

Board Characteristics and Environmental Performance

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Abstract

As corporate priorities transition from traditional financial metrics such as earnings per share (EPS) to an integrated emphasis on environmental, social, and governance (ESG) criteria, both investor and stakeholder expectations have significantly transformed. Modern businesses are increasingly mandated not only to act with urgency but also to cultivate cross-sector partnerships aimed at establishing carbon-reducing ecosystems, thus addressing and mitigating pressing environmental and social risks. Within this shifting landscape, the board of directors assumes a central role, championing sustainable development and strengthening the principles of corporate governance. This study rigorously explores the influence of the board on environmental performance, identifying critical determinants that shape this relationship through a corporate governance lens. Employing a robust random-effects model, this research evaluates a comprehensive panel dataset comprising 5,616 firm-year observations from Taiwan's electronics sector over the period from 2006 to 2020. Specifically, the study investigates how board size and meeting frequency impact environmental performance metrics. Findings reveal that larger board sizes are positively correlated with enhanced environmental outcomes, whereas meeting frequency does not yield a statistically significant effect on environmental performance. This investigation deepens the theoretical discourse on the intricate nexus between corporate governance and environmental performance while providing actionable insights for corporate leaders and regulatory bodies. By emphasizing the essential role of board composition, particularly board size, this study elucidates the fundamental connection between board structure and a firm's enduring commitment to sustainability. These findings reinforce a governance framework that promotes long-term ecological stewardship and social responsibility, laying a robust foundation for corporate practices that are both effective and sustainable.

Keywords: Environmental Performance, Carbon Emissions, Board Meeting, Board Size.

JEL Classifications: C32; F31, M48.

Introduction

With increasing climate change and changing global political and economic conditions, firms today face many new risks that have never been seen in the past. Are they able to handle unknown and unpredictable situations flexibly? "Tenacity" is the key to sustainability. Sustainable thinking will stimulate the optimization and upgrading of modern enterprise risk management. Similarly, institutional investors include ESG (Environmental, Social, and Governance) indicators in their asset allocation and portfolio decisions to ensure that long-term profits remain under the impact of emerging risks; when financial institutions conduct corporate lending audits, they also begin to incorporate ESG indices into the assessment, including assessing the management of applicants on climate change issues, thereby assessing whether they have potential ESG risks and whether they may affect enterprise operations in the future. Therefore, if enterprises cannot demonstrate positive ESG actions and risk management, it will be difficult in the future to obtain the necessary operating funds in the financial markets.

In the past, maximizing profit was the primary goal for businesses. However, now, regardless of industry or firm size, it is essential to prioritize ESG while earning profits in order to truly survive in the long term. However, many firms feel that they cannot do ESG well or cannot achieve it at all, so they choose not to do it. In reality, this is not a zero-sum nexus but rather a gradual transformation process for firms. Businesses must undertake proactive measures and engage in collaborative efforts within their respective industries to cultivate an interdependent ecosystem that effectively mitigates carbon emissions, thereby fortifying their resilience against impending risks. Driven by regulatory authorities, there has been a significant surge in the quantity of non-financial disclosures pertaining to climate-related aspects by listed firms in recent years. The ongoing utilization of corporate data integration serves as a crucial foundation

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for advancing industrial development. Importantly, the transition from an exclusive focus on earnings per share (EPS) in the past to the present emphasis on ESG considerations signifies a remarkable shift in the expectations of investors and other stakeholders. They no longer solely prioritize corporate financial information; instead, they demand transparent disclosure of ESG performance, which is crucial for assessing a company's resilience and sustainable governance capabilities.

For stakeholders, the disclosure of non-financial information offers a comprehensive means to comprehend the company's future prospects beyond mere financial figures. Therefore, ESG (Environmental, Social, and Governance) considerations should not be viewed solely as compliance obligations. Instead, enterprises ought to swiftly transition from superficially disclosing existing information to adopting a sustained perspective. This approach enables a thorough examination of the firm's resilience, identification of risks and opportunities, and facilitates effective communication with interested parties while aligning with the company's strategic direction. The board of directors assumes a pivotal role in promoting sustainable development and bolstering corporate governance.

