway, France, and Germany, implemented through mandatory quotas or soft recommendations, have further strengthened requirements for female representation on corporate boards. These measures aim to enhance board diversity, improve governance quality and transparency, and promote gender equality by fostering a more inclusive perspective at the governance level. Parallel developments are also observed in managerial gender diversity, where several European countries have implemented policies to promote gender balance in top management teams. For instance, Sweden and Spain have set explicit targets for female representation in senior management and encourage firms to incorporate gender diversity considerations in hiring and promotion processes. European regulators also emphasize voluntary disclosure of gender diversity progress, requiring firms to regularly report the gender composition of both boards and management teams.

In Taiwan, regulatory authorities such as the Financial Supervisory Commission (FSC) and the Taiwan Stock Exchange (TWSE) have not imposed mandatory gender quotas for board or managerial composition. However, they have introduced various regulations and policy initiatives encouraging listed firms to adopt gender diversity practices. Since 2018, the FSC has required all listed firms to disclose the gender composition of their boards in annual reports, including the proportion of female directors, and has emphasized board diversity as a core element of corporate governance. Furthermore, the Corporate Governance 3.0-Sustainable Development Roadmap issued by the FSC in 2020 further highlights the importance of board diversity, including gender, background, and professional expertise, and encourages

firms to set concrete targets for increasing the representation of women on both boards and in top management.

As an interesting anecdote, the growing presence of female executives in Taiwan's corporate sector provides a compelling real-world backdrop for examining the relationship between female CEO leadership and ESG performance. Several female CEOs have achieved remarkable success in highly competitive industries while receiving widespread recognition for their managerial capabilities. For example, Hsiu-Lan Hsu, CEO of GlobalWafers and Chairperson of Sino-American Silicon Products Inc., has earned international recognition in the semiconductor wafer industry and was ranked first in the *Harvard Business Review* Taiwan's "Best Female CEOs of Listed Companies" for three consecutive terms. Likewise, Hui-Ching Tsai, President of HIWIN Technologies Corp., successfully transformed a traditional precision machinery manufacturer into a leading smart automation enterprise and was recognized by Forbes as one of Asia's most powerful businesswomen. In the technology sector, Li-Ning Hung, CEO of Wiwynn Corporation, has distinguished herself through outstanding financial performance and substantial growth in firm value, making her one of Taiwan's most prominent female corporate leaders.

In the academic literature, extensive research has examined the effects of board gender diversity and managerial gender diversity on various financial and economic outcomes. From a positive perspective, gender diversity can enhance firm performance by improving decision quality. Adams and Ferreira (2009) document that gender-diverse boards provide broader perspectives, which help mitigate excessive overconfidence and groupthink. Diverse viewpoints enable boards to make more balanced assessments of risk, opportunity, and market dynamics, thereby improving firm performance. Carter, Simkins and Simpson (2003) find that female board representation is positively associated with firm financial performance and market valuation. Post and Byron (2015) synthesize the existing evidence and show that female board representation is positively related to long-term financial performance, particularly in environments characterized by higher uncertainty, where gender-diverse boards tend to exhibit greater resilience. This effect is attributed to higher risk sensitivity among female directors. The study further suggests that during periods of market volatility or economic shocks, the inclusion of female directors enhances firms' risk management capabilities, thereby contributing to financial stability and growth.

At the managerial level, gender diversity is also found to be positively associated with firm performance. Kramer, Konrad, Erkut and Hooper (2006) show that firms with a higher proportion of women in top management teams tend to exhibit stronger operational efficiency and decision quality. Catalyst (2004) reports that firms led by women in senior management generally demonstrate superior outcomes in innovation and employee satisfaction, which in turn enhances overall economic performance. These findings suggest that female executives not only contribute diverse leadership styles but also play a critical role in managerial decision processes, thereby generating favorable effects on financial outcomes.

Overall, both managerial practice and academic research consistently highlight board and executive gender diversity as an important governance issue.

As noted above, in contemporary research on corporate management and corporate governance, board gender diversity and managerial gender diversity have been extensively examined. A substantial body of empirical evidence documents their positive effects on key outcomes such as firm financial performance, firm value, and financing costs. Prior studies suggest that gender diversity enhances the breadth and comprehensiveness of corporate decision-making, thereby improving governance structures and financial outcomes (Adams and Ferreira, 2009; Carter, Simkins and Simpson, 2003). Existing research further shows that board gender diversity is associated with firm value (Adams and Ferreira, 2009), risk-taking behavior (Huang and Kisgen, 2013), financing costs (Gul, Srinidhi and Ng, 2011), and investment efficiency (Baik, Chen and Godsell, 2024). Collectively, these studies significantly enrich our understanding of the economic implications of gender diversity in corporate decision-making, financial performance, and capital market outcomes.

However, despite extensive research on the financial implications of gender diversity, relatively fewer studies have examined how gender diversity, particularly the distinctive leadership traits of female executives in boards and top management teams, affects firm outcomes in corporate social responsibility (CSR) and environmental, social, and governance (ESG) performance. Accordingly, this study focuses on managerial gender diversity, with particular attention to how female chief executive officers influence firm ESG performance through their distinct leadership characteristics and value orientations, thereby addressing the research gap that has been largely dominated by studies on board gender diversity.

This gap is especially salient in the current era in which sustainable finance and corporate social responsibility have become increasingly important. ESG strategy formulation and implementation are not only responses to regulatory requirements and societal expectations but are also emerging as central determinants of a firm's sustainable competitiveness and capital market valuation. From a theoretical perspective, male and female executives differ significantly in decision-making styles, risk preferences, and ethical orientations. Prior research suggests that female leaders tend to exhibit more cautious leadership styles and place greater emphasis on long-term sustainability and stakeholder balance (Kramer, Konrad, Erkut and Hooper, 2006). Specifically, female executives are more likely to adopt conservative risk management approaches when facing complex business decisions and tend to demonstrate stronger ethical awareness and social responsibility orientation (Liu, Wei and Xie, 2014). These characteristics lead female executives to place greater emphasis on corporate social responsibility and long-term value creation in managerial decision-making, rather than focusing solely on short-term financial outcomes. Consequently, female top executives may embed a stronger sense of social responsibility into corporate decision processes, thereby promoting firm-level ESG engagement, which is crucial for long-term sustainable development and competitive advantage.

Drawing on the Upper Echelons Theory proposed by Hambrick and Mason (1984), firm top executives imprint their backgrounds, experiences, personalities, and value systems on organizational decision-making processes. When a firm is led by a female chief executive officer, such gender-specific leadership attributes are expected to influence major strategic decisions, their implementation, and the structure of corporate governance. In particular, female executives' ethical awareness, risk aversion, risk management capabilities, and heightened sensitivity to stakeholder demands may lead firms to place greater emphasis on stakeholder interests and to strengthen commitments to sustainability and corporate social responsibility (Post and Byron, 2015). These characteristics not only improve firm performance in environmental protection, social welfare, and governance practices but may also enhance social legitimacy and market trust. Accordingly, this study is motivated to examine whether female CEOs, through their distinctive leadership styles and value orientations, contribute to superior ESG performance.

Within the institutional and social context of Taiwan, this research question is particularly salient. In recent years, Taiwan has witnessed a rising prominence of female leaders in both political participation and financial markets. The proportion and influence of women in decision-making positions have increased significantly, whether in central and local government or in listed firms and financial institutions. This structural shift not only reflects progress in gender equality but also provides a natural setting to observe how female decision-makers influence corporate sustainability strategies. At the same time, regulators have actively promoted sustainable governance through institutional design and policy guidance. For example, the Financial Supervisory Commission's Corporate Governance 3.0-Sustainable Development Roadmap issued in 2020 explicitly prioritizes strengthening board diversity and improving ESG disclosure quality, encouraging listed firms to gradually incorporate gender diversity principles and enhance sustainability performance and transparency. Overall, this study responds to both policy and academic demands by addressing the research gap between executive gender diversity and ESG strategy formation.

The primary objective of the study is to examine whether female CEO influence firm ESG performance and whether CEO duality moderates this relation. Specifically, we investigate whether firms led by female CEO exhibit superior ESG performance and whether the concentration of decision-making authority arising from CEO duality weakens or even reverses the potential sustainability benefits associated with female leadership. The sample comprises 1,722 firms listed on the TWSE and TPEX over the period 2016–2024. There are two main contributions. First, this study extends the literature on gender diversity and corporate sustainability by shifting the focus from board gender diversity to CEO gender. Prior studies predominantly examine whether female directors or board gender diversity improve ESG performance (e.g., Post, Rahman and Rubow, 2011; Ben-Amar, Chang and McIlkenny, 2017; Byron and Post, 2016), whereas relatively little evidence considers whether the gender of the CEO, who is ultimately responsible for strategic decision-making, affects corporate sustainability outcomes. Moreover,

this study incorporates CEO duality into the analysis. Although female CEO may enhance ESG performance through stronger stakeholder orientation and long-term perspectives, CEO duality may weaken board monitoring and governance effectiveness, thereby attenuating or even reversing the positive effect of female leadership on ESG performance.

Second, this study adopts a comprehensive ESG measurement framework to provide a more nuanced assessment of corporate sustainability. Rather than relying on a single ESG indicator, we examine overall ESG scores, industry-adjusted rankings, environmental, social, and governance pillar scores, and their corresponding industry-adjusted rankings. This design allows us to investigate whether female CEOs exert heterogeneous effects across individual ESG dimensions and whether the governance consequences of CEO duality differ across environmental, social, and governance performance. In contrast to prior studies that typically employ a single ESG measure (e.g., Khan, Serafeim and Yoon, 2016; Eccles, Ioannou and Serafeim, 2014; Grewal, Riedl and Serafeim, 2020), our multidimensional approach provides a more comprehensive understanding of how executive gender and governance structure jointly shape corporate sustainability.

The remainder of this paper is organized as follows. The next section reviews the literature and develops the hypotheses concerning the relationship between female CEOs and firm ESG performance. Section 3 introduces the variables, econometric models, sample selection, and data sources. Section 4 presents the empirical results, including descriptive statistics, correlation analysis, and regression estimation result. Section 5 concludes and discusses the managerial and policy implications, study limitations, and directions for future research.

2. Literature Review and Hypothesis Development

2.1 Development and Regulation of Board and Managerial Gender Diversity

In Europe, gender diversity in both boards of directors and top management teams has increasingly become an important and continuously enforced policy agenda, with many countries introducing formal regulations and requirements to promote gender balance. The promotion of gender diversity is not only reflected in corporate governance practices but also supported by government initiatives and regulatory frameworks. The overarching objective of these policies is to advance gender equality and enhance female participation in corporate leadership. For example, since 2012 the European Union has actively promoted gender diversity, particularly at the board level. Under the EU Directive on Gender Balance on Boards, listed firms are expected to achieve at least 40 percent gender balance on their boards. The directive requires that, starting from 2016, listed firms in EU member states should ensure a minimum of 40 percent female representation on boards. Firms that fail to meet this target are required to explain to shareholders why the target was not achieved and to provide a concrete action plan for improvement (European Commission, 2012).

Beyond EU-wide regulation, several European countries have implemented more

specific and stringent policies. For instance, Norway became the first country in the world in 2003 to mandate that listed firms maintain at least 40% female representation on their boards. The policy has been highly effective, with female representation on Norwegian boards rising rapidly to approximately 40% within a few years. This successful case has encouraged other European countries to adopt similar measures, such as Spain in 2010 and France in 2011, both of which introduced comparable legal requirements. In contrast, countries such as Sweden, Belgium, and the Netherlands have emphasized voluntary approaches to gender diversity, implementing incentive-based mechanisms such as government awards, tax benefits, and other economic incentives to encourage firms to improve gender balance.

With respect to managerial gender diversity, although European regulatory efforts have primarily focused on boards of directors, several countries have begun to emphasize gender balance in top management teams as well. For example, since 2016 Switzerland has required large listed firms to disclose the gender composition of their senior management teams. Although such requirements are not mandatory in terms of outcomes, they have encouraged firms to pay greater attention to the gender structure of top management and to disclose gender diversity information in annual reports. Moreover, many European countries and firms have increasingly recognized the positive implications of female representation in senior management for firm performance and corporate social responsibility. As a result, support for female leaders has gradually increased, and firms have made efforts to reduce gender barriers in corporate leadership structures.

In the United States, regulatory requirements regarding board gender diversity and managerial gender diversity are relatively less stringent, yet they are still subject to certain disclosure rules and policy initiatives. Under the requirements of the U.S. Securities and Exchange Commission (SEC), listed firms are required to periodically disclose the composition of their boards of directors and top management teams, including gender, race, and other diversity-related characteristics. In 2018, California enacted legislation requiring publicly listed firms to have at least one female director by the end of 2021, with expectations of progressively increasing female representation thereafter. In addition, regulators in New York City and other jurisdictions have introduced similar initiatives, further strengthening attention to gender balance in corporate boards. Since 2021, the NASDAQ stock exchange has required listed firms to have at least two diverse directors, including at least one female director and one director from an underrepresented minority group or from the LGBTQ+ community. Firms that fail to comply must provide an explanation. With respect to managerial gender diversity, although the United States does not impose mandatory quotas as in some European countries, many listed firms have voluntarily promoted gender diversity in top management teams. The U.S. corporate culture emphasizes voluntary disclosure and transparency, and many firms publicly report the gender composition of their management teams and commit to increasing the representation of female executives. For example, many large U.S. corporations have participated in the

“2020 Women on Boards” initiative, which aimed to achieve at least 20 percent female representation on corporate boards by 2020.

In Taiwan, to promote sustainable corporate development and board diversity, the Financial Supervisory Commission (FSC) announced in 2023 that, starting in 2024, all listed firms must appoint at least one female director. Furthermore, if the proportion of female directors does not reach one-third by 2025, firms will be required to disclose the reasons and remedial measures in their annual reports. The FSC also released the “Sustainable Development Action Plan for Listed Firms (2023),” which outlines five major policy directions, one of which is to increase the proportion of female directors. A three-stage gradual implementation framework has been adopted. First, from 2023, initial public offering firms are required to appoint at least one female director. Second, from 2024, listed firms are expected to appoint at least one female director upon the renewal of board terms. Third, if female directors do not reach one-third of the board by 2025, firms must disclose the reasons and corrective actions in their annual reports.

