environments

Article

Effects of Board Independence on Greenhouse Gas Emissions and Financial Consequences: Evidence from South Korea

Sang Joon Kim [1,2], Hohyun Kim [3] and Erdal Atukeren [2,*]

[1] Seoul Business School, aSSIST University, 46, Ewhayeodae 2-gil, Seodaemun-gu, Seoul 03767, Republic of Korea
[2] BSL Business School Lausanne, Rte. de la Maladierè 21, P.O. Box 73, CH-1022 Chavannes, Switzerland
[3] School of Management and Economics, Handong Global University, 558 Handong-ro, Buk-gu, Pohang 37554, Republic of Korea
* Correspondence: erdal.atukeren@bsl-lausanne.ch

Abstract: Because of climate change issues, greenhouse gas (GHG) emissions have been emerging as an important research topic in recent years. This study examines the role of corporate governance in reducing GHG emissions by focusing on board independence. We use the industry fixed effect panel regression model to analyze data from 156 listed South Korean firms during the period from 2011 to 2019. Our results suggest that board independence is related positively with the reduction in GHG emissions. In addition, our evidence shows that firms with higher levels of GHG emissions have better financial performance, but board independence weakens the relation. Our findings imply that an independent board tends to focus on balancing the firm's financial versus environmental performance. This quantitative study contributes to our understanding of the effects of corporate effects on firms' GHG emissions and their financial consequences. The findings have implications for corporate managers and policymakers with respect to choosing corporate governance structures that reduce GHG emissions effectively.

Keywords: board independence; corporate governance; greenhouse gas (GHG); environmental performance; financial performance; ESG

check for updates

Citation: Kim, S.J.; Kim, H.; Atukeren, E. Effects of Board Independence on Greenhouse Gas Emissions and Financial Consequences: Evidence from South Korea. *Environments* **2023**, *10*, 56. https://doi.org/10.3390/environments10030056

Academic Editors: Shu-Yuan Pan, Daeseung Kyung, Cheng-Hsiu Yu and Yu-Pin Lin

Received: 5 February 2023
Revised: 14 March 2023
Accepted: 16 March 2023
Published: 18 March 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Climate change is one of the most critical issues in global society today, and its associated problems have influenced corporate businesses and assets significantly [1]. Scientific evidence shows that greenhouse gas (GHG) emissions play a significant role in global warming and climate change [2]. Global efforts such as the "United Nations Framework Convention on Climate Change" and the "Paris Agreement" have been made to address climate concerns. In addition, most developed countries have announced "Net Zero" plans to reduce net GHG emissions to zero. Corporations are among the largest emitters of GHGs and thus have a responsibility to address this issue. Accordingly, the questions concerning the way corporations should be governed and the way governance structures determine Environmental, Social, and Governance (ESG) performance have been raised [3,4]. Scholars have investigated the role that corporate governance plays in GHG emissions, as effective governance practices can help companies reduce their carbon footprint and mitigate climate risks [2,4]. Among firm-related governance factors, board composition, institutional ownership, laws and regulations, accounting and auditing, and stakeholder pressure have been studied [5–7]. Further, researchers have attempted to understand the relation between carbon performance and financial performance, but have obtained heterogeneous results. For example, Refs. [8,9] demonstrated a positive relation between reduced GHG emissions and financial performance, but Refs. [10,11] found a negative association between the two. In this study, we attempt to examine the

role that board independence plays in reducing GHG emissions as well as its effect on the relation between GHG emissions and financial performance.