Additionally, the literature also suggests that the frequency of board meetings is positively associated with environmental performance (Frias-Aceituno et al., 2013; García Martín & Herrero, 2020; Elsayih et al., 2021). Furthermore, board size has been found to have a positive impact on environmental performance (Bosun-Fakunle et al., 2023) and environmental disclosures (Ben-Amar et al., 2017; Prado-Lorenzo & Garcia-Sanchez, 2010; Giannarakis et al., 2017, and Hossain et al., 2017). Therefore, this study aims to examine the relationship between board meeting, board size, and environmental performance (CO₂ emissions) in the electronics industry in Taiwan from 2006 to 2020, and found that board size has a positive effect on reducing CO₂ emissions, while board meetings do not have a significant impact. The findings have important implications for policy makers and businesses looking to improve their environmental performance.

This study is organized as follows: The next section discusses the literature review. Following that, the section presents the data utilized in the study, followed by the empirical results. Subsequently, the study presents proposals and conclusions. The final section discusses the research limitations and provides recommendations for future studies.

Literature Review

Board Meetings and Environmental Performance

The company will persistently revise its operational and risk management practices to establish a new paradigm in the market. When assessing ESG (Environmental, Social, and Governance) risks, firms can perceive them as opportunities and strive to integrate ESG principles into their existing business models, strategies, products, and services. Lipton and Lorsch (1992) found that the greater the frequency of board meetings, the more effectively the board can exert control over the company and transform it into a body that values social and environmental issues and a disseminator of more abundant or superior information. The primary focus will be on utilizing sustainable transformation to augment enterprise value. Holding frequent board meetings is a significant aspect of the board's functional capability (Jensen, 1993; Vafeas, 1999). Laksmana (2008) asserted that board meetings have the potential to enhance the performance of both financial and non-financial outcomes. A board of directors that convenes more frequently is also more likely to respond better to issues and exercise greater managerial control in the realms of society and the environment. This, in turn, can have a significant impact on carbon emissions (Prado-Lorenzo & Garcia-Sanchez, 2010). A higher frequency of board meetings has been found to have a positive correlation with improved board communication, leading to better operational strategy implementation (Jizi, Salama et al., 2014) and fulfilling shareholders' interests (Vafeas, 1999). The board's involvement in the financial reporting process, including determining the content of financial reports, tends to encourage the disclosure of more information in those reports. This inclination stems from the board members' long-term commitment to the company's social responsibilities (Johnson & Greening, 1999; Hillman & Dalziel, 2003). As board meetings become more frequent, there is an increased likelihood of gaining a deeper understanding of the company's

performance, leading to the adoption of appropriate actions to address complex challenges, such as greenhouse gas emissions. Furthermore, this enhanced understanding makes it more probable for the board to effectively monitor the company's carbon initiatives (Elsayih et al., 2021).

While Prado Lorenzo et al. (2009) examined the relationship between board meetings and corporate social responsibility information. They found no association between the frequency of board meetings and issues pertaining to corporate social responsibility or carbon emissions. Liao et al. (2015) conducted a study on the corporate governance and carbon emission disclosure of 329 major firms in the United Kingdom. They found no association between the frequency of board meetings and carbon emission disclosure. However, they did observe a significant negative correlation between carbon-related issues, such as carbon risk management, and carbon disclosure. Several studies (Frias-Aceituno et al., 2013; García Martín & Herrero, 2020; Elsayih et al., 2021) have reported that a higher frequency of board meetings is associated with lower levels of CO₂ emissions. Thus, frequent board meetings may serve as an indicator of a strategic focus on environmental issues, potentially having a significant impact on a company's environmental performance. Based on this, the frequency of board meetings can be considered as an indicator of a strategic environmental focus, which could exert a substantial impact on a firm's carbon performance. Consequently, our hypothesis is as follows:

H1. All other things being equal, the number of board meetings is negatively associated with CO₂ emissions of a firm.