2.2 Benefits and Costs of Board and Managerial Gender Diversity

A substantial body of domestic and international empirical research has examined how board gender diversity and managerial gender diversity affect firms’ economic outcomes, including financial performance, firm value, risk management, and financing costs. The evidence generally indicates that the direction and magnitude of gender diversity effects are context dependent and may vary with institutional environments, cultural settings, and governance structures.

With respect to financial performance, boards with higher levels of gender diversity are often associated with higher decision-making quality and improved operating outcomes. Adams and Ferreira (2009) document that the presence of female directors increases firms’ engagement in corporate social responsibility activities, which in turn enhances long-term financial performance. Dezso and Ross (2012) find that female executives improve managerial quality and strategic decision-making, leading to higher shareholder returns, particularly in highly competitive markets where female leadership exhibits stronger risk management capabilities under economic uncertainty. However, some studies raise concerns regarding the robustness of this relationship. For instance, Terjesen, Sealy and Singh (2009), using a sample of European listed firms, find that although female board representation may improve governance quality, its direct effect on short-term financial performance is limited and requires a longer horizon to materialize.

Regarding firm value, several studies document a positive association between board gender diversity and market valuation. Tobin’s q , which measures market value relative to the replacement cost of assets and captures a firm’s growth potential, is frequently used in this literature. Joy, Carter, Wagner and Narayanan (2007) reports that U.S. listed firms with higher proportions of female directors exhibit significantly higher Tobin’s q than firms with lower gender diversity, suggesting that female directors contribute new perspectives that foster innovation and enhance market valuation. However, contrasting evidence is also documented.

Dodd, Frijns, Gong and Liao (2024) find that the effect of gender diversity on Tobin's q is limited, particularly in highly competitive industries where gender diversity does not necessarily translate into higher firm value.

From a risk perspective, gender-diverse boards are generally associated with lower firm risk, particularly in terms of reduced stock return volatility and lower downside risk. Female directors tend to introduce more cautious and conservative decision-making styles in corporate governance, which helps mitigate managerial overconfidence and excessive risk-taking behavior, thereby reducing stock return volatility (Bernardi, Bosco and Columb, 2009). Chen, Li, Truong and Chan (2025) find that gender-diverse boards are associated with lower crash risk, particularly in high-risk industries, where the prudent leadership style of female executives helps buffer firms against extreme market fluctuations. However, Lückerath-Rovers (2013) documents that although gender diversity may enhance transparency in decision-making, it may also create coordination challenges. In the absence of effective collaboration mechanisms, such frictions may increase decision-making errors and ultimately elevate overall firm risk.

Regarding financing conditions, the presence of female directors is associated with lower financing costs, particularly in debt financing. Female executives tend to promote more conservative and transparent financial policies, thereby reducing the cost of capital (Bøhren and Strøm, 2010). Boulouta (2013) argues that female directors enhance a firm's social image and reputation, leading investors and lenders to adopt more favorable perceptions and consequently lowering financing costs. However, Ramos, Bennett, Massey and Hewstone (2019) find that in certain regions or cultural contexts, investor acceptance of female directors remains limited, which may increase the cost of equity financing. When gender diversity does not substantively improve governance structures, such symbolic diversity may instead intensify market skepticism regarding the effectiveness of governance reforms, thereby increasing financing costs.

With respect to environmental performance, prior research suggests that firms with a higher proportion of female executives are more proactive in adopting carbon reduction initiatives and tend to achieve higher energy efficiency and lower carbon emissions. For instance, Zhu (2019), using Chinese firm-level data, documents a significant association between board gender diversity and firms' carbon emissions and energy conservation outcomes. Female executives are often more actively involved in formulating and implementing environmental policies and are more likely to advocate for initiatives that reduce firms' carbon footprints and environmental impacts. Such firms tend to adopt more innovative and proactive measures, including greater reliance on renewable energy, improvements in energy efficiency, and optimization of resource utilization in production processes. Recent research suggests that the effectiveness of board gender diversity in improving firms' environmental performance is contingent upon the institutional and cultural context. Wang, Ones, Yazar and Mete (2023) find that board gender diversity is positively associated with environmental performance across an international sample of firms, although the strength of this relationship varies substantially across

cultural clusters. Chen, Yan and Yu (2025) show that the positive effect of female board representation is evident in Western economies but largely absent in East Asia, where female directors are more likely to be insider directors with limited independence. Their findings further indicate that only independent female directors significantly enhance firms' environmental performance in East Asian firms.

2.3 The Effect of Female CEOs on Firm ESG Performance

Upper Echelons Theory posits that executives' values, cognitive bases, and personal characteristics shape strategic choices and ultimately influence organizational outcomes (Hambrick and Mason, 1984). While CEO possess substantial discretion over corporate strategy and resource allocation, their personal attributes are expected to affect firms' ESG activities and performance. Within this framework, CEO gender represents an important managerial characteristic that may systematically influence ESG-related decision making.

Research in psychology, sociology, organizational behavior, and behavioral economics suggests that female leaders exhibit behavioral characteristics that differ, on average, from those of their male counterparts in ways that are relevant to ESG decisions. Women generally demonstrate stronger ethical orientation, greater empathy, higher social sensitivity, and a stronger preference for cooperation, fairness, and long-term relationship building (Gilligan, 1982; Eagly, Johannesen-Schmidt and van Engen, 2003). They are also more likely to exhibit prudent judgment, lower levels of overconfidence, and greater risk aversion when making decisions under uncertainty (Byrnes, Miller and Schafer, 1999; Croson and Gneezy, 2009). These behavioral tendencies encourage greater attention to stakeholder welfare, regulatory compliance, information transparency, and long-term value creation rather than short-term profit maximization.

Such characteristics are closely aligned with the objectives of ESG. Compared with male executives, female CEOs may place greater emphasis on environmental stewardship, carbon reduction, energy efficiency, employee welfare, workplace equality, customer protection, responsible supply-chain management, community engagement, tax compliance, and timely, transparent disclosure. They are also more likely to support governance practices that strengthen board accountability, internal control, and ethical corporate conduct. Consequently, firms led by female CEO are expected to integrate sustainability considerations more extensively into strategic decision making and resource allocation (Nielsen and Huse, 2010).

These behavioral mechanisms are consistent with Stakeholder Theory of Freeman (1984), which argues that sustainable firm value depends on balancing the interests of shareholders with those of employees, customers, suppliers, communities, governments, and other stakeholders. Female CEO are therefore expected to devote greater attention to stakeholder relationships and long-term sustainability objectives. Resource Dependence Theory further suggests that leadership diversity enhances firms' access to external knowledge, networks, and legitimacy, improving organizational responsiveness to sustainability-related challenges (Pfeffer, 1972). Empirical evidence likewise indicates that female leadership contributes to stronger

CSR engagement, more effective board deliberation, and superior ESG performance (Bear, Rahman and Post, 2010; Post and Byron, 2015). Agency Theory provides an additional explanation. Because ESG initiatives require credible disclosure, effective oversight, and long-term investment, governance quality plays a central role in their successful implementation. Female executives have been associated with stronger monitoring, greater financial reporting quality, higher ethical standards, and more conservative managerial behavior, thereby reducing agency conflicts and strengthening governance effectiveness (Adams and Ferreira, 2009). These governance characteristics facilitate the implementation of sustainability strategies while improving accountability and organizational transparency.

The positive association between female CEO and ESG performance is also consistent with Legitimacy Theory. As investors, regulators, and society increasingly emphasize sustainable development and corporate accountability, firms face growing pressure to demonstrate responsible business practices. Female CEO may strengthen firms' legitimacy by promoting environmental protection, social responsibility, transparent governance, and responsible stakeholder engagement, thereby enhancing corporate reputation and long-term competitiveness (Boulouta, 2013; Dezsó and Ross, 2012). Recent studies further suggest that female leadership promotes organizational resilience and long-term stakeholder value creation, reinforcing firms' commitment to sustainable development (Glass and Cook, 2018). Based on above arguments, this study proposes the following hypothesis:

Hypothesis 1A: *Firms led by female CEO exhibit superior ESG performance.*

However, some scholars argue that top management gender diversity may exert negative effects on corporate social responsibility and environmental, social, and governance performance. This perspective can be examined through organizational theory, corporate governance theory, and tokenism theory. First, from an organizational theory perspective, Social Identity Theory suggests that gender diversity in top management may generate differences in culture and identity among team members, thereby affecting decision-making efficiency. When board or executive team members come from different gender backgrounds, communication barriers and coordination frictions may arise, reducing overall decision efficiency. Although such diversity may introduce new perspectives in some contexts, it may also lead to conflict and tension in decision processes, thereby undermining consistency and speed of decision-making (Van Knippenberg and Schippers, 2007). In gender-diverse executive teams, if these differences are not effectively managed, decision processes may become more time-consuming, thereby weakening firms' responsiveness and implementation capacity in ESG-related issues.

Second, from a corporate governance perspective, gender diversity may be merely symbolic compliance rather than substantive governance improvement. In response to external pressure for gender diversity, some firms may implement superficial

changes, such as appointing female executives without granting them meaningful authority or decision-making power. Such symbolic compliance may exacerbate agency problems, where directors formally represent shareholder interests but do not materially improve governance quality or advance ESG objectives (Jensen and Meckling, 1976). If female executives serve only symbolic roles within boards or management teams without substantive participation in governance, they may fail to contribute meaningfully to CSR or ESG initiatives, thereby reinforcing a form of “window-dressing” governance and leading to weaker long-term ESG performance. Third, from the perspective of tokenism, token individuals refer to minority members appointed to senior positions primarily to satisfy legal or social expectations, rather than to exercise substantive influence. These individuals are often perceived as symbolic figures rather than effective decision-makers. Prior research suggests that when female executives are appointed primarily in response to external pressure for gender equality, they often face the dilemma of symbolic leadership and are unable to exercise real decision-making authority or influence firm operations (Kanter, 1977). This situation may prevent firms from achieving genuine progress in CSR and ESG performance. Even if firms appear to comply with gender diversity requirements, the lack of substantive diversity and effective leadership may hinder performance in social responsibility and sustainability outcomes (Bilimoria and Piderit, 1994). Based on the above three arguments, this study develops an alternative and competing hypothesis:

Hypothesis 1B: *Firms led by female CEO exhibit poorer ESG performance.*

3. Variables, Econometric Model, and Sample Data

3.1 Research Variables

3.1.1 Dependent Variable: ESG Performance

This study employs the Taiwan Economic Journal (TEJ) Sustainability Index, which was introduced in 2022 to evaluate the sustainability performance of publicly listed firms in Taiwan. This framework comprises three dimensions: Environmental (E), Social (S), and Governance (G). The environmental dimension evaluates firms’ environmental management practices, including carbon emissions, wastewater treatment, and energy management. The social dimension assesses labor rights, employee welfare, social participation, and customer protection, reflecting firms’ commitment to stakeholder responsibility. The governance dimension captures regulatory compliance, supply chain management, risk management, and other governance-related practices that reflect managerial quality and corporate oversight. Indicators within each dimension are first aggregated to generate environmental, social, and governance performance scores, which are subsequently combined using a weighted methodology to derive an overall ESG score.

In this study, ESG performance is measured using six overall indicators. First, the ESG rating (*esgrating*), which classifies firms into seven ESG rating categories based on overall ESG score, A+, A, B+, B, B-, C, and C-, and then converted into a discrete numerical scale ranging from 7 to 1, where higher values indicate better

ESG performance. Second, the ESG score (*esgscore*) is the continuous score, ranging from 0 to 100, where 0 represents the worst overall ESG performance and 100 represents the best performance. Third, the industry rank within the Taiwan Stock Exchange industry classification (*esgexr*), is constructed based on the ranking of overall ESG score within its industry group. For example, if a firm's overall ESG score is ranked second among 25 firms in a given year, the notation is (2/25), and this study transforms it as $[100 - (2/25) \times 100] = 92$, where a higher value indicates better overall ESG performance within the Taiwan Stock Exchange industry classification. Fourth, the ESG score ranking across all rated firms in the same year (*esgwr*), is constructed using the same transformation method, where higher values indicate better overall ESG performance. Fifth, the ESG score ranking within the Sustainability Accounting Standards Board (SASB) industry classification (*esgmr*), which is similarly transformed, where higher values indicate better overall ESG performance within the SASB main industry classification. Sixth, the ESG score ranking within the SASB sub-industry classification (*esgsr*), which is also constructed using the same approach, where higher values indicate superior overall ESG performance within the SASB sub-industry classification.

This study further considers three component ESG scores from the Taiwan Economic Journal (TEJ) Sustainability Index and their corresponding industry rankings. These include the environmental score (*envscore*) and its rankings within SASB main industry classification (*envmr*) and sub-industry classification (*envsr*), the social score (*socscore*) and its rankings within SASB main industry classification (*socmr*) and sub-industry classification (*socsr*), and the governance score (*govscore*) and its rankings within SASB main industry classification (*govmr*) and sub-industry classification (*govsr*). Higher values of these nine ESG variables indicate better performance on E, S, and G, both in absolute terms and relative to peers in SASB industry classification.

3.1.2 Main Explanatory Variables: Female CEO

This study follows the literature on top management team gender diversity and constructs four variables to capture female participation in senior leadership. First, the female CEO dummy variable (*fceo*) identifies whether the firm's highest executive decision-maker is female. It takes a value of 1 if the chief executive officer, general manager is female, and 0 otherwise. This variable captures the gender identity of the firm's top executive and reflects potential effects on corporate governance, risk preferences, and strategic decision-making. Second, the female vice CEO dummy variable (*fvceo*) indicates whether the vice general manager, vice CEO is female. It equals 1 if a female holds any of these positions and 0 otherwise. Third, the dual female leadership dummy (*bfceo*) captures whether both the CEO and vice CEO positions are simultaneously held by a female. It takes a value of 1 when both top executive roles are occupied by female managers and 0 otherwise. This variable reflects the collective presence and intensity of female representation in top management and captures potential interaction effects in managerial

coordination, decision-making dynamics, and governance influence among female executives. Fourth, the female CEO duality dummy (*fduality*) measures whether a female CEO simultaneously serves as chair of the board. It equals 1 if the female CEO also holds the board chair position and 0 otherwise. This variable captures the degree of power concentration in female leadership and its potential implications for corporate governance and firm decision-making.