Carbon performance is described generally as measures or processes that reduce GHG emissions [12]. A large investment is required to improve carbon performance with ambiguous consequences that affect various stakeholders in different ways [1]. Corporate managers tend to make short-term decisions in response to market pressures to increase investment value and stock prices [13]. According to the previous literature [3,6], internal directors are more inclined to pursue short-term economic goals, while outside directors who represent various stakeholders tend to adopt a long-term perspective. Therefore, a diversified and unbiased board is required to alleviate conflicts of interest among various stakeholders [7]. However, few empirical studies have explored the relation between board independence and GHG emissions. Moreover, existing studies have investigated the effects of board characteristics on carbon disclosure rather than GHG emissions. In general, carbon disclosure is a binary variable that takes a value of 1 for firms that disclose their carbon footprint information. Many empirical studies have been conducted to understand the association between GHG emissions and financial performance [9,11,14] but have obtained inconclusive results. Thus, some scholars have attempted to employ various moderators, including governance-related variables, to understand when reduced GHG emissions improve financial performance. However, thus far, few studies have investigated board independence to understand GHG emissions and financial performance. In this study, we focus on board independence as our main corporate governance measure because corporate governance experts consider board independence an important factor that can bridge the gap between managers' and shareholders' interests [13]. The purpose of this study is to fill that gap by investigating the relation between board independence and GHG emissions and board independence's effect on the relation between carbon and financial performance.

This study employs board independence data together with GHG emissions and financial data of listed firms that operate in South Korea. Board independence is defined as the proportion of outside directors on the board. GHG emissions data are obtained from the National GHG Emissions Information System. As the amount of GHG emissions are quantitative, not qualitative data, a more precise analysis can be conducted [15]. We apply Tobin's q as a market-based measure of financial performance, and use return on equity (ROE) as an accounting-based metric. The sample contains 1404 firm-year observations for 156 listed companies from 2011 to 2019. The effects of board independence on GHG emissions and on the relation between GHG emissions and financial performance are investigated using multivariate regression models.

The results show that board independence is related positively with a reduction in GHG emissions. This positive relation is consistent with the finding of [1], which also found a positive relation between independent directors and carbon performance. In addition, our evidence shows that companies that produce more GHG emissions have better financial performance, but board independence weakens that positive relation. These findings suggest that independent directors are more likely to consider the benefits and long-term financial consequences of reducing GHG emissions. When we divide the sample into two groups, one with a higher percentage of independent directors versus one with a lower percentage, firms with a higher proportion of outside directors show a negative relation between GHG emissions and financial performance. In addition, the patterns are more significant when a market-based measure of financial results is employed rather than an accounting-based measure. These results imply that independent directors tend to pursue sustainable development by balancing financial versus environmental performance. Further, they appreciate the financial benefits resulting from reducing GHG emissions from a long-term perspective.

This empirical research contributes to the existing body of literature on corporate governance and carbon performance in numerous ways. First, we provide empirical evidence of the way governance-related factors influence GHG emissions as well as the relation between GHG emissions and financial performance. Other studies have used

quality indices to measure carbon performance, such as participation in CDP, or aggregated quality indices such as ASSETS4 or MSCI ESG STATS. By employing the actual amount of GHG emissions at the firm level, we present quantitative information on the extent to which board independence contributes to the decrease in GHG emissions and weakens the relation between GHG emissions and financial performance. Second, our evidence suggests a moderating variable to explain the heterogeneous relation between environmental and financial performance. Many scholars have attempted to determine this relation by considering diverse variables. For example, Ref. [16] employed firm size as a moderating variable; Refs. [17,18], pollution levels; and Refs. [19,20], environmental strategies, but few studies have investigated board characteristics in the GHG emissions context. Finally, we extend the scope of empirical research by using a South Korean sample. South Korea's carbon emissions have continued to increase and ranked seventh worldwide as of 2019. The trend in Korea is in contrast to that in the U.S. and Europe, which have shown a decreasing trend every year. Korea's per capita GHG emissions are 11 tons: twice that of Europe. Some researchers have examined the effect of Corporate Social Responsibility (CSR) performance or Environmental, Social, and Governance (ESG) rating on financial performance in Korea [21,22], but few studies have been conducted to understand GHG emissions at the firm level in South Korea. In summary, our findings suggest the importance of corporate governance structure in addressing challenges of climate change and the policy implications that certain numbers of outside directors should be maintained to balance a firm's financial versus environmental performance.

The remainder of this study is organized as follows: In Section 2, the theoretical backgrounds of the relation between corporate governance and carbon performance are examined and our research hypotheses are formulated. In Section 3, we discuss the study's methodology and empirical models. Section 4 describes the principal findings, and finally, the research findings are discussed in Section 5.