Board Size and Environmental Performance

The global outbreaks of epidemics, occurrences of extreme climate events, and evolving global political and economic landscapes consistently exert a profound influence on the sustainability of enterprises. In the face of this dynamic and demanding environment, firms should proactively adopt ESG initiatives, fortify risk management practices, and embrace sustainable transformation at an early stage. By doing so, they can not only navigate the challenges but also identify new opportunities for future business endeavors. Board members have shifted their focus from exclusively prioritizing corporate financial information to demanding transparent disclosure of ESG performance. This shift is critical in assessing a company's resilience and its ability to maintain sustainable governance practices. According to the monitoring hypothesis, the size of the board is associated with monitoring effectiveness and has a certain impact on voluntary information disclosure (Karamanou & Vafeas, 2005). Akhtaruddin et al. (2009) conducted a study on corporate governance and voluntary disclosure using a sample of 562 observations of firms listed in Malaysia in 2002. They argue that a larger board size has the potential to enhance the board's oversight and facilitation of value creation activities, leading to increased voluntary information disclosure by the company. Therefore, firms with larger board sizes may be more inclined to address issues related to carbon emission disclosure in order to enhance their corporate value. The board's oversight and supervision align the goals of managers with shareholder interests, playing a critical role in formulating, implementing, and reviewing company policies.

The larger the board size, the greater the potential for diversity in its composition, including a higher likelihood of including directors with specialized backgrounds. This enables board members to provide higher quality advice to the management team (Zahra & Pearce, 1989). Generally, a larger board size is considered advantageous (Judge & Zeithaml, 1992). Large boards may face challenges in making effective environmental strategic decisions (Firstenberg & Malkiel, 1994; Bonn, Yoshikawa & Phan, 2004). A larger board size can bring more diverse perspectives and expertise, which can improve decision-making and performance monitoring (Dalton et al., 1999), as well as enhance the board's ability to oversee and promote value-creation events (Akhtaruddin et al., 2009). Furthermore, a larger board may have a greater ability to fulfill its social responsibilities and improve firm performance (Chang, 2015; Veronica Siregar & Bachtiar, 2010; Kiel & Nicholson, 2003; Jackling & Johl, 2009; Yammesri & Herath, 2010), deal with environmental uncertainty, and foster connections with business partners (Pfeffer & Salancik, 1978). This, in turn, can have positive effects on firm performance and sustainability outcomes.

Veronica Siregar & Bachtiar (2010) conducted a study on 87 listed firms on the Indonesian Stock

Exchange in 2003. They investigated the impact of board size, foreign ownership, firm size, profitability, and leverage on corporate social responsibility reporting, as well as the potential influence of CSR reporting on future firm performance. The study found a positive and nonlinear relationship between board size and CSR, indicating that larger board sizes are associated with increased disclosure of CSR information. However, excessively large board sizes were found to have a diminishing effect on CSR reporting. Yunus et al. (2016) investigated the relationship between carbon management strategies and internal organizational factors, as well as corporate governance, such as environmental management systems, corporate governance committees, board size, and board independence, in the top 200 listed firms in Australia. They found that internal organizational factors and corporate governance, including board size, play significant roles in carbon management. Specifically, firms engaged in carbon management were more likely to have larger board sizes. Giannarakis et al. (2017) conducted a study on the influence of environmental performance on environmental disclosure. The sample consisted of 102 publicly listed firms in the S&P 500 index from 2009 to 2013. Greenhouse gas emissions were considered as a measure of environmental performance, and the Carbon Disclosure Leadership Index was used as a measure of environmental disclosure. Board size was included as a control variable. The findings revealed a significant negative relationship between board size and carbon disclosure. Manurung et al. (2017) conducted a study and discovered a negative relationship between board size and carbon emissions. They argued that even when firms face pressure to disclose carbon emissions information, they may still refuse to do so if there are potential litigation or risks involved. In such cases, the pressure and costs associated with litigation or risks outweigh the benefits of disclosure, leading to a refusal to disclose carbon emissions. A number of studies have suggested a negative relationship between board size and carbon emissions disclosure. (Ben-Amar et al., 2017; Prado-Lorenzo & Garcia-Sanchez, 2010; Giannarakis et al., 2017; Hossain et al., 2017).