3.1.3 Control Variables

This study follows Reverte (2009), Chih, Chih and Chen (2010), Kansal, Joshi and Singh Batra (2014), Liang and Renneboog (2017), Cheng, Chang and Chen (2022), and Ding, Wang, Xu and Lin (2024) to consider several control variables that may influence firm ESG performance. First, firm size (*scale*) is included because larger firms tend to have higher market visibility and attract greater attention from investors, media, and stakeholders, which increases pressure to engage in corporate social responsibility and allocate more resources to ESG activities, leading to better ESG performance. It is defined as the natural logarithm of total assets. Second, the debt ratio (*debt*) captures financial leverage and is negatively associated with ESG performance, suggesting that financial constraints may reduce firms' investment in social responsibility initiatives (Ke, 2023). It is defined as total liabilities divided by total assets. Third, return on assets (*roa*) measures profitability. More profitable firms tend to have greater financial resources to invest in CSR activities, and therefore exhibit better ESG performance. It is defined as after-tax net income divided by average total assets. Fourth, asset turnover (*aturn*) measures operational efficiency in generating sales from assets. Higher values indicate more efficient resource utilization and stronger managerial capability. Such firms are generally better able to respond to market dynamics and incorporate sustainability considerations into operations. It is defined as net sales divided by average total assets.

Fifth, institutional shareholding (*insthold*) captures the proportion of shares held by institutional investors. Active institutional participation enhances governance quality, strengthens monitoring mechanisms, and improves transparency, thereby promoting ESG performance. It is defined as shares held by all institutional investors divided by total shares outstanding. Sixth, family control (*family*) identifies whether a firm is controlled by a single family. It takes a value of 1 for family-controlled firms and 0 for government-controlled, professionally managed, or shared-control firms. Family control may reduce stakeholder-oriented resource allocation due to the prioritization of family interests. Seventh, the coverage of directors' and officers' liability insurance (*doli*), defined as the natural logarithm of coverage amount of directors' and liability insurance, reflecting the degree of governance protection for board members and executives. The definitions and notation of the explained variables, explanatory variables, and control variables are summarized in Table 1.

Table 1: Abbreviations and definitions of variable

Variable	Abbreviation	Definition
Explained Variable—ESG Performance		
ESG ratings	<i>esgrating</i>	The TESG ratings range from A+ to C- and are converted into integer values from 7 to 1, with higher values indicating stronger overall ESG performance
ESG score	<i>esgscore</i>	The TESG score ranges from 0 to 100, with higher values indicating stronger overall ESG performance
The rank of ESG score in the full sample for a given year	<i>esgwr</i>	A rank of (2/25) is converted to a percentile score using $[100 - (2/25) \times 100] = 92$, where higher percentiles denote stronger overall ESG performance within the full sample in a given year
The rank of ESG score within the Taiwan Stock Exchange industry classification	<i>esgexr</i>	A rank of (2/25) is converted to a percentile score using $[100 - (2/25) \times 100] = 92$, where higher percentiles denote stronger overall ESG performance within the TWSE industry classification
The rank of ESG score within the SASB main industry classification	<i>esgmr</i>	TESG score ranking within the SASB main industry classification, converted into a percentile using the above formula
The rank of ESG score within the SASB sub-industry classification	<i>esgsr</i>	A firm's TESG score ranking within the sub industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
Environmental score	<i>envscore</i>	The TESG environmental score ranges from 0 to 100, with higher values indicating stronger environmental performance
The rank of environmental score within the SASB main industry classification	<i>envmr</i>	The TESG environmental score ranking within the main industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
The rank of environmental score within the SASB sub-industry classification	<i>envsr</i>	The TESG environmental score ranking within the sub-industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
Social score	<i>socscore</i>	The TESG social score ranges from 0 to 100, with higher values indicating stronger social performance
The rank of social score within the SASB main industry classification	<i>socmr</i>	The TESG social score ranking within the main industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
The rank of social score within the SASB sub-industry classification	<i>socsr</i>	The TESG social score ranking within the sub-industry classification of the SASB, with the rank converted to a percentile using the same formula as described above

Corporate governance score	<i>govscore</i>	The TESG corporate governance score ranges from 0 to 100, with higher values indicating stronger corporate governance performance
The rank of corporate governance score within the SASB main industry classification	<i>govmr</i>	The TESG corporate governance score ranking within the main industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
The rank of corporate governance within the SASB sub-industry classification	<i>govsr</i>	The TESG corporate governance score ranking within the sub-industry classification of the SASB, with the rank converted to a percentile using the same formula as described above
Explanatory Variable- Presence of Female CEO		
Dummy for a firm's CEO is female	<i>fceo</i>	Equal to 1 if a firm's CEO is female, and 0 otherwise.
Dummy for a firm's vice CEO is female	<i>fvceo</i>	Equal to 1 if a firm's vice CEO is female, and 0 otherwise.
Dummy for a firm's CEO and vice CEO are both female	<i>bfceo</i>	Equal to 1 if a firm's CEO and vice CEO are female, and 0 otherwise
Dummy for a firm's CEO is female and served as board chairman	<i>fduality</i>	Equal to 1 if a firm's CEO is female and also served as board chairman, and 0 otherwise
Control Variable		
Firm size	<i>scale</i>	The natural logarithm of total assets
Debt ratio	<i>debtr</i>	Total liabilities divided by total assets
Returns on assets	<i>roa</i>	After-tax net income divided by average total assets
Asset turnover	<i>aturn</i>	Net sales divided by total assets
Institutional investors' shareholdings	<i>insthold</i>	(The number of shares hold by all institutional investors / number of shares outstanding) * 100%
Family control	<i>family</i>	If the type of corporate control is single-family controlled, then it is 1, and 0 otherwise
The coverage of D&O insurance	<i>doli</i>	The natural logarithm of the total directors' and officers' liability insurance coverage amount

Note: This table reports the abbreviations and definitions of the variables. Variable definitions are based on the Taiwan Economic Journal (TEJ) database and the authors' own specifications.

3.2 Econometric Model

This study employs multiple regression analysis to estimate whether female chief executive leadership is associated with higher or lower firm ESG performance. The baseline regression model is specified as follows:

$$\mathbf{ESG}_{i,t} = \beta_0 + \beta_1 \cdot \mathbf{FCEO}_{i,t} + \beta_2 \cdot \text{scale}_{i,t} + \beta_3 \cdot \text{debtr}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \cdot \text{aturn}_{i,t} + \beta_6 \cdot \text{insthold}_{i,t} + \beta_7 \cdot \text{family}_{i,t} + \beta_8 \cdot \text{doli}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where the subscripts i and t denote firm i and year t , respectively. **ESG** represents a vector of firm ESG performance measures, including the ESG rating (*esgrating*), ESG score (*esgscore*), ESG ranking among all rated firms in the same year (*esgwr*), ESG ranking within Taiwan Stock Exchange industry classifications (*esgexr*), ESG ranking within SASB main industry classifications (*esgmr*), ESG ranking within SASB sub-industry classifications (*esgsr*), environmental score (*envscore*), environmental ranking within SASB main industry classification (*envmr*), environmental ranking within SASB sub-industries classification (*envsr*), social score (*socscore*), social ranking within SASB main industry classification (*socmr*), social ranking within SASB sub-industry classification (*socsr*), governance score (*govscore*), governance ranking within SASB main industry classification (*govmr*), and governance ranking within SASB sub-industry classification (*govsr*). **FCEO** represents a vector of female CEO-related variables, including the female CEO dummy (*fceo*), the female vice CEO dummy (*fvceo*), the dual female leadership dummy indicating both CEO and vice CEO are female (*bfceo*), and the female CEO duality dummy indicating that a female CEO also serves as board chair (*fduality*). The control variables include firm size (*scale*), debt ratio (*debtr*), return on assets (*roa*), asset turnover (*aturn*), institutional shareholdings (*insthold*), dummy of family-controlled (*family*), and the amount of directors' and officers' liability insurance coverage (*doli*). When ESG performance is measured by the ordinal ESG rating (*esgrating*), the model is estimated using an ordered probit specification. When ESG performance is measured by the remaining fourteen continuous ESG-related variables, the model is estimated using pooled ordinary least squares (OLS). A positive and statistically significant estimate of β_1 supports Hypothesis 1A, whereas a negative and statistically significant estimate of β_1 supports Hypothesis 1B.

3.3 Sample and Data Sources

The sample consists of 1,722 non-financial listed firms in the Taiwan Stock Exchange (TWSE) and the Taipei Exchange (TPEX). Financial firms, including banks, bills finance companies, securities firms, insurance firms, and financial holding companies, are excluded due to substantial differences in accounting systems and regulatory environments relative to non-financial firms. The sample period spans from 2016 to 2024 with annual frequency. Data on firm's executive team-member gender identification, financial characteristics, corporate governance

variables, and ESG performance are primarily obtained from the Taiwan Economic Journal database (<https://www.tejwin.com/en/>) and the Market Observation Post System of the Taiwan Stock Exchange (<https://emops.twse.com.tw/server-java/t58query>).

4. Empirical Results

4.1 Descriptive Statistics and Correlation Analysis

Table 2 reports the descriptive statistics, where Panel A presents the full sample of 15,199 firm-year observations for non-financial listed and over-the-counter firms in Taiwan from 2016 to 2024, including means, standard deviations, minimum values, and maximum values. Panel B reports the descriptive statistics for the subsample of firms with female CEOs ($f_{ceo} = 1$), while Panel C reports the corresponding statistics for firms without female CEOs ($f_{ceo} = 0$). The last column presents the differences in means between the two subsamples along with t -test results.

First, focusing on overall ESG performance measures, firms led by female CEOs exhibit superior performance across most ESG-related variables. Specifically, female CEO firms show significantly higher values in the ESG rating ($esgrating$), ESG score ($esgscore$), overall ESG ranking ($esgwr$), ESG rankings within SASB main industry classifications ($esgmr$) and sub-industry classifications ($esgsr$), as well as ESG rankings within TWSE industry classifications ($esgexr$), compared with non-female CEO firms. For example, the average ESG rating for female CEO firms is 4.0171, higher than 3.8884 for non-female CEO firms. The corresponding ESG scores are 55.456 and 54.633, respectively. The average SASB main industry ESG ranking is 58.559 for female CEO firms compared with 55.803 for non-female CEO firms. The differences reported in the last column are all positive and are mostly statistically significant at the 1% level, indicating that firms led by female CEOs generally exhibit superior ESG performance. This evidence is consistent with the Hypothesis 1A, suggesting that female executives may place greater emphasis on stakeholder interests, social responsibility, and long-term sustainability, thereby enhancing firm ESG outcomes.

In the environmental domain, female CEO firms also outperform their counterparts. Specifically, environmental score ($envscore$), environmental ranking within SASB main industries ($envmr$), and environmental ranking within SASB sub-industries ($envsr$) are all significantly higher for female CEO firms. For instance, the average environmental score is 55.920 for female CEO firms, compared with 54.959 for non-female CEO firms. The corresponding values of $envmr$ and $envsr$ are 57.501 and 56.629 for female CEO firms, respectively, both exceeding 54.696 and 53.427 for non-female CEO firms. These differences are statistically significant at the 1% level, indicating that female CEO firms exhibit stronger environmental performance both in absolute terms and after industry adjustment. In the social dimension, the average values of social score ($socscore$), social ranking within SASB main industries ($socmr$), and social ranking within SASB sub-industries ($socsr$) are also significantly higher for female CEO firms than for non-female CEO firms. Most of

these differences are statistically significant at the 5% or 1%, suggesting that female CEO firms perform better in employee relations, social responsibility, supply chain management, and stakeholder engagement. In the governance dimension, female CEO firms also exhibit significantly higher values of governance score (*govscore*), governance ranking within SASB main industries (*govmr*), and governance ranking within SASB sub-industries (*govsr*) relative to non-female CEO firms. This indicates that female CEO firms demonstrate superior performance in board governance, information transparency, and the quality of governance systems.

In addition, the descriptive statistics of the control variables reveal several notable patterns. Firms led by female CEOs exhibit significantly larger firm size (*scale*), indicating that female CEOs are more frequently observed in larger firms. Institutional shareholdings (*insthold*) is also significantly higher, suggesting that institutional investors may have a preference for firms with female leadership or that such firms are more likely to attract institutional support. Moreover, the proportion of family-controlled firms (*family*) is significantly higher among female CEO firms, indicating that female CEOs in Taiwan are more likely to be found in family-owned firms. In contrast, asset turnover (*aturn*) is significantly lower in female CEO firms, suggesting relatively more conservative operational efficiency. Table 3 reports the Pearson correlation coefficients among variables, focusing on the 15 ESG performance measures and the four female CEO-related variables. The lower-triangular correlation matrix reveals a systematic and heterogeneous structure in the associations between female leadership variables and ESG outcomes. First, examining row 16 (*fceo*), most correlations with the 15 ESG variables are positive and statistically significant, indicating that when a firm is led by a female CEO, it tends to exhibit better performance across overall ESG measures as well as across the environmental, social, and governance dimensions. These results support the argument that female CEOs contribute positively to ESG performance and are consistent with the prediction of Hypothesis 1A. Female CEOs, compared with male CEOs, are more likely to adopt long-term oriented and risk-averse strategies in decision-making and to exhibit greater sensitivity to stakeholder concerns. This in turn leads firms to place greater emphasis on environmental protection, social responsibility, and governance quality. Female executives are generally more cautious in information disclosure and internal control systems, which helps reduce information asymmetry and agency problems, thereby increasing market trust and ultimately improving ESG performance.