2. Literature Review and Hypotheses Development

2.1. Effects of Corporate Governance on Carbon Performance

According to the agency theory, conflicts of interest are often observed between managers and shareholders because managers attempt to increase their short-term interests at the expense of shareholders' long-term interests [23]. From the manager's perspective, significant investments are required to improve environmental performance by redesigning production processes or acquiring new equipment. In contrast, rewards for environmental performance are realized in the long term [24]. This explains why CEOs are reluctant to invest in projects that do not offer short-term financial benefits [6]. Previous studies have shown that corporate governance improves carbon performance [2], and independent directors tend to pursue sustainable development from a long-term perspective [1]. Ref. [25] found that diverse and independent boards provide better corporate governance by sharing experiences and opinions from broader and different domains. According to [13], independent directors play a crucial role in determining how well a company performs and protecting stakeholders by preventing managerial self-interest. Further, independent directors can help minimize moral risks by monitoring managerial behavior. By mediating conflicts between minority and majority shareholders and monitoring managers, independent directors can improve managers' performance, which ultimately leads to better company performance. In particular, independent directors, who have interests different from management, can provide an effective monitoring mechanism and restrict management's opportunistic behavior [26]. Because independent directors are more attuned to social demands [27] and are more concerned with social performance [6], they make greater efforts to improve a firm's environmental image by reducing GHG emissions. In addition, independent directors have a strong stakeholder orientation because outside directors do not participate in daily operations [6] and do not have a direct financial stake in a firm [28]. The stakeholder orientation allows a company to consider the requirements of all of a firm's stakeholders beyond focusing on the mere interests of shareholders or management [29].

Thus, while CEOs are reluctant to invest in reducing GHG emissions that take a long time to realize financial benefits, independent directors can appreciate the opportunities that can be realized through GHG emission reduction projects and prevent CEOs from overlooking these opportunities [1].

The previous literature has examined the effects of board characteristics on environmental performance at the firm level by focusing on the relation between board diversity and carbon disclosure or between board independence and disclosure quality. According to [30], independent directors affect participation in the Carbon Disclosure Project (CDP) positively and the national diversity of a board has a substantial positive effect on carbon disclosures. Further, [31,32] reported that independent directors have positive effects on the quality of disclosures, while in contrast, Ref. [33] suggested that they have no effect on carbon performance. In addition, Ref. [7] investigated the relation between various board characteristics and carbon performance, and concluded that board independence is associated favorably with carbon reduction measures, but has no influence on reducing GHG emissions. Thus, previous studies have not provided consistent results.

The findings of the positive association between independent directors and carbon performance were presented by [1,30]. In these studies, carbon performance was measured by participation in CDP, which is voluntary, as a firm is not under a statutory obligation. CDP participation is used often as a variable in governance-related studies, but it reduces the validity of the research [2]. Because CDP participation is not a quantitative indicator of reduced GHG emissions, their reduction by firms cannot be captured in an analysis model based on firms' participation in CDP. Therefore, a variable to measure the amount of GHG emission reduction is required to comprehend the independent directors' effects on the reduction. In this study, the following hypothesis (Hypothesis 1) is tested by analyzing the relation between the percentage of outside directors on the board and the amount of GHG emissions at the firm level:

Hypothesis 1. *Board independence has a positive effect on a firm's reduction of GHG emissions.*

2.2. The Relation between Carbon and Financial Performance

Many scholars have attempted to resolve the long-standing debate on the association between corporate environmental performance (CEP) and corporate financial performance (CFP) [34–37]. Among existing studies, large numbers of works have found that the relation between CEP and CFP is positive, but other studies have shown a negative or nonsignificant relation. In the same manner, numerous academics have analyzed the relation between financial and carbon performance, which is defined as the inverse value of GHG emissions. These findings have shown contradictory results or insignificant relations as well. Refs. [8,38–43] demonstrated a positive relation, indicating that the reduction in carbon emissions improves financial performance. In contrast, Refs. [11,44,45] suggested that a decrease in carbon emissions affects financial performance adversely. Ref. [8] found that carbon performance has a negative effect on Return on Assets (ROA) but a positive effect on Tobin's q, which demonstrates that different results may be obtained depending upon the financial performance measures used. Meanwhile, Refs. [46–49] indicated that there was no significant relation between carbon performance and financial performance, while Refs. [50–53] suggested a curvilinear (U-shaped) relation by demonstrating that financial results can be improved at the optimal level of carbon performance.