However, certain studies have been unable to establish a significant correlation between the size of the board and the disclosure of CO₂ emissions. Kılıç & Kuzey (2019) conducted a study on a sample of 154 firms listed on the Istanbul Stock Exchange from 2011 to 2015. They found that board size had no significant impact on carbon emission disclosure. Liao et al. (2015) conducted a study on a total of 329 firms in the 2011 CDP FTSE350 report. They explored the impact of board characteristics on the voluntary disclosure of carbon emissions. The findings revealed a significant positive relationship between board size and carbon emission disclosure. Moreover, board size exhibited a more pronounced effect on non-carbon-intensive sectors compared to carbon-intensive industries. However, there was no significant association between board size and carbon activities, such as providing carbon reduction incentives, setting strategic goals for carbon reduction, and managing carbon risk. Budiharta & Kacaribu (2020) examined a sample of 18 non-financial firms listed on the Indonesian Stock Exchange from 2016 to 2018. They found that board size does not affect carbon emission disclosure. The study analyzed collected data and discovered inconsistencies between carbon emission disclosure and board size. The reason for this is that board members have varying levels of understanding and concern regarding carbon emission disclosure. Firms with high carbon disclosure tend to have fewer board members, and vice versa. The lack of impact may be due to the potential damage to the company's image or the influence on shareholders' perception of the firm's operations that can arise from disclosing carbon emissions. It may even lead to litigation risks.

In light of other factors such as firm size, ownership structure, and corporate governance practices, the relationship between board size and CO₂ emissions may exhibit varying influences. To comprehensively comprehend this relationship and identify the specific circumstances in which a larger board size could potentially lead to adverse effects on CO₂ emissions, additional research is necessary. Hence, the following hypotheses are proposed:

H2. All other things being equal, the board size is negatively associated with CO₂ emissions of a firm.

Methodology

Data

In this study, Taiwan Stock Exchange (TSE)-listed firms were used for sample data, obtained from the Taiwan Economic Journal (TEJ) database. The initial sample consisted of 5899 observations of firm-year involved in CO₂ emissions, as reported in their financial reports from 2006 to 2020. However, 283 observations were excluded due to missing data on the board of directors for 280 of them and incomplete CO₂ emissions data for 3 of them. Thus, the final unbalanced panel data comprised 5616 firm-year observations from 2006 to 2020.

Empirical Model

The fundamental model aims to examine the correlation between carbon emissions and corporate governance. Subsequently, we proceeded with the estimation of the following model.

$$CO_{2i,t} = \alpha_{0i,t} + \alpha_1 Meeting_{i,t} + \alpha_2 Bsize_{i,t} + \alpha_3 Debt_{i,t} + \alpha_3 R\&D_{i,t} + \alpha_4 Fsize_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where i is 1...5616, t is the time indicator (2016 to 2020), $\alpha_{0i,t}$ is the constant, and $\varepsilon_{i,t}$ is the residual.

The proxy for environmental performance used in this study is CO₂ emissions intensity, as the approach of Scarpellini et al. (2019). To address the issue of heterogeneity, the ratio of CO₂ emissions to net sales revenue was employed, following the methodologies of Luo & Tang (2014) and Hoffmann & Busch (2008). Based on previous research by scholars such as Vafeas (1999), Nelson et al.(2010), Brick & Chidambaran (2007), Laksmana (2008), and Liao et al.(2015), the frequency of board meetings (Meeting) is defined as the total number of meetings held in a given year. Building on previous research by scholars such as Kang et al.(2007), Lim et al. (2007), and Liao et al.(2015), board size (Bsize) is defined as the total number of directors in the board of directors. To control for extraneous factors, we assessed the "Debt" ratio as long-term debt divided by total assets. Lenders have the right to request access to a company's carbon emission information to help assess risks related to contracts, as suggested by Clarkson et al. (2008). Firms with higher debt ratios are more likely to disclose voluntary information (Prencipe, 2004). By disclosing more information about their social and environmental activities, firms can reduce information asymmetry with lenders and consequently lower agency costs (Prado-Lorenzo et al., 2009). As firms become increasingly reliant on funding from lenders, they voluntarily disclose information to meet lenders' expectations (Rankin et al., 2011). Therefore, the debt ratio is included as a control variable in this study. Additionally, we used the "R&D" ratio to represent the Research and Development investment to net sales revenue, and "Fsize" was evaluated as the natural logarithm of total assets to measure firm size. Scholars such as Watts & Zimmerman (1978), Said et al. (2009), Haniffa and Cooke (2005), Branco & Rodrigues (2008), Luo & Tang (2012), Gamerschlag et al. (2011), Tauringana & Chithambo (2015), and Giannarakis et al. (2017) argue that managers of larger firms are more likely to disclose information on carbon emissions. Therefore, company size is included as a control variable in this study.