The correlations in row 17 (*fvceo*) are also predominantly positive and statistically significant, indicating that higher female representation in senior management, even at the vice CEO level, is associated with better ESG performance across both aggregate and component measures. This further supports the positive role of managerial gender diversity in corporate sustainability. Row 18 (*bfceo*) also shows mostly positive and statistically significant correlations with ESG variables, suggesting that firms in which both top executive positions are held by women tend to exhibit superior ESG performance across all dimensions. In contrast, row 19 (*fduality*) shows predominantly negative correlations with most ESG indicators,

many of which are statistically significant at the 10% level, particularly in overall ESG performance and governance-related variables. This suggests that when a female CEO also serves as board chair, the concentration of power may weaken board monitoring functions and adversely affect ESG outcomes.

The above finding is consistent with the corporate governance literature on CEO duality and associated agency problems. From an agency theory perspective, CEO duality may weaken board monitoring functions and concentrate decision-making authority in a single individual, thereby reducing governance checks and balances. Even if female CEOs are generally associated with stronger ESG orientation, the simultaneous concentration of managerial and board control may weaken independent oversight of management, thereby undermining ESG implementation. In addition, power concentration may induce overconfidence or decision biases, preventing the effective realization of governance advantages and potentially reversing the expected positive ESG effects. To sum up, the correlation analysis result in Table 3 indicates a positive association between female leadership and firm ESG performance, while overly concentrated governance structures are associated with weaker ESG outcomes.

Table 2: Summary Statistics

Variable	Panel A. Full Sample					Panel B. Subsample of firms with female CEO (<i>fceo</i> =1)					Panel C. Subsample of firms without female CEO (<i>fceo</i> =0)					Panel D. Difference in Means
	# of obs.	Mean	St. Dev.	Min.	Max.	# of obs.	Mean	St. Dev.	Min.	Max.	# of obs.	Mean	St. Dev.	Min.	Max.	
<i>esgrating</i>	14,494	3.8997	1.5131	1.0000	7.0000	1,289	4.0171	1.5677	1.0000	7.0000	13,202	3.8884	1.5073	1.0000	7.0000	0.1287***
<i>esgscore</i>	14,494	54.706	8.3539	28.890	83.730	1,289	55.456	8.8549	30.170	83.730	13,202	54.633	8.3003	28.890	83.730	0.8230***
<i>esgwr</i>	14,494	56.179	28.349	0.0000	99.959	1,289	58.399	28.793	0.0000	99.958	13,202	55.966	28.297	0.0000	99.959	2.4335***
<i>esgmr</i>	14,494	56.045	28.146	0.0000	99.885	1,289	58.559	28.932	0.0000	99.874	13,202	55.803	28.058	0.0000	99.885	2.7555***
<i>esgsr</i>	14,494	54.563	28.274	0.0000	99.762	1,289	57.036	29.027	0.0000	99.270	13,202	54.325	28.189	0.0000	99.762	2.7117***
<i>esgexr</i>	14,494	54.770	28.384	0.0000	99.609	1,289	57.627	29.047	0.0000	99.609	13,202	54.495	28.305	0.0000	99.583	3.1319***
<i>envscore</i>	14,494	55.042	12.161	23.320	92.160	1,289	55.920	12.091	26.340	90.780	13,202	54.959	12.1650	23.320	92.160	0.9617***
<i>envmr</i>	14,494	54.939	28.014	0.0000	99.885	1,289	57.501	27.712	0.0000	99.718	13,202	54.696	28.031	0.0000	99.885	2.8055***
<i>envsr</i>	14,494	53.706	27.722	0.0000	99.762	1,289	56.629	27.615	0.0000	99.301	13,202	53.427	27.717	0.0000	99.762	3.2015***
<i>socscore</i>	14,494	54.969	10.925	26.020	91.000	1,289	55.714	11.522	26.970	88.250	13,202	54.897	10.864	26.020	91.000	0.8172**
<i>socmr</i>	14,494	55.386	28.422	0.0000	99.885	1,289	57.143	28.989	0.0000	99.874	13,202	55.216	28.364	0.0000	99.885	1.9270**
<i>socsr</i>	14,494	54.034	28.526	0.0000	99.762	1,289	55.445	28.970	0.0000	99.277	13,202	53.899	28.482	0.0000	99.762	1.5454*
<i>govscore</i>	14,494	54.303	10.501	19.650	84.410	1,289	54.984	11.124	22.720	80.740	13,202	54.237	10.437	19.650	84.410	0.7467**
<i>govmr</i>	14,494	53.335	28.828	0.0000	99.885	1,289	55.285	30.059	0.0000	99.878	13,202	53.146	28.700	0.0000	99.885	2.1385**
<i>govsr</i>	14,494	52.036	28.887	0.0000	99.759	1,289	53.561	30.044	0.0000	99.759	13,202	51.889	28.769	0.0000	99.759	1.6723*
<i>fceo</i>	15,199	0.0864	0.2809	0.0000	1.0000	1,313	1.0000	0.0000	1.0000	1.0000	13,886	0.0000	0.0000	0.0000	0.0000	1.0000
<i>fvceo</i>	15,199	0.2487	0.4323	0.0000	1.0000	1,313	0.3313	0.4709	0.0000	1.0000	13,886	0.2409	0.4276	0.0000	1.0000	0.0904***
<i>bfceo</i>	15,199	0.0286	0.1667	0.0000	1.0000	1,313	0.3313	0.4709	0.0000	1.0000	13,886	0.0000	0.0000	0.0000	0.0000	0.3313***
<i>fduality</i>	15,199	0.0223	0.1477	0.0000	1.0000	1,313	0.2582	0.4378	0.0000	1.0000	13,886	0.0000	0.0000	0.0000	0.0000	0.2582***
<i>scale</i>	15,199	22.122	1.4598	16.664	29.429	1,313	22.187	1.4113	18.314	26.953	13,886	22.115	1.4642	16.664	29.429	0.0718*
<i>debtr</i>	15,199	36.461	17.292	8.6390	68.972	1,313	36.288	18.129	8.6390	68.972	13,886	36.477	17.212	8.6390	68.972	-0.1893
<i>roa</i>	15,068	4.5785	10.705	-121.87	98.540	1,313	4.1477	10.727	-60.230	64.870	13,755	4.6196	10.702	-121.87	98.540	-0.4718
<i>aturn</i>	15,068	0.5921	0.4068	0.0400	1.5500	1,313	0.5423	0.4228	0.0400	1.5500	13,755	0.5969	0.4049	0.0400	1.5500	-0.0546***
<i>insthold</i>	14,614	42.171	21.407	7.7330	80.297	1,307	46.422	20.970	7.7330	80.297	13,306	41.755	21.405	7.7330	80.297	4.6666***
<i>family</i>	14,676	0.6293	0.4830	0.0000	1.0000	1,313	0.6702	0.4703	0.0000	1.0000	13,361	0.6253	0.4841	0.0000	1.0000	0.0450***
<i>doli</i>	13,859	17.562	4.4067	0.0000	23.065	1,257	17.632	4.1085	0.0000	21.633	12,601	17.555	4.4356	0.0000	23.065	0.0779

Note: This table reports the Pearson correlation coefficient matrix among the variables. An asterisk indicates statistical significance at the 10% level.

Definitions of all variables are provided in Table 1.

Table 3: Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) <i>esgrating</i>	1.0000																		
(2) <i>esgscore</i>	0.9671*	1.0000																	
(3) <i>esgwr</i>	0.9672*	0.9618*	1.0000																
(4) <i>esgmr</i>	0.9608*	0.9562*	0.9931*	1.0000															
(5) <i>esgsr</i>	0.9160*	0.9112*	0.9471*	0.9535*	1.0000														
(6) <i>esgexr</i>	0.9310*	0.9272*	0.9611*	0.9626*	0.9358*	1.0000													
(7) <i>envscore</i>	0.7137*	0.7546*	0.6989*	0.6897*	0.6657*	0.6767*	1.0000												
(8) <i>envmr</i>	0.6886*	0.7050*	0.6911*	0.6840*	0.6596*	0.6713*	0.9362*	1.0000											
(9) <i>envsr</i>	0.6638*	0.6787*	0.6658*	0.6603*	0.6867*	0.6538*	0.9012*	0.9584*	1.0000										
(10) <i>socscore</i>	0.7626*	0.7907*	0.7507*	0.7441*	0.6947*	0.7135*	0.5191*	0.4815*	0.4588*	1.0000									
(11) <i>socmr</i>	0.7426*	0.7516*	0.7526*	0.7538*	0.7065*	0.7173*	0.4808*	0.4650*	0.4481*	0.9547*	1.0000								
(12) <i>socsr</i>	0.7041*	0.7125*	0.7131*	0.7145*	0.7447*	0.6957*	0.4713*	0.4571*	0.4777*	0.8937*	0.9395*	1.0000							
(13) <i>govscore</i>	0.6949*	0.7027*	0.7071*	0.7095*	0.6827*	0.6899*	0.2833*	0.2687*	0.2611*	0.2618*	0.2461*	0.2322*	1.0000						
(14) <i>govmr</i>	0.6877*	0.6904*	0.7065*	0.7105*	0.6845*	0.6901*	0.2845*	0.2689*	0.2623*	0.2604*	0.2443*	0.2309*	0.9754*	1.0000					
(15) <i>govsr</i>	0.6614*	0.6637*	0.6807*	0.6847*	0.7065*	0.6736*	0.2789*	0.2637*	0.2803*	0.2419*	0.2287*	0.2499*	0.9392*	0.9628*	1.0000				
(16) <i>fceo</i>	0.0242*	0.0280*	0.0244*	0.0279*	0.0273*	0.0314*	0.0225*	0.0285*	0.0329*	0.0213*	0.0193*	0.0154*	0.0202*	0.0211*	0.0165*	1.0000			
(17) <i>fvceo</i>	0.1353*	0.1418*	0.1363*	0.1370*	0.1199*	0.1434*	0.1248*	0.1058*	0.0998*	0.1263*	0.1226*	0.1036*	0.0754*	0.0739*	0.0638*	0.0588*	1.0000		
(18) <i>bfceo</i>	0.0616*	0.0675*	0.0573*	0.0601*	0.0570*	0.0687*	0.0479*	0.0488*	0.0515*	0.0688*	0.0590*	0.0530*	0.0344*	0.0337*	0.0336*	0.5582*	0.2983*	1.0000	
(19) <i>fduality</i>	-0.0480*	-0.0452*	-0.0500*	-0.0490*	-0.0518*	-0.0446*	-0.0013	0.0040	-0.0029	-0.0152*	-0.0198*	-0.0247*	-0.0807*	-0.0775*	-0.0797*	0.4912*	0.0265*	0.2680*	1.0000

Note: This table reports the Pearson correlation coefficient matrix among the variables. An asterisk indicates statistical significance at the 10% level. Definitions of all variables are provided in Table 1.

4.2 Baseline Regression Results

To further examine the effect of female senior executives on firm ESG performance, this study employs multivariate regression models while controlling for variables documented in the prior literature that may influence ESG outcomes. To mitigate potential multicollinearity concerns, four female CEO-related variables are separately included across Model (1) to (4). The specification includes control variables such as firm size (*scale*), debt ratio (*debtr*), return on assets (*roa*), asset turnover (*aturn*), institutional shareholdings (*insthold*), dummy for family-controlled (*family*), and directors' and officers' liability insurance coverage (*doli*). Table 4 reports the regression results on the relation between female leadership and firm ESG performance. Across specifications, the main explanatory variables consistently show that when ESG is measured by either the ESG rating (*esgrating*) in Panel A or the ESG score (*esgscore*) in Panel B, the coefficients on female CEO (*fceo*), female vice CEO (*fvceo*), and dual female top leadership (*bfceo*) are all positive and statistically significant at the 1% level. For instance, in Panel A, the estimated coefficients for Models (1) to (3) are 0.120, 0.155, and 0.237 respectively. In Panel B, the corresponding coefficients are 0.969, 1.140, and 1.866. These results indicate that higher female representation in top management is associated with superior overall ESG performance.

In contrast, Model (4) shows that the coefficient on female CEO duality (*fduality*), defined as a female CEO concurrently serving as board chair, is significantly negative. The estimated coefficients are -0.288 in Panel A and -1.775 in Panel B. This suggests that when decision-making power is concentrated in a single individual, firm ESG performance deteriorates. This finding is consistent with corporate governance theory regarding CEO duality and the weakening of board monitoring functions. Female CEOs are generally more risk-averse and stakeholder-oriented, and therefore tend to promote long-term sustainability strategies while enhancing disclosure quality and governance transparency, which improves ESG outcomes. However, when the CEO simultaneously serves as board chair, excessive concentration of authority may weaken board independence, exacerbate agency problems, and introduce decision-making bias, thereby offsetting the potential governance benefits.

Regarding control variables, the regression results are broadly consistent with the prior literature. Firm size (*scale*), return on assets (*roa*), asset turnover (*aturn*), institutional shareholdings (*insthold*), and directors' and officers' liability insurance coverage (*doli*) are mostly positive and statistically significant. This suggests that larger firms, more profitable and operationally efficient firms, firms with stronger external monitoring, and firms with stronger legal risk protection mechanisms tend to exhibit better ESG performance. In contrast, debt ratio (*debtr*) and family-controlled firms (*family*) are significantly negatively associated with ESG performance, indicating that highly leveraged firms or firms with more concentrated governance structures tend to perform worse in ESG outcomes. The empirical results in Table 4 indicate that female senior executives have a positive impact on firm sustainability performance. They also highlight the importance of an

appropriate governance structure, particularly the avoidance of excessive power concentration, in enabling the realization of these benefits.

To consider ESG rating standards and disclosure environments may differ substantially across industries, this study re-estimates the regression using industry-adjusted overall ESG performance measures as dependent variables. Specifically, ESG performance is measured by the firm's ranking within the full sample of rated firms in a given year (*esgwr*) and by its ranking within the Taiwan Stock Exchange industry classification (*esgexr*). Table 5 reports the empirical results. Regardless of whether ESG performance is measured using the overall industry ranking (Panel A) or the TWSE industry-adjusted ranking (Panel B), the coefficients on female CEO (*fceo*), female vice CEO (*fvceo*), and dual female top leadership (*bfceo*) remain positive and statistically significant at the 1% level, indicating that higher female participation in top management is associated with significantly better ESG performance. The positive effect of female executives on ESG performance is not driven by industry-specific sustainability advantages but instead reflects managerial style and leadership characteristics. In contrast, Model (4) in both panels shows that the coefficient on female CEO duality (*fduality*) remains significantly negative, showing that the concentration of decision-making power in a single individual continues to weaken firm ESG performance. This result again supports corporate governance theory suggesting that the separation of CEO and board chair roles enhances monitoring effectiveness. The governance advantages associated with female leadership, including risk aversion and stakeholder orientation, may be undermined when excessive power concentration exists.