The stakeholder theory, resource-based view, and eco-efficiency concept explain the positive relation between carbon and financial performance. According to stakeholder theory, firms communicate with many stakeholders [54]. When a firm responds to stakeholder pressure, legitimacy is established in its relation with stakeholders and the firm's reputation can be enhanced [55]. As a result, the firm gains a competitive advantage and improves its financial performance. If a company improves its carbon performance, the risk of environmental lawsuits diminishes and the capital market recognizes the company's efforts by reducing the risk premium, which also leads to improved financial performance [1,2].

However, when a firm fails to communicate properly with the regulatory body that creates environmental standards, the firm's reputation is damaged, and environmentally conscious consumers' demand for the firm's products and services decreases [56]. Further, customers are willing to pay a higher price for the goods of a firm with better environmental performance, which increases the company's financial performance [57]. Another theory is the Resource-based View (RBV), which presents the VRIO (Value, Rarity, Imitability, and Organization) framework to identify resources that allow a firm to obtain a competitive advantage [58]. Per the RBV theory, a company's actions and strategies in response to its business environment can be used as resources to gain a competitive advantage [8]. For example, developing clean production processes allows a company to take advantage of them to obtain a competitive advantage [35]. If a company invests actively in an environmental strategy beyond pollution control, company-specific capabilities can be developed, and competitors cannot imitate or reproduce these capabilities in a short period of time [59]. In addition, environmentally friendly practices can make a firm attractive, help recruit talented employees, and reduce employee turnover [60]. Lastly, the eco-efficiency concept illustrates the positive relation between carbon and financial performance by demonstrating that financial results can be enhanced by lowering input materials and enhancing manufacturing process efficiency [61]. A company can reduce operational costs related to resources and energy through a business strategy referred to as the eco-efficiency concept [62], and environmental performance can be achieved by reducing operational costs [61]. Further, a decrease in carbon emissions decreases the firm's operational expenses and contributes to the firm's improved financial performance [63].

The claim that reducing carbon emissions has an unfavorable effect on financial performance is based on the neoclassical view. Neoclassical theorists contend that environmental investment reduces profitability and eliminates the opportunity to improve competitiveness [64]. The reduction in GHG emissions imposes additional costs on companies [65], and environmental protection does not realize immediate financial benefits and affects companies' financial structure adversely in the short-term [66]. The resources employed to enhance environmental performance may be deployed more effectively to increase business efficiency [67] and responding to the environment has negative effects on corporate performance. Because of the compromise between environmental and financial performance, firms' profits will decline if they invest more in pollution control [50,68]. Accordingly, several studies have demonstrated that carbon performance affects financial performance detrimentally.

Because of the heterogeneous results of the relation between environmental and financial performance, several scholars have analyzed various moderators to understand "When does it pay to be green?" For instance, Refs. [69,70] indicated that larger companies derive more financial benefits from improved environmental performance. According to [71], environmental performance has varied consequences on financial performance for polluting and non-polluting sectors because of differing stakeholder needs. In [17,18], the authors employed the level of pollution (i.e., high-polluting industries and clean industries) as moderating variables, but, again, these studies demonstrated contradictory results. Ref. [72] found that internationalization, which is measured by dividing foreign sales by total sales, strengthens the relation between climate change mitigation and sales effectiveness. Moreover, carbon-intensive industry was added as a moderator variable in [73], which demonstrated that the effect of cost of equity is greater for companies that operate in less-carbon-intensive sectors. Further, the industry context was considered to determine whether the relationship between GHG emissions and financial performance differs between B2B (Business-to-Business) and B2C (Business-to-Customer) contexts [74]. Their findings suggest a positive relation between GHG emissions and Tobin's q for B2B firms and a negative relation for B2C firms. According to [75], carbon performance has a positive effect on the cost of debt only for firms that do not participate in the CDP. However, Ref. [19] did not find significant differences between public companies and private companies or between high-polluting companies and less-polluting companies. This study