Research Design

The Panel Data model and the conventional Least Squares model differ significantly in their assumptions regarding the intercept term. This study datal employs Panel Data, which encompasses both cross-sectional and time-series data. It takes into account the potential heteroscedasticity arising from variations in the error term within the Panel data's cross-section. Moreover, it recognizes the presence of omitted variables and the possibility of autocorrelation in the time series. The key disparity between the Panel Data model and the Ordinary Least Squares (OLS) model lies in the varying assumptions made regarding the intercept terms. The Panel Data model permits each individual within the sample to possess distinct intercept terms, thereby capturing the heterogeneity across individuals. Furthermore, based on the nature of the intercept term, it can be categorized into two models: the fixed-effect model and the random-effect model. Specifically, fixed-effect models make inferences solely based on the available data for the respective individuals, while random-effect models treat the individuals and their associated data as random samples drawn from a larger matrix.

The selection of these models depends on the research objectives and assumptions, aiming to conduct more accurate analysis and inference. Fixed effects can be classified into two types: "region-specific fixed effects" and "time-specific fixed effects." The region-specific fixed effects consider the unique characteristics of each region and their long-term impact on the dependent variable within the region or over the years. This effect remains constant over time and is controlled for other explanatory variables. On the other hand, the time-specific fixed effects capture the specific characteristics of each time period (t) and their short-term influence on the dependent variable across regions. This effect remains constant across regions and is controlled for other explanatory variables. The random effects model, also known as the error component model, shares the same region-specific and time-specific effects as the fixed effects model, with the key difference lying in the intercept term of the regression equation. The random effects model emphasizes the overall variation across the population rather than the specific differences between individual units. It treats the observed data as a random sample from a population with high similarity, assuming that the individual differences are randomly generated.

The Hausman Test, proposed by Hausman (1978), serves to identify the appropriate data model by assessing the consistency between the fixed-effect model and the random-effect model. If there is no significant difference in the estimated values between the two models, it implies that the random-effect model is more efficient. On the other hand, if a notable difference in the estimates exists, it suggests the utilization of a fixed-effect model.

Empirical Results

Table 1 displays the descriptive statistics for the unbalanced panel sample spanning the period of 2006 to 2020, consisting of 5616 firm-year observations. The CO₂ emission intensity had a mean (median) value of 0.1734 (0.0214) and a maximum value of 12.9362. The mean (median) value of Board meeting frequency was 7.4516 (7) and the maximum value was 20. The mean (median) value of Board size was 7.3907 (7), with a maximum value of 15. The Debt had a mean (median) value of 0.4119 (0.4077) and a maximum value of 0.8743. The R&D investment had a mean (median) value of 0.048443 (0.029725) with a maximum value of 8.6920. Additionally, the mean (median) natural logarithm of Firm Size was 6.8907 (6.7882) with a maximum value of 8.6920. All variables are found to be non-normally distributed according to the Jarque-Bera statistics.