In contrast to the TWSE industry classification, which is primarily based on operational characteristics and sector affiliation, SASB classification is grounded in financial materiality and emphasizes the key sustainability risks and disclosure priorities specific to each industry. Using SASB-based within-industry rankings (*esgmr* and *esgsr*) allows for a more precise assessment of a firm's relative ESG performance under industry-specific sustainability constraints, thereby reducing measurement error arising from heterogeneous ESG relevance across industries. The empirical results in Table 6 show that regardless of whether ESG performance is measured using SASB main industry-level rankings (Panel A) or SASB sub-industry-level rankings (Panel B), the coefficients on the main explanatory variables including female CEO (*fceo*), female vice CEO (*fvceo*), and dual female top leadership (*bfceo*) remain positive and statistically significant at the 1% level, that the positive effect of female leadership on ESG outcomes is robust across industry classification frameworks and is not confined to specific sectors or classification schemes. Consistent with prior findings, Model (4) in both panels of Table 6 shows that the coefficient on female CEO duality (*fduality*) remains significantly negative, showing that even under the SASB classification structure, excessive concentration of power continues to undermine firm ESG performance.

This study further examines whether the impact of female senior executives on firm overall ESG performance is driven primarily by specific ESG dimensions. Accordingly, environmental performance is used as the dependent variable,

including both the original environmental score and industry-adjusted environmental measures based on SASB classification. Table 7 reports the results. Across three different specifications, including the unadjusted environmental score (Panel A) and SASB subindustry-adjusted environmental rankings (Panels B and C), the coefficients on female CEO (*fceo*), female vice CEO (*fvceo*), and dual female top leadership (*bfceo*) are consistently positive and mostly significant at the 1% level, indicating that higher female participation in top management is consistently associated with better environmental performance, and the relationship remains robust even after industry adjustment.

A particularly noteworthy finding is that the coefficient on female CEO duality (*fduality*) remains positive across all three panels, and becomes statistically significant at the 10% level in Panel B with a coefficient of 2.365. This result contrasts sharply with the previously documented significantly negative effect on overall ESG performance, suggesting that even under conditions of concentrated power, female leaders continue to actively promote environmental policies and investments. This outcome highlights that female CEOs tend to place relatively greater emphasis on environmental issues. Environmental investments typically involve high upfront costs and long-term payoffs, such as the adoption of carbon reduction technologies, pollution control infrastructure, and green supply chain management. These decisions therefore require strong long-term orientation and risk awareness at the managerial level. Female senior executives are generally characterized as more risk-averse and more stakeholder-oriented, which makes them more likely to support such environmental investments. Even when CEO duality potentially weakens monitoring mechanisms, female CEOs still exhibit a positive impact on environmental performance, indicating that their intrinsic preference for environmental responsibility may outweigh the adverse effects associated with governance concentration.

This study next re-examines firm performance in the social dimension as the dependent variable, incorporating both the original social score and industry-adjusted social performance measures based on the SASB industry classification. Table 8 reports the results. Across three different specifications, including the unadjusted social score (Panel A) and SASB industry-ranked social performance measures (Panels B and C), the most of main explanatory variables consistently exhibit a positive and statistically significant relationship. This indicates that higher female participation in top management is associated with significantly better social performance, including employee relations, customer protection, supply chain responsibility, and community engagement, and that this relationship remains robust after industry adjustment. In contrast, the coefficient on female CEO duality (*fduality*) is generally negative across the three panels yet remains statistically insignificant.

The above result differs from the significantly negative effect observed in overall ESG performance. Although power concentration may weaken board monitoring functions, in the social dimension the stakeholder orientation and social responsibility awareness of female CEOs are sufficient to offset, or even dominate,

the potential adverse effects of imperfect governance structures. The emphasis placed by female CEOs on social performance enables firms to maintain stable outcomes in the social dimension even under CEO duality. Social performance is closely related to key intangible assets such as human capital management, corporate reputation, customer relationships, and supply chain stability. Strong social performance helps reduce labor disputes, enhance employee productivity, strengthen brand loyalty, and mitigate potential litigation and regulatory risks arising from product liability or social controversies. Female senior executives are generally more attentive to communication, fairness, and long-term relationship building, and are therefore more likely to allocate resources to employee welfare, workplace diversity and inclusion, consumer protection, and corporate social responsibility initiatives.

Finally, this study uses corporate governance performance as the dependent variable and similarly incorporates both the raw governance score and the SASB industry-ranked governance measures as indicators of governance performance. The empirical results in Table 9 show that across three different specifications of governance performance, including the unadjusted governance score and SASB industry-adjusted governance rankings, the coefficients on the main explanatory variables including female CEO (*fceo*), female vice CEO (*fvceo*), and dual female top leadership (*bfceo*) are all positive and statistically significant. This indicates that higher female participation in top management is associated with significantly better corporate governance performance, and that this relationship remains robust after industry adjustment. In sharp contrast to the environmental and social dimensions, the coefficient on female CEO duality (*fduality*) is significantly negative across all three panels, suggesting that power concentration substantially weakens governance performance. This finding reflects that governance rating systems impose a strong penalty on CEO duality because it directly concerns board independence and monitoring effectiveness. Corporate governance fundamentally emphasizes checks and balances and institutional design. As the CEO simultaneously serves as board chair, agency conflicts and managerial moral hazard are amplified. Even if female leaders exhibit stronger risk awareness and stakeholder orientation, such intrinsic traits cannot fully offset the structural deficiencies arising from weakened governance mechanisms.

The overall empirical evidence indicates that female senior executives have a consistent and robust positive impact on firm sustainability performance. Whether using raw ESG scores or industry-adjusted rankings based on the TWSE classification and the SASB framework, female CEOs, female vice CEOs, and dual female top leadership are all associated with significantly higher overall ESG performance, and this effect is consistently observed across environmental, social, and governance dimensions. However, the study also finds that when a female CEO simultaneously serves as board chair, firm ESG performance is adversely affected, and this negative effect is primarily driven by a significant decline in governance performance. Since governance ratings heavily rely on board independence and power balance mechanisms, CEO duality is typically treated as a major governance

deficiency and is strongly penalized. In contrast, in the environmental dimension, even under power concentration, female CEOs tend to promote long-term and strategically oriented environmental investments, resulting in sustained or even improved performance. In the social dimension, their stakeholder orientation and human-centered leadership prevent performance deterioration despite governance weaknesses. The intrinsic preferences of female leaders toward environmental and social concerns may partially offset the adverse effects of imperfect governance structures, but they are insufficient to fully compensate for deficiencies in the structurally driven corporate governance dimension.

Table 4: Regression Results for the Effects of Female CEO on Overall ESG Performance (esgrating v.s esgscore)

Explanatory Variables	Panel A. Explained variable: <i>esgrating</i>				Panel B. Explained variable: <i>esgscore</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	0.120*** (3.90)				0.969*** (4.60)			
<i>fvceo</i>		0.155*** (7.60)				1.140*** (8.22)		
<i>bfceo</i>			0.237*** (4.59)				1.866*** (5.31)	
<i>fduality</i>				-0.288*** (-4.90)				-1.775*** (-4.44)
<i>scale</i>	0.396*** (51.14)	0.389*** (49.95)	0.395*** (50.91)	0.395*** (50.96)	2.871*** (57.76)	2.811*** (56.17)	2.855*** (57.44)	2.860*** (57.52)
<i>debttr</i>	-0.00701*** (-12.42)	-0.00718*** (-12.72)	-0.00701*** (-12.43)	-0.00696*** (-12.33)	-0.0506*** (-13.17)	-0.0518*** (-13.49)	-0.0506*** (-13.17)	-0.0502*** (-13.08)
<i>roa</i>	0.00210** (2.24)	0.00211** (2.25)	0.00215** (2.30)	0.00211** (2.25)	0.0165*** (2.58)	0.0166*** (2.60)	0.0169*** (2.65)	0.0165*** (2.59)
<i>aturn</i>	0.420*** (17.23)	0.411*** (16.87)	0.419*** (17.18)	0.413*** (16.93)	2.784*** (16.84)	2.710*** (16.42)	2.772*** (16.78)	2.731*** (16.52)
<i>insthold</i>	0.000796* (1.75)	0.00104** (2.29)	0.000823* (1.81)	0.000957** (2.11)	0.00573* (1.84)	0.00758** (2.45)	0.00594* (1.91)	0.00696** (2.24)
<i>family</i>	-0.232*** (-12.49)	-0.229*** (-12.33)	-0.228*** (-12.31)	-0.228*** (-12.29)	-1.575*** (-12.44)	-1.547*** (-12.24)	-1.547*** (-12.23)	-1.548*** (-12.23)
<i>doli</i>	0.0172*** (8.44)	0.0168*** (8.22)	0.0173*** (8.48)	0.0175*** (8.55)	0.112*** (8.00)	0.108*** (7.76)	0.112*** (8.05)	0.113*** (8.11)
constant					-10.03*** (-9.68)	-8.870*** (-8.52)	-9.697*** (-9.36)	-9.734*** (-9.39)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R^2					0.285	0.288	0.286	0.285
pseudo R^2	0.085	0.086	0.085	0.085				
Model Sig. (p -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on overall ESG performance, measured by ESG ratings (*esgrating*) (Panel A) and ESG score (*esgscore*) (Panel B), respectively. Models (1)~(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debttr*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t -statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5: Regression Results for the Effects of Female CEO on Overall ESG Performance (*esgwr* v.s *esgexr*)

Explanatory Variables	Panel A. Explained variable: <i>esgwr</i>				Panel B. Explained variable: <i>esgexr</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	2.873*** (3.94)				3.533*** (4.73)			
<i>fvceo</i>		3.865*** (8.05)				4.627*** (9.41)		
<i>bfceo</i>			5.059*** (4.15)				7.248*** (5.81)	
<i>fduality</i>				-7.092*** (-5.12)				-6.241*** (-4.40)
<i>scale</i>	9.018*** (52.38)	8.818*** (50.87)	8.976*** (52.11)	8.979*** (52.17)	8.373*** (47.49)	8.133*** (45.84)	8.315*** (47.16)	8.333*** (47.25)
<i>debt</i>	-0.174*** (-13.08)	-0.178*** (-13.40)	-0.174*** (-13.07)	-0.173*** (-12.99)	-0.129*** (-9.45)	-0.134*** (-9.83)	-0.129*** (-9.45)	-0.128*** (-9.36)
<i>roa</i>	0.0662*** (3.00)	0.0666*** (3.02)	0.0674*** (3.05)	0.0667*** (3.02)	0.0717*** (3.17)	0.0721*** (3.19)	0.0735*** (3.25)	0.0718*** (3.17)
<i>aturn</i>	9.675*** (16.90)	9.437*** (16.51)	9.636*** (16.84)	9.490*** (16.58)	8.464*** (14.44)	8.177*** (13.98)	8.423*** (14.38)	8.277*** (14.11)
<i>insthold</i>	0.000107 (0.01)	0.00595 (0.55)	0.000944 (0.09)	0.00400 (0.37)	-0.00310 (-0.28)	0.00399 (0.36)	-0.00250 (-0.23)	0.00136 (0.12)
<i>family</i>	-4.549*** (-10.37)	-4.458*** (-10.19)	-4.469*** (-10.19)	-4.456*** (-10.17)	-4.452*** (-9.91)	-4.342*** (-9.69)	-4.346*** (-9.68)	-4.355*** (-9.70)
<i>doli</i>	0.439*** (9.08)	0.427*** (8.85)	0.441*** (9.12)	0.445*** (9.20)	0.404*** (8.17)	0.390*** (7.89)	0.407*** (8.22)	0.410*** (8.27)
constant	-148.2*** (-41.26)	-144.3*** (-39.99)	-147.2*** (-40.99)	-147.1*** (-40.99)	-135.6*** (-36.86)	-130.9*** (-35.45)	-134.3*** (-36.53)	-134.5*** (-36.57)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R^2	0.248	0.251	0.248	0.249	0.214	0.218	0.215	0.214
Model Sig. (p -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on overall ESG performance, measured by the ranking ESG score in whole evaluated firm for a given year (*esgwr*) (Panel A) and the ranking ESG score in TWSE industry classification (*esgexr*), respectively. Models (1)~(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debt*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t -statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Regression Results for the Effects of Female CEO on Overall ESG Performance (*esgmr* v.s *esgsr*)