includes board independence as a moderator to understand the relation between GHG emissions and financial performance. According to arguments of the neoclassical theory, we assume that companies that produce larger amounts of GHG emissions show better financial performance. However, independent directors appreciate the benefits of reducing GHG emissions and pursue sustainable development from a long-term viewpoint [1]. Therefore, it is expected that the relation between the reduction in GHG emissions and financial performance will be weaker for companies with high board independence.

Hypothesis 2. *A positive effect of carbon performance on financial performance is more significant for companies with high board independence than companies with less independence.*

3. Materials and Methods

The sample data were obtained from South Korean firms that are obligated to report their GHG emissions data. According to the "Carbon Neutral Green Growth Framework Act" that was established in 2010, carbon-intensive firms that produce over 50,000 tons CO_2-eq or plants that produce over 15,000 tons CO_2-eq annually must report their GHG emissions. These firms are required to reveal their Scope 1 (direct emissions) and Scope 2 (indirect emissions) according to the Greenhouse Gas Protocol, which provides guidance on the ways to quantify and report the emissions figures [76]. The number of firm-year observations included in the full sample is 7312 from 2011 to 2019, which includes 951 entities. These entities' total emissions accounted for 89% of nationwide emissions in 2019. After unlisted firms and public institutions were removed, the number of firms in the sample decreased to 391, which accounts for 35% of nationwide emissions. Further, listed firms with 9-year emissions data were obtained for the final sample to employ a balanced panel to accommodate each firm's year-by-year variations sufficiently. Finally, a sample of 1404 firm-year observations was obtained, which included 156 listed firms. In 2019, the total emission amount from these 156 firms was 222,562,867 tons CO_2-eq, which accounted for 31% of nationwide emissions. Next, the emissions data were matched with financial data from DataGuide. Appendix A details the sample selection procedure that yielded 1404 firm-year data. The panel unit-root test results show that the GHG emissions variables are stationary.

The industry distribution of sample firms is provided in Appendix B. Samples from firms that manufacture chemicals and chemical products constitute 17% of the total sample, followed by those that manufacture basic metals (14%); those that manufacture pulp, paper, and paper products (12%); and those that manufacture electronic components, computers, and visual, counting, and communication equipment (9%).

To understand the association between board independence and GHG emissions, a GHG intensity variable (*CARBON*) is regressed on board independence (*B_IND*), as in Equation (1):

$$CARBON_{i,t+1} = \beta_0 + \beta_1\, B\_IND_{i,t} + \gamma X_t + \text{year\_fixed\_effects} + \text{industry\_fixed\_effects} + \varepsilon_{i,t,} \quad (1)$$

where i denotes firms and t, periods. The dependent variable, *CARBON*, is measured by dividing the total GHG emissions by total assets (*GHG/TA*) and by sales (*GHG/SALES*), respectively. The amount of GHG emissions is converted to kilograms, while a company's assets and sales are measured in thousands of Korean won (KRW). This indicates how much GHG is produced per total asset measured by one thousand KRW and per sales of one thousand KRW, respectively. The independent variable, board independence (*B_IND*), is computed as the number of outside directors divided by the total number of directors, and represents the independence in decision-making [30]. In addition, the equation includes control variables that are known to influence carbon performance [1,6]. Profitability (*ROA*) is determined by dividing net income by total assets. To determine leverage (*LEV*), total liabilities are divided by total assets. Capital expenditure (*CAPEX*) is defined as the ratio of capital expenditure to sales. The ratio of market-to-book value of equity (*MB*) is also included as a control variable, as companies with a larger market-to-book ratio have more

investment opportunities and are more likely to demonstrate superior environmental performance [6]. Further, the regression model includes year and industry dummy variables. The fixed effect model eliminates unobserved industry features that are associated highly with the explanatory variables and adjusts for time-invariant industry characteristics.

In our study, the potential endogeneity problem is