Table 1. Descriptive Statistics

	<i>Mean</i>	<i>Medium</i>	<i>Max.</i>	<i>Min.</i>	<i>Std.Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Jarque-Bera</i>
CO ₂	0.173666	0.00251	12.9362	8.92E-06	1.22483	9.351976	92.4179	1952824***
Meeting	7.451567	7.00000	20.0000	0.000000	3.60802	0.810520	4.89239	1452.893***
Bsize	7.39067	7.00000	15.0000	4.00000	2.25470	1.43524	5.48864	3377.333***
Debt	6.890682	6.788186	8.692000	5.745900	0.602417	0.852550	3.641855	776.7271***
R&D	0.048443	0.029725	0.277114	0.000000	0.057489	2.156812	7.761114	9658.481***
Fsize	0.411935	0.407666	0.874348	0.062749	0.171647	0.166834	2.496073	85.47497***

Notes: *** indicate significance at the 1 % levels, separately. CO₂, used for the ratio of carbon emission to net sales revenue to minimize heterogeneity problem which arises from different size. Meeting is the number of meetings of the board of directors; Bsize is the number of board members; Debt used for the total debts divided by total assets and R&D used for the ratio of R&D investment to net sales revenue. Fsize is the natural logarithm of total assets.

Table 2 presents the Pearson correlation analysis results, which revealed significant negative associations between CO₂ emissions and Meeting, Board size, Debt, and Firm size, while a positive association was observed with R&D. Furthermore, Meeting was negatively associated with Debt and Firm size, but

positively associated with Board size. Board size was positively associated with Debt. Debt was negatively associated with R&D, while a positive association was found with Firm size. Lastly, R&D showed significant negative associations with Firm size.

Table 2. Pearson Correlation Analysis

Probability	CO ₂	Meeting	Bsize	Debt	R&D	Fsize
CO ₂	1.000000					
Meeting	-0.027361**	1.000000				
Bsize	-0.054508***	0.094515***	1.000000			
Debt	-0.130158***	-0.025143	0.059387***	1.000000		
R&D	0.060550***	0.024581	-0.004982	-0.174745***	1.000000	
Fsize	-0.057994***	-0.048905***	-0.007424	0.295205***	-0.351870***	1.000000

Notes: *** indicate significance at the 1 % levels, separately. CO₂, used for the ratio of carbon emission to net sales revenue to minimize heterogeneity problem which arises from different size. Meeting is the number of meetings of the board of directors; Bsize is the number of board members; Debt used for the total debts divided by total assets and R&D used for the ratio of R&D investment to net sales revenue. F size is the natural logarithm of total assets.

The Hausman test was employed to determine the suitability of the random-effects model versus the fixed-effects model for the study. The result of the test, as shown in Table 3, indicated that the probability value (0.1156) greater than the chi-square value. As a result, the null hypothesis was not rejected, suggesting that the random-effects model is indeed appropriate for our study.

Table 3. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f	P-value
Cross-section random	8.840572	5	0.1156

The results of model 1, as presented in the random-effects panel data analyses results depicted in Table 3, reveal an insignificant correlation between board meetings and carbon emission intensity. This finding does not provide support for Hypothesis 1. This suggests that there is no correlation between the frequency of board meetings and carbon emissions, which is consistent with the results of Prado-Lorenzo et al. (2009) ; Liao et al. (2015) and Hossain et al. (2017) (Prado Lorenzo, 2009). On the other hand, the coefficient estimate for board size is -0.01391, which is significant at the $p < 0.01$ level. This result indicates that board size has a significantly negative effect on carbon emission intensity, implying that a larger board can improve environmental performance. Thus, Hypothesis 2 is verified. This finding is consistent with the results of Ben-Amar et al. (2017), Prado-Lorenzo & Sánchez (2010), Giannarakis et al. (2017), and Hossain et al. (2017). It supports the argument that a larger board can promote better carbon performance by reducing carbon emissions.

Regarding the coefficient estimations of the control variables, the results showed that both the debt ratio and firm size were significantly negatively related to carbon emission intensity. This suggests that firms with high debt ratios may need to allocate more resources to repay their debt, and creditors may request more information from the company to assess potential risks. As a result, firms may choose to voluntarily disclose information or reduce carbon emissions to mitigate risks. The finding that larger firms tend to have better environmental performance through increased CSR aligns with previous studies, including Bosun-Fakunle et al. (2023) ; Ben-Amar et al. (2017); Prado-Lorenzo & Garcia-Sanchez (2010); Giannarakis et al.(2017), and Hossain et al.(2017). This may be due to the fact that larger firms are subject to greater scrutiny and expectations from investors and the media, which incentivizes them to prioritize transparency and social responsibility initiatives.