Explanatory Variables	Panel A. Explained variable: <i>esgmr</i>				Panel B. Explained variable: <i>esgsr</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	3.217*** (4.42)				3.260*** (4.36)			
<i>fvceo</i>		3.998*** (8.34)				3.307*** (6.71)		
<i>bfceo</i>			5.558*** (4.57)				5.478*** (4.38)	
<i>fduality</i>				-6.792*** (-4.92)				-7.464*** (-5.26)
<i>scale</i>	8.770*** (51.05)	8.562*** (49.51)	8.723*** (50.76)	8.730*** (50.82)	8.169*** (46.26)	7.993*** (44.93)	8.122*** (45.98)	8.126*** (46.04)
<i>debt</i>	-0.177*** (-13.35)	-0.181*** (-13.68)	-0.177*** (-13.34)	-0.176*** (-13.25)	-0.182*** (-13.32)	-0.185*** (-13.57)	-0.182*** (-13.31)	-0.180*** (-13.22)
<i>roa</i>	0.0677*** (3.07)	0.0680*** (3.09)	0.0690*** (3.13)	0.0680*** (3.08)	0.0465** (2.05)	0.0466** (2.06)	0.0477** (2.10)	0.0469** (2.07)
<i>aturn</i>	9.705*** (16.99)	9.453*** (16.58)	9.661*** (16.92)	9.516*** (16.66)	8.744*** (14.89)	8.520*** (14.52)	8.698*** (14.82)	8.543*** (14.55)
<i>insthold</i>	-0.000213 (-0.02)	0.00609 (0.57)	0.000769 (0.07)	0.00399 (0.37)	-0.00219 (-0.20)	0.00364 (0.33)	-0.00113 (-0.10)	0.00215 (0.20)
<i>family</i>	-4.528*** (-10.35)	-4.430*** (-10.15)	-4.440*** (-10.15)	-4.433*** (-10.13)	-5.011*** (-11.14)	-4.921*** (-10.96)	-4.922*** (-10.95)	-4.910*** (-10.92)
<i>doli</i>	0.445*** (9.23)	0.433*** (8.98)	0.447*** (9.27)	0.450*** (9.34)	0.424*** (8.56)	0.414*** (8.36)	0.426*** (8.60)	0.430*** (8.67)
constant	-142.8*** (-39.86)	-138.8*** (-38.55)	-141.8*** (-39.57)	-141.8*** (-39.57)	-129.4*** (-35.14)	-126.0*** (-34.02)	-128.4*** (-34.85)	-128.3*** (-34.85)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R^2	0.241	0.244	0.241	0.241	0.207	0.208	0.207	0.207
Model Sig. (p -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on overall ESG performance, measured by the ranking ESG score in SASB main industry classification (*esgmr*) (Panel A) and the ranking ESG score in SASB sub-industry classification (*esgsr*), respectively. Models (1)–(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debt*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t -statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7: Regression Results for the Effects of Female CEO on Environmental Performance

Explanatory Variables	Panel A. Explained variable: <i>envscore</i>				Panel B. Explained variable: <i>envmr</i>				Panel C. Explained variable: <i>envsr</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	1.054*** (3.27)				3.095*** (4.10)				3.410*** (4.48)			
<i>fvceo</i>		1.425*** (6.70)				2.435*** (4.89)				2.450*** (4.87)		
<i>bfceo</i>			1.510*** (2.80)				4.196*** (3.32)				4.872*** (3.83)	
<i>fduality</i>				0.603 (0.98)				2.365* (1.65)				0.862 (0.60)
<i>scale</i>	4.038*** (53.01)	3.964*** (51.67)	4.024*** (52.80)	4.034*** (52.94)	8.645*** (48.49)	8.512*** (47.35)	8.605*** (48.23)	8.636*** (48.41)	7.703*** (42.81)	7.567*** (41.71)	7.658*** (42.54)	7.687*** (42.69)
<i>debttr</i>	-0.0593*** (-10.08)	-0.0608*** (-10.34)	-0.0593*** (-10.07)	-0.0593*** (-10.07)	-0.130*** (-9.46)	-0.133*** (-9.63)	-0.130*** (-9.45)	-0.130*** (-9.46)	-0.128*** (-9.19)	-0.130*** (-9.36)	-0.128*** (-9.18)	-0.128*** (-9.16)
<i>roa</i>	-0.0136 (-1.39)	-0.0134 (-1.37)	-0.0133 (-1.35)	-0.0139 (-1.42)	-0.0123 (-0.54)	-0.0124 (-0.54)	-0.0115 (-0.50)	-0.0134 (-0.59)	0.00728 (0.31)	0.00714 (0.31)	0.00825 (0.36)	0.00633 (0.27)
<i>aturn</i>	3.284*** (12.97)	3.197*** (12.64)	3.268*** (12.91)	3.268*** (12.90)	7.234*** (12.20)	7.052*** (11.90)	7.184*** (12.12)	7.195*** (12.13)	6.047*** (10.11)	5.857*** (9.79)	5.994*** (10.02)	5.977*** (9.98)
<i>insthold</i>	-0.0127*** (-2.67)	-0.0106** (-2.22)	-0.0123** (-2.58)	-0.0117** (-2.46)	-0.0570*** (-5.11)	-0.0520*** (-4.67)	-0.0556*** (-4.99)	-0.0541*** (-4.86)	-0.0401*** (-3.56)	-0.0347*** (-3.09)	-0.0386*** (-3.44)	-0.0367*** (-3.27)
<i>family</i>	-0.585*** (-3.02)	-0.551*** (-2.85)	-0.558*** (-2.88)	-0.573*** (-2.95)	-1.087** (-2.39)	-1.010** (-2.22)	-1.010** (-2.22)	-1.055** (-2.32)	-1.487*** (-3.25)	-1.405*** (-3.07)	-1.400*** (-3.06)	-1.441*** (-3.14)
<i>doli</i>	0.108*** (5.06)	0.104*** (4.85)	0.109*** (5.09)	0.108*** (5.06)	0.261*** (5.21)	0.254*** (5.07)	0.262*** (5.24)	0.261*** (5.20)	0.241*** (4.78)	0.235*** (4.64)	0.243*** (4.82)	0.242*** (4.80)
constant	-35.24*** (-22.18)	-33.81*** (-21.17)	-34.92*** (-21.98)	-35.12*** (-22.10)	-137.8*** (-37.05)	-135.1*** (-36.12)	-136.9*** (-36.80)	-137.5*** (-36.95)	-117.7*** (-31.38)	-115.0*** (-30.46)	-116.7*** (-31.10)	-117.3*** (-31.23)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R^2	0.218	0.220	0.218	0.218	0.186	0.187	0.186	0.185	0.155	0.155	0.154	0.154
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on environmental performance, measured by environmental score (*envscore*), ranking environmental score in SASB main industry classification (*envmr*) (Panel B), and the ranking environmental score in SASB sub-industry classification (*envsr*) (Panel C), respectively. Models (1)–(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debttr*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Regression Results for the Effects of Female CEO on Social Performance

Explanatory Variables	Panel A. Explained variable: <i>socscore</i>				Panel B. Explained variable: <i>socmr</i>				Panel C. Explained variable: <i>socsr</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	0.953***				2.444***				2.119***			
	(3.43)				(3.29)				(2.79)			
<i>fvceo</i>		1.162***				3.254***				2.378***		
		(6.34)				(6.65)				(4.74)		
<i>bfceo</i>			2.645***				5.814***				5.075***	
			(5.70)				(4.69)				(3.99)	
<i>fduality</i>				-0.170				-1.210				-2.242
				(-0.32)				(-0.86)				(-1.55)
<i>scale</i>	3.912***	3.852***	3.893***	3.906***	9.199***	9.031***	9.155***	9.182***	8.727***	8.602***	8.688***	8.708***
	(59.60)	(58.24)	(59.33)	(59.49)	(52.45)	(51.12)	(52.20)	(52.33)	(48.59)	(47.51)	(48.37)	(48.47)
<i>debtr</i>	-0.0599***	-0.0611***	-0.0599***	-0.0597***	-0.152***	-0.156***	-0.153***	-0.152***	-0.167***	-0.169***	-0.167***	-0.166***
	(-11.80)	(-12.04)	(-11.82)	(-11.77)	(-11.25)	(-11.51)	(-11.26)	(-11.22)	(-12.01)	(-12.19)	(-12.02)	(-11.97)
<i>roa</i>	-0.0168**	-0.0167**	-0.0160*	-0.0170**	0.000583	0.000893	0.00213	0.000193	-0.0267	-0.0266	-0.0254	-0.0269
	(-1.99)	(-1.98)	(-1.90)	(-2.01)	(0.03)	(0.04)	(0.09)	(0.01)	(-1.16)	(-1.15)	(-1.10)	(-1.16)
<i>aturn</i>	2.837***	2.764***	2.831***	2.811***	7.922***	7.722***	7.899***	7.843***	6.575***	6.420***	6.555***	6.487***
	(13.00)	(12.67)	(12.98)	(12.87)	(13.59)	(13.25)	(13.56)	(13.44)	(11.01)	(10.75)	(10.98)	(10.86)
<i>insthold</i>	0.00537	0.00722*	0.00524	0.00637	-0.00910	-0.00415	-0.00902	-0.00642	-0.0174	-0.0134	-0.0173	-0.0149
	(1.31)	(1.76)	(1.28)	(1.56)	(-0.83)	(-0.38)	(-0.82)	(-0.59)	(-1.55)	(-1.20)	(-1.55)	(-1.33)
<i>family</i>	-0.900***	-0.871***	-0.867***	-0.884***	-2.386***	-2.309***	-2.308***	-2.341***	-3.332***	-3.270***	-3.263***	-3.284***
	(-5.39)	(-5.22)	(-5.19)	(-5.29)	(-5.34)	(-5.18)	(-5.17)	(-5.24)	(-7.28)	(-7.16)	(-7.14)	(-7.18)
<i>doli</i>	0.113***	0.109***	0.113***	0.113***	0.313***	0.303***	0.315***	0.315***	0.276***	0.269***	0.277***	0.278***
	(6.12)	(5.93)	(6.16)	(6.14)	(6.36)	(6.16)	(6.40)	(6.39)	(5.47)	(5.33)	(5.50)	(5.52)
constant	-32.89***	-31.71***	-32.48***	-32.72***	-151.4***	-148.1***	-150.4***	-150.9***	-139.2***	-136.8***	-138.4***	-138.7***
	(-24.03)	(-23.04)	(-23.74)	(-23.89)	(-41.38)	(-40.28)	(-41.14)	(-41.23)	(-37.17)	(-36.30)	(-36.96)	(-37.02)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R^2	0.271	0.272	0.272	0.270	0.226	0.228	0.226	0.225	0.195	0.196	0.196	0.195
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on social performance, measured by social score (*socscore*), ranking social score in SASB main industry classification (*socmr*) (Panel B), and the ranking social score in SASB sub-industry classification (*socsr*) (Panel C), respectively. Models (1)–(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debtr*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9: Regression Results for the Effects of Female CEO on Corporate Governance Performance

Explanatory Variables	Panel A. Explained variable: <i>govscore</i>				Panel B. Explained variable: <i>govmr</i>				Panel C. Explained variable: <i>govsr</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	0.868*** (2.89)				2.438*** (2.95)				2.163*** (2.60)			
<i>fvceo</i>		0.905*** (4.57)				2.454*** (4.50)				1.996*** (3.63)		
<i>bfceo</i>			1.179** (2.35)				3.231** (2.34)				3.563** (2.56)	
<i>fduality</i>				-5.061*** (-8.90)				-13.42*** (-8.57)				-13.74*** (-8.71)
<i>scale</i>	1.238*** (17.47)	1.190*** (16.66)	1.227*** (17.31)	1.217*** (17.21)	3.273*** (16.77)	3.143*** (15.97)	3.243*** (16.60)	3.216*** (16.51)	3.102*** (15.78)	2.995*** (15.11)	3.071*** (15.62)	3.045*** (15.53)
<i>debt</i>	-0.0367*** (-6.70)	-0.0376*** (-6.86)	-0.0366*** (-6.69)	-0.0359*** (-6.57)	-0.0993*** (-6.58)	-0.102*** (-6.75)	-0.0992*** (-6.58)	-0.0972*** (-6.46)	-0.117*** (-7.71)	-0.119*** (-7.84)	-0.117*** (-7.71)	-0.115*** (-7.59)
<i>roa</i>	0.0549*** (6.03)	0.0549*** (6.03)	0.0551*** (6.05)	0.0555*** (6.11)	0.136*** (5.41)	0.136*** (5.41)	0.136*** (5.43)	0.137*** (5.48)	0.116*** (4.59)	0.116*** (4.59)	0.117*** (4.62)	0.117*** (4.66)
<i>aturn</i>	2.619*** (11.12)	2.559*** (10.86)	2.606*** (11.06)	2.517*** (10.70)	6.884*** (10.60)	6.718*** (10.35)	6.844*** (10.55)	6.608*** (10.20)	7.070*** (10.82)	6.930*** (10.60)	7.039*** (10.77)	6.796*** (10.42)
<i>insthold</i>	0.0230*** (5.19)	0.0246*** (5.56)	0.0234*** (5.29)	0.0246*** (5.57)	0.0504*** (4.13)	0.0547*** (4.49)	0.0515*** (4.23)	0.0546*** (4.50)	0.0312** (2.54)	0.0350*** (2.85)	0.0320*** (2.61)	0.0353*** (2.88)
<i>family</i>	-2.800*** (-15.51)	-2.775*** (-15.39)	-2.778*** (-15.39)	-2.752*** (-15.29)	-7.213*** (-14.51)	-7.145*** (-14.38)	-7.152*** (-14.39)	-7.084*** (-14.28)	-7.332*** (-14.65)	-7.274*** (-14.54)	-7.273*** (-14.53)	-7.205*** (-14.43)
<i>doli</i>	0.117*** (5.87)	0.114*** (5.74)	0.117*** (5.90)	0.120*** (6.05)	0.375*** (6.84)	0.368*** (6.71)	0.376*** (6.87)	0.384*** (7.02)	0.339*** (6.15)	0.333*** (6.04)	0.341*** (6.17)	0.348*** (6.32)
constant	25.21*** (17.06)	26.15*** (17.59)	25.47*** (17.23)	25.76*** (17.47)	-24.24*** (-5.95)	-21.68*** (-5.29)	-23.53*** (-5.78)	-22.77*** (-5.60)	-19.60*** (-4.78)	-17.49*** (-4.24)	-18.91*** (-4.61)	-18.15*** (-4.44)
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R ²	0.085	0.086	0.085	0.089	0.077	0.078	0.077	0.081	0.069	0.069	0.069	0.074
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on corporate governance performance, measured by corporate governance score (*govscore*), ranking corporate governance score in SASB main industry classification (*govmr*) (Panel B), and the ranking corporate governance score in SASB sub-industry classification (*govsr*) (Panel C), respectively. Models (1)~(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debt*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

4.2 Additional Tests

To this point, the empirical models primarily examine the association between female top executive variables and firm ESG performance within the same period. However, such a specification may give rise to concerns regarding contemporaneous correlation and reverse causality. Specifically, female executive representation and ESG performance may be jointly determined by unobservable firm characteristics, organizational culture, or macroeconomic conditions, thereby inducing correlation between the explanatory variables and the error term and potentially biasing the estimation results. Moreover, if firm ESG performance itself affects the appointment and promotion decisions of female executives, contemporaneous models may be unable to clearly identify the direction of causality. To mitigate these potential endogeneity concerns and strengthen causal inference, this study further adopts a dynamic regression estimation by introducing one-period lagged specifications ($t-1$) for the four female executive variables. All control variables are likewise lagged by one period.

Table 10 reports the dynamic regression results for the effects of female executive variables on overall firm ESG performance. Panel A employs ESG rating (*esgrating*) as the dependent variable, whereas Panel B adopts ESG score (*esgscore*). The estimation results indicate that the coefficients on the lagged female CEO variable (*fceo_{t-1}*), lagged female vice CEO variable (*fvceo_{t-1}*), and the lagged variable indicating both the CEO and vice CEO are female (*bfceo_{t-1}*) are all significantly positive. The findings suggest that firms led by female CEOs or female vice CEOs in the prior year, or firms simultaneously led by female CEOs and female vice CEOs, exhibit superior ESG performance and ESG ratings in the subsequent year. Greater female participation in top management is therefore associated with stronger future sustainability performance. In contrast, the lagged female CEO-chair duality variable (*fduality_{t-1}*) exhibits a significantly negative effect, indicating that when a female CEO simultaneously serves as board chair, the firm's future ESG performance declines significantly. As previously mentioned, even when female executives possess stronger ESG orientation and stakeholder awareness, excessive concentration of power may still generate governance risks and adversely affect overall ESG performance. The directions of the main explanatory variables remain largely unchanged after adopting lagged female executive variables and lagged controls, demonstrating the robustness of the empirical findings.

Table 11 reports the lagged-variable regression results for the effects of female executive variables on the individual dimensions of firm ESG performance. Panel A employs environmental performance score (*envscore*) as the dependent variable, Panel B employs social performance score (*socscore*), and Panel C employs governance performance score (*govscore*). The estimation results show that the lagged female CEO variable (*fceo_{t-1}*), lagged female vice CEO variable (*fvceo_{t-1}*), and the lagged variable indicating that both the CEO and vice CEO are female (*bfceo_{t-1}*) are predominantly positive and statistically significant. These findings indicate that firms led by female CEOs or female vice CEOs in the prior year, or

firms simultaneously led by female CEOs and female vice CEOs, achieve superior environmental, social, and governance performance in the subsequent year. On the contrary, the female CEO-chair duality variable (*fduality*_{*t-1*}) exhibits a more pronounced adverse governance effect. When a female CEO simultaneously serves as board chair, the firm's future governance performance deteriorates significantly. As before, while female executives may possess stronger stakeholder orientation and sustainability awareness that contribute positively to environmental and social performance, excessive concentration of managerial and board leadership authority in the same individual may still weaken board monitoring and checks-and-balances mechanisms, thereby impairing governance quality.

The research sample comprises 1,722 non-financial firms listed on the Taiwan Stock Exchange and the Taipei Exchange during 2016-2024, spanning 33 industries and 9 fiscal years. To mitigate the potential effects of industry structural differences and macroeconomic fluctuations on ESG performance, the regression models incorporate 32 industry dummy variables and 8 year dummy variables to control for industry heterogeneity and time effects. The empirical results reported in Tables 12 and 13 are generally consistent with the previous findings. The female CEO variable (*fceo*), female vice CEO variable (*fvceo*), and the variable indicating that both the CEO and vice CEO are female (*bfceo*) continue to exhibit significantly positive effects on overall firm ESG performance, regardless of whether ESG rating (*esgrating*) or ESG score (*esgscore*) is employed as the dependent variable. In contrast, the female CEO-chair duality variable (*fduality*) exhibits significantly negative effects, with estimated coefficients of -0.313 and -1.887 in Panels A and B, respectively, both significant at the 1% level. The findings indicate that even after further controlling for industry and year effects, female executives continue to enhance overall firm ESG performance, whereas excessive concentration of authority arising from female CEO-chair duality may still weaken governance quality and adversely affect overall ESG performance.

From the perspective of individual ESG dimensions, the results in Table 13 indicate that female executives exert predominantly positive effects on environmental, social, and governance performance. In the environmental dimension, the female CEO variable, female vice CEO variable, and the variable indicating both positions are held by women all exhibit significantly positive effects, with estimated coefficients of 0.775, 1.185, and 1.408, respectively. In the social dimension, the corresponding coefficients are 0.487, 0.844, and 2.235, with most estimates reaching statistical significance, suggesting that female executives contribute positively to firm environmental and social responsibility performance. However, in the governance dimension, although the female vice CEO variable continues to exhibit a significantly positive effect with an estimated coefficient of 0.551, the female CEO-chair duality variable (*fduality*) exhibits a significantly negative effect, with an estimated coefficient of -5.032 significant at the 1% level. This evidence suggests that concentration of the CEO and board chair positions in the same individual significantly impairs governance performance. After controlling for industry and year fixed effects, the empirical evidence continues to support the view that female

executives improve firm ESG performance, particularly in the environmental and social dimensions, whereas governance quality remains highly dependent on institutional arrangements and checks-and-balances mechanisms.

Table 10: Dynamic Regression Results for the Effects of Female CEO on Overall ESG Performance (*esgrating* v.s *esgscore*)

Explanatory Variables	Panel A. Explained variable: <i>esgrating</i>				Panel B. Explained variable: <i>esgscore</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i> _{<i>t-1</i>}	0.117***				1.005***			
	(3.64)				(4.60)			
<i>fvceo</i> _{<i>t-1</i>}		0.156***				1.139***		
		(7.55)				(8.09)		
<i>bfceo</i> _{<i>t-1</i>}			0.257***				2.020***	
			(4.72)				(5.49)	
<i>fduality</i> _{<i>t-1</i>}				-0.351***				-2.092***
				(-5.81)				(-5.10)
<i>scale</i> _{<i>t-1</i>}	0.392***	0.386***	0.391***	0.391***	2.824***	2.767***	2.809***	2.814***
	(50.25)	(49.12)	(50.05)	(50.13)	(56.59)	(55.08)	(56.29)	(56.41)
<i>debt</i> _{<i>t-1</i>}	-0.00709***	-0.00727***	-0.00710***	-0.00705***	-0.0488***	-0.0500***	-0.0488***	-0.0485***
	(-12.36)	(-12.65)	(-12.37)	(-12.28)	(-12.55)	(-12.86)	(-12.56)	(-12.47)
<i>roa</i> _{<i>t-1</i>}	0.00539***	0.00541***	0.00545***	0.00543***	0.0415***	0.0415***	0.0419***	0.0417***
	(5.72)	(5.74)	(5.78)	(5.77)	(6.51)	(6.53)	(6.58)	(6.55)
<i>aturn</i> _{<i>t-1</i>}	0.420***	0.412***	0.419***	0.412***	2.762***	2.691***	2.749***	2.703***
	(17.48)	(17.13)	(17.43)	(17.13)	(17.01)	(16.60)	(16.94)	(16.64)
<i>insthold</i> _{<i>t-1</i>}	0.00152***	0.00175***	0.00153***	0.00167***	0.0107***	0.0125***	0.0109***	0.0119***
	(3.33)	(3.86)	(3.38)	(3.68)	(3.44)	(4.06)	(3.51)	(3.85)
<i>family</i> _{<i>t-1</i>}	-0.234***	-0.231***	-0.231***	-0.230***	-1.601***	-1.574***	-1.571***	-1.574***
	(-12.50)	(-12.35)	(-12.31)	(-12.30)	(-12.58)	(-12.39)	(-12.35)	(-12.37)
<i>doli</i> _{<i>t-1</i>}	0.0161***	0.0157***	0.0161***	0.0163***	0.105***	0.101***	0.105***	0.106***
	(9.72)	(9.45)	(9.75)	(9.84)	(9.28)	(8.99)	(9.32)	(9.38)
constant					-8.973***	-7.871***	-8.658***	-8.702***
					(-8.62)	(-7.53)	(-8.32)	(-8.36)
No. of Obs.	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550
Adj. <i>R</i> ²					0.295	0.298	0.296	0.296
pseudo <i>R</i> ²	0.089	0.090	0.089	0.089				
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the dynamic regression estimates of effects of the presence of female CEO on overall ESG performance, measured by ESG ratings (*esgrating*) (Panel A) and ESG score (*esgscore*) (Panel B), respectively. Models (1)~(4) employs different measures of the presence of female CEO with one-period lag, including the dummy for a firm with female CEO (*fceo*_{*t-1*}), the dummy for a firm with female vice CEO (*fvceo*_{*t-1*}), the dummy for a firm has female CEO and vice CEO (*bfceo*_{*t-1*}), and the dummy for a firm with female CEO and CEO duality (*fduality*_{*t-1*}). The control variables include firm size (*scale*_{*t-1*}), debt ratio (*debt*_{*t-1*}), return on assets (*roa*_{*t-1*}), asset turnover (*aturn*_{*t-1*}), institutional investors' shareholdings (*insthold*_{*t-1*}), dummy for family-controlled firms (*family*_{*t-1*}), and dummy for having D&O insurance coverage (*doli*_{*t-1*}). The sample period spans from 2016 to 2024. The numbers reported in parentheses are *t*-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 11: Dynamic Regression Results for the Effects of Female CEO on Three Individual ESG Performance

Explanatory Variables	Panel A. Explained variable: <i>envscore</i>				Panel B. Explained variable: <i>socscore</i>				Panel C. Explained variable: <i>govscore</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i> _{<i>t-1</i>}	1.218*** (3.62)				0.959*** (3.31)				0.914*** (2.93)			
<i>fvceo</i> _{<i>t-1</i>}		1.470*** (6.79)				1.184*** (6.35)				0.850*** (4.22)		
<i>bfceo</i> _{<i>t-1</i>}			2.064*** (3.64)				2.751*** (5.64)				1.129** (2.14)	
<i>fduality</i> _{<i>t-1</i>}				0.920 (1.46)				-0.513 (-0.95)				-5.663*** (-9.69)
<i>scale</i> _{<i>t-1</i>}	4.009*** (52.24)	3.936*** (50.93)	3.994*** (52.01)	4.006*** (52.18)	3.887*** (58.82)	3.828*** (57.52)	3.869*** (58.57)	3.882*** (58.72)	1.155*** (16.19)	1.112*** (15.46)	1.145*** (16.04)	1.138*** (16.00)
<i>debt</i> _{<i>t-1</i>}	-0.0534*** (-8.93)	-0.0549*** (-9.18)	-0.0534*** (-8.92)	-0.0534*** (-8.91)	-0.0587*** (-11.39)	-0.0599*** (-11.63)	-0.0588*** (-11.41)	-0.0585*** (-11.35)	-0.0368*** (-6.61)	-0.0376*** (-6.76)	-0.0368*** (-6.60)	-0.0361*** (-6.51)
<i>roa</i> _{<i>t-1</i>}	0.0124 (1.26)	0.0124 (1.27)	0.0128 (1.31)	0.0122 (1.24)	0.00592 (0.70)	0.00595 (0.71)	0.00655 (0.78)	0.00593 (0.70)	0.0803*** (8.82)	0.0803*** (8.82)	0.0805*** (8.84)	0.0811*** (8.92)
<i>aturn</i> _{<i>t-1</i>}	3.460*** (13.85)	3.370*** (13.51)	3.442*** (13.79)	3.444*** (13.78)	2.777*** (12.91)	2.705*** (12.59)	2.770*** (12.89)	2.744*** (12.75)	2.469*** (10.63)	2.412*** (10.39)	2.453*** (10.57)	2.355*** (10.17)
<i>insthold</i> _{<i>t-1</i>}	-0.00840* (-1.76)	-0.00607 (-1.28)	-0.00798* (-1.68)	-0.00719 (-1.51)	0.0104** (2.53)	0.0122*** (2.99)	0.0102** (2.49)	0.0114*** (2.79)	0.0283*** (6.37)	0.0298*** (6.74)	0.0287*** (6.49)	0.0297*** (6.74)
<i>family</i> _{<i>t-1</i>}	-0.602*** (-3.07)	-0.568*** (-2.90)	-0.568*** (-2.90)	-0.588*** (-3.00)	-0.852*** (-5.06)	-0.825*** (-4.90)	-0.818*** (-4.85)	-0.835*** (-4.95)	-2.900*** (-15.94)	-2.877*** (-15.82)	-2.878*** (-15.81)	-2.854*** (-15.74)
<i>doli</i> _{<i>t-1</i>}	0.0928*** (5.36)	0.0885*** (5.11)	0.0933*** (5.38)	0.0928*** (5.35)	0.0996*** (6.67)	0.0961*** (6.44)	0.1000*** (6.70)	0.100*** (6.70)	0.122*** (7.56)	0.119*** (7.41)	0.122*** (7.58)	0.124*** (7.75)
constant	-34.66*** (-21.65)	-33.25*** (-20.67)	-34.32*** (-21.43)	-34.56*** (-21.58)	-32.17*** (-23.34)	-31.03*** (-22.40)	-31.79*** (-23.08)	-32.01*** (-23.21)	26.97*** (18.12)	27.82*** (18.58)	27.20*** (18.27)	27.47*** (18.51)
No. of Obs.	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550	13,550
Adj. <i>R</i> ²	0.224	0.226	0.224	0.223	0.276	0.277	0.277	0.275	0.094	0.095	0.094	0.100
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the dynamic regression estimates of effects of the presence of female CEO on three individual ESG performance, measured by environmental score (*envscore*) (Panel A), social score (*socscore*) (Panel B), corporate governance score (*govscore*) (Panel C), respectively. Models (1)~(4) employs different measures of the presence of female CEO with one-period lag, including the dummy for a firm with female CEO (*fceo*_{*t-1*}), the dummy for a firm with female vice CEO (*fvceo*_{*t-1*}), the dummy for a firm has female CEO and vice CEO (*bfceo*_{*t-1*}), and the dummy for a firm with female CEO and CEO duality (*fduality*_{*t-1*}). The control variables include firm size (*scale*_{*t-1*}), debt ratio (*debt*_{*t-1*}), return on assets (*roa*_{*t-1*}), asset turnover (*aturn*_{*t-1*}), institutional investors' shareholdings (*insthold*_{*t-1*}), dummy for family-controlled firms (*family*_{*t-1*}), and dummy for having D&O insurance coverage (*doli*_{*t-1*}). The sample period spans from 2016 to 2024. The numbers reported in parentheses are t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 12: Regression Results for the Effects of Female CEO on Overall ESG Performance (*esgrating* v.s *esgscore*) (Controlling Industry and Year Fixed Effects)