Table 4. Random-Effects Panel Data Analyses

<i>Variable</i>	<i>Coefficient</i>	<i>t-Statistic</i>
Meeting	0.001779	0.997799
Bsize	-0.013910	3.281767***
Debt	-0.160362	-4.546571***
R&D	-0.259920	-1.059968
Fsize	-0.168932	-2.598188***
Constant	1.450390	5.970505
F-Value	10.96216	
R-squared	0.015142	

Notes: *** indicate significance at the 1 % levels, separately. CO₂, used for the ratio of carbon emission to net sales revenue to minimize heterogeneity problem which arises from different size. Meeting is the number of meetings of the board of directors; Bsize is the number of board members; Debt used for the total debts divided by total assets and R&D used for the ratio of R&D investment to net sales revenue. Fsize is the natural logarithm of total assets.

Conclusions

Among the three pivotal aspects of ESG (Environmental, Social, and Governance), climate change undeniably possesses the most substantial environmental impact on enterprises. Since the advent of the Industrial Revolution, human civilization has granted remarkable levels of convenience in daily life, but it has also inflicted considerable harm upon our planet. In a report published by the World Economic Forum in 2021, "extreme climate risks" have consistently been identified as the most probable future risks for five consecutive years. Managing greenhouse gases stands as the paramount concern in climate governance. Following the Paris Agreement in 2015, governments worldwide have committed to achieving carbon neutrality and net-zero emissions, with a collective pledge to reduce human-induced net emissions into the atmosphere to zero by the year 2050.

Furthermore, driven by foreign investment pressures and international customer demands, the voluntary publication of reports by enterprises has increasingly become a prevailing practice. Moreover, an escalating number of firms at the global level are releasing ESG summaries and establishing multilingual sustainable websites. These initiatives place emphasis on the correlation between business performance and sustainable strategies, reflecting the growing recognition of the importance of integrating ESG considerations into corporate practices. The Board of Directors plays a critical role in promoting sustainable development for businesses. Adopting a comprehensive ESG sustainable development strategy to encourage innovative operating models and management systems can not only increase profitability but also help achieve the goal of reaching net-zero carbon emissions by 2050. This study examined the relationship between board meetings, board size, and CO₂ emissions in Taiwan's electronics industry from 2006 to 2020. Results showed that the frequency of board meetings had no correlation with carbon emissions, while a larger board size was associated with better environmental performance. The study suggests that the electronics industry can utilize the board's sustainable development responsibility to pursue energy conservation and carbon reduction, fulfilling its social responsibility.

Research Limitations and Recommendations

The carbon emissions in this study stem exclusively from the value conscientiously disclosed by the company on TEJ. The dependability of said value remains undetermined. Subsequently, in order to satisfy the requisites of legal and regulatory entities, the company merely prompted the attention of its board of directors towards

the matter of sustainable development. As a result, the Taiwan Financial Supervisory Commission issued the sustainable development roadmap for listed firms in 2022, progressively obligating firms to divulge their carbon emissions. Conceivably, the magnitude of mandatory disclosure by firms deviates considerably from that of voluntary disclosure. Hence, this study proposes that forthcoming investigations be undertaken to compare the mandatory disclosure of carbon emissions and actual carbon emissions.

In 2017, Taiwan-listed firms completed the establishment of independent directors. However, there is still room for improvement regarding the norms related to independent directors, including the number of seats and their term of office. In 2021, the "Corporate Governance 3.0 - Sustainable Development Blueprint" was introduced to strengthen the relevant provisions concerning independent directors on the board. The aim is to enhance the sustainable value of the company. Therefore, this research proposal suggests investigating the impact of other factors, such as board diversity, independent directors, and managers' shareholding, on carbon emissions in Taiwan-listed firms. Additionally, exploring carbon emissions through the Carbon Disclosure Scheme can provide valuable insights.

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