Explanatory Variables	Panel A. Explained variable: <i>esgrating</i>				Panel B. Explained variable: <i>esgscore</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	0.0761**				0.553***			
	(2.42)				(2.66)			
<i>fvceo</i>		0.118***				0.833***		
		(5.65)				(6.02)		
<i>bfceo</i>			0.207***				1.525***	
			(3.91)				(4.39)	
<i>fduality</i>				-0.313***				-1.887***
				(-5.30)				(-4.85)
<i>scale</i>	0.444***	0.437***	0.442***	0.443***	3.111***	3.058***	3.096***	3.108***
	(52.62)	(51.22)	(52.30)	(52.60)	(59.81)	(57.97)	(59.38)	(59.79)
<i>debt</i>	-0.00515***	-0.00528***	-0.00513***	-0.00513***	-0.0370***	-0.0379***	-0.0368***	-0.0368***
	(-8.45)	(-8.65)	(-8.41)	(-8.40)	(-9.20)	(-9.43)	(-9.16)	(-9.17)
<i>roa</i>	0.00258***	0.00256***	0.00263***	0.00259***	0.0149**	0.0147**	0.0152**	0.0149**
	(2.67)	(2.64)	(2.72)	(2.67)	(2.34)	(2.31)	(2.40)	(2.34)
<i>aturn</i>	0.437***	0.433***	0.435***	0.433***	2.936***	2.903***	2.925***	2.906***
	(16.19)	(16.03)	(16.14)	(16.03)	(16.62)	(16.44)	(16.56)	(16.45)
<i>insthold</i>	0.000260	0.000462	0.000284	0.000344	0.00204	0.00346	0.00219	0.00261
	(0.55)	(0.97)	(0.60)	(0.72)	(0.65)	(1.10)	(0.70)	(0.83)
<i>family</i>	-0.222***	-0.221***	-0.220***	-0.219***	-1.483***	-1.470***	-1.466***	-1.462***
	(-11.53)	(-11.45)	(-11.41)	(-11.36)	(-11.66)	(-11.57)	(-11.53)	(-11.50)
<i>doli</i>	0.0200***	0.0197***	0.0200***	0.0201***	0.0989***	0.0966***	0.0987***	0.0993***
	(8.50)	(8.37)	(8.49)	(8.55)	(6.36)	(6.22)	(6.35)	(6.39)
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
constant	No	No	No	No	Yes	Yes	Yes	Yes
No. of Obs.	13.774	13.774	13.774	13.774	13.774	13.774	13.774	13.774
Adj. R^2					0.329	0.331	0.330	0.330
pseudo R^2	0.103	0.104	0.103	0.104				
Model Sig. (p -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on overall ESG performance, measured by ESG ratings (*esgrating*) (Panel A) and ESG score (*esgscore*) (Panel B), respectively. Models (1)~(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debt*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). 32 Industry dummy variables (**Ind. Dummies**) and 8 year dummy variables (**Year Dummies**) are also incorporated into model. The sample period spans from 2016 to 2024. The numbers reported in parentheses are t -statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table 13: Regression Results for the Effects of Female CEO on Three Individual ESG Performance
(Controlling for Industry and Year Fixed Effects)**

Explanatory Variables	Panel A. Explained variable: <i>envscore</i>				Panel B. Explained variable: <i>socscore</i>				Panel C. Explained variable: <i>govscore</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>fceo</i>	0.775** (2.41)				0.487* (1.79)				0.373 (1.24)			
<i>fvceo</i>		1.185*** (5.53)				0.844*** (4.67)				0.551*** (2.74)		
<i>bfceo</i>			1.408*** (2.61)				2.235*** (4.92)				0.715 (1.42)	
<i>fduality</i>				0.329 (0.54)				-0.325 (-0.64)				-5.032*** (-8.92)
<i>scale</i>	4.247*** (52.72)	4.172*** (51.05)	4.234*** (52.42)	4.251*** (52.76)	4.196*** (61.73)	4.142*** (60.06)	4.172*** (61.26)	4.197*** (61.74)	1.458*** (19.31)	1.423*** (18.56)	1.451*** (19.16)	1.446*** (19.21)
<i>debt</i>	-0.0399*** (-6.41)	-0.0411*** (-6.61)	-0.0398*** (-6.38)	-0.0401*** (-6.43)	-0.0360*** (-6.85)	-0.0368*** (-7.01)	-0.0356*** (-6.79)	-0.0360*** (-6.85)	-0.0378*** (-6.48)	-0.0384*** (-6.58)	-0.0378*** (-6.47)	-0.0372*** (-6.40)
<i>roa</i>	-0.00569 (-0.58)	-0.00597 (-0.61)	-0.00547 (-0.55)	-0.00604 (-0.61)	-0.0169** (-2.03)	-0.0170** (-2.05)	-0.0162* (-1.95)	-0.0170** (-2.05)	0.0453*** (4.91)	0.0452*** (4.89)	0.0455*** (4.92)	0.0458*** (4.97)
<i>aturn</i>	3.352*** (12.25)	3.305*** (12.08)	3.340*** (12.20)	3.349*** (12.23)	2.669*** (11.56)	2.636*** (11.42)	2.656*** (11.51)	2.660*** (11.51)	3.259*** (12.70)	3.237*** (12.62)	3.253*** (12.68)	3.189*** (12.46)
<i>insthold</i>	-0.00665 (-1.37)	-0.00463 (-0.95)	-0.00635 (-1.31)	-0.00619 (-1.27)	-0.00228 (-0.55)	-0.000883 (-0.21)	-0.00227 (-0.55)	-0.00193 (-0.47)	0.0153*** (3.35)	0.0162*** (3.56)	0.0154*** (3.38)	0.0161*** (3.54)
<i>family</i>	-0.552*** (-2.80)	-0.533*** (-2.71)	-0.533*** (-2.71)	-0.544*** (-2.76)	-0.641*** (-3.86)	-0.628*** (-3.78)	-0.620*** (-3.73)	-0.632*** (-3.80)	-2.859*** (-15.49)	-2.850*** (-15.44)	-2.850*** (-15.44)	-2.817*** (-15.30)
<i>doli</i>	0.0772*** (3.21)	0.0739*** (3.07)	0.0768*** (3.19)	0.0766*** (3.18)	0.133*** (6.54)	0.131*** (6.43)	0.133*** (6.53)	0.133*** (6.53)	0.0845*** (3.74)	0.0829*** (3.67)	0.0843*** (3.73)	0.0862*** (3.83)
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774	13,774
Adj. R ²	0.251	0.252	0.251	0.250	0.330	0.331	0.331	0.330	0.109	0.110	0.109	0.114
Model Sig. (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the regression estimates of effects of the presence of female CEO on three individual ESG performance, measured by environmental score (*envscore*) (Panel A), social score (*socscore*) (Panel B), corporate governance score (*govscore*) (Panel C), respectively. Models (1)–(4) employs different measures of the presence of female CEO, including the dummy for a firm with female CEO (*fceo*), the dummy for a firm with female vice CEO (*fvceo*), the dummy for a firm has female CEO and vice CEO (*bfceo*), and the dummy for a firm with female CEO and CEO duality (*fduality*). The control variables include firm size (*scale*), debt ratio (*debt*), return on assets (*roa*), asset turnover (*aturn*), institutional investors' shareholdings (*insthold*), dummy for family-controlled firms (*family*), and dummy for having D&O insurance coverage (*doli*). 32 Industry dummy variables (**Ind. Dummies**) and 8 year dummy variables (**Year Dummies**) are also incorporated into model. The sample period spans from 2016 to 2024. The numbers reported in parentheses are t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

5. Conclusion and Implications

5.1 Research Conclusion and Policy Implications

This study examines the effects of female CEOs on firm ESG performance using a sample of 1,722 non-financial firms listed on the TWSE and the TPEX during 2016~2024. The analysis addresses an important gap in the literature, which has largely focused on board gender diversity while relatively overlooking gender characteristics within top executive leadership. According to Upper Echelons Theory, major corporate decisions reflect managers' values and cognitive characteristics. Female leaders are generally associated with stronger stakeholder orientation, ethical awareness, and long-term sustainability perspectives, which may shape firm strategies and behaviors that place greater emphasis on ESG objectives. In addition, risk-aversion and prosocial orientation perspectives suggest that female executives tend to adopt more prudent decisions emphasizing compliance and transparency, thereby improving firm sustainability performance. However, Critical Mass Theory and tokenism perspectives also suggest that female CEOs may face external scrutiny, resource constraints, and governance resistance, limiting the extent to which their values can be translated into substantive corporate actions. Against this theoretical backdrop, this study empirically investigates the relationship between female executives and ESG performance, thereby contributing to ongoing discussions regarding sustainable finance and corporate governance development.

Using descriptive statistics, correlation analysis, multiple regression estimation, dynamic regression estimation, and specifications controlling for industry and year fixed effects, the empirical evidence indicates that female executive participation exerts a consistent and robust positive effect on ESG performance. Regardless of whether ESG performance is measured using raw ESG scores or industry-adjusted ranking indicators based on the industry classifications of the TWSE and the SASB, firms led by female CEOs, female vice CEOs, or female CEO-vice CEO leadership teams exhibit significantly superior overall ESG performance as well as stronger environmental, social, and governance performance. The findings demonstrate that the positive effects of female executives remain robust across alternative measurement approaches and industry classification frameworks. However, this study also identifies an important exception. When a female CEO simultaneously serves as board chair, overall firm ESG performance deteriorates significantly, with the negative effect primarily driven by a substantial decline in governance performance. The evidence reflects the strong emphasis placed by governance rating systems on board independence and checks-and-balances mechanisms, under which CEO-chair duality is treated as a major governance deficiency.

The empirical findings further reveal that the effects of female leadership vary across ESG dimensions. In the environmental dimension, even under conditions of concentrated authority, female CEOs continue to promote long-term environmental investments, thereby sustaining significantly stronger environmental performance. In the social dimension, stronger stakeholder orientation and human-centered

leadership likewise prevent firm social performance from deteriorating significantly despite governance structure deficiencies. In contrast, within the governance dimension, the institutional weaknesses associated with CEO-board chair duality cannot be offset by managerial characteristics, resulting in significantly adverse effects. Overall, this study highlights the interaction between managerial characteristics and institutional design. Female executives contribute positively to firm environmental and social performance and improve overall ESG outcomes, whereas governance quality remains highly dependent on institutional arrangements and separation-of-powers mechanisms. These findings deepen the understanding of the relationship between gender diversity and corporate sustainability and provide important implications for policymakers and corporate governance practice.

For securities regulators and policymakers, given the significant and robust positive effects of female executives on firm ESG performance, institutional mechanisms should be strengthened to enhance gender diversity within top management. For example, the gender composition of senior executives could be incorporated into mandatory disclosure requirements and corporate governance evaluation systems, while greater information transparency and rating mechanisms could further encourage market attention toward managerial diversity. At the same time, because the empirical evidence indicates that CEO-board chair duality exerts significantly adverse effects on governance performance, regulators should strengthen governance requirements or evaluation weights related to the separation of the CEO and board chair positions in order to preserve checks-and-balances mechanisms and governance quality.

For corporate leadership, gender diversity should be viewed not only as a social objective but also as a strategic asset that enhances ESG performance. Firms should actively cultivate and appoint female executives and integrate ESG objectives into managerial decision-making and performance evaluation systems to promote long-term value creation. Nevertheless, firms should also avoid excessive concentration of authority. Particularly under CEO-board chair duality, even the advantages associated with female leadership may be undermined by governance structure deficiencies. Firms should therefore strengthen board independence and monitoring mechanisms to ensure effective alignment between institutional design and managerial talent. For investors, the gender composition of top management may serve as an important ESG investment indicator. Female leadership contributes positively to overall firm ESG performance, although investors should simultaneously evaluate corporate governance structures carefully, particularly the governance risks associated with the concentration of authority implied by CEO-board chair duality.

5.2 Suggestions for Future Research

This study suggests that future research could further examine the impact of female CEOs on corporate carbon or green-house-gas emission efficiency. According to upper echelons theory, managerial values and cognitive bases are reflected in major corporate decisions. Female CEOs are generally characterized by stronger stakeholder orientation, long-term strategic thinking, and risk-averse preferences, which may lead them to promote energy conservation, carbon reduction initiatives, green investment, and sustainability transition strategies, thereby reducing firm-level carbon emissions. The perspectives of prosocial behavior and ethical orientation further suggest that female executives place greater emphasis on environmental and social responsibility, which may strengthen firms' commitment to carbon reduction targets.

Future research may also consider additional non-gender characteristics of female CEOs to develop a more granular understanding of their effects on ESG performance or carbon emission outcomes. Educational background, professional training such as expertise in finance, law, or accounting, industry experience, and tenure may shape a CEO's capability and efficiency in implementing sustainability strategies and carbon reduction decisions. For instance, executives with finance or accounting backgrounds may be better able to evaluate the cost effectiveness of green investments, while those with industry experience may possess deeper knowledge of carbon reduction technologies and operational constraints. In addition, age and managerial tenure may proxy for risk preferences and decision maturity, whereas cross cultural experience may enhance familiarity with international ESG standards and sustainability trends. Personal life characteristics such as marital status and parental status may also influence values and long-term orientation, thereby indirectly affecting corporate sustainability decisions. These attributes may either strengthen or weaken the impact of female CEOs on ESG or carbon emission performance. Accordingly, incorporating these dimensions in future research would allow a shift from a gender-based explanation toward a more micro level analysis of individual managerial traits, thereby providing a more comprehensive understanding of how top executives shape firm's ESG outcomes.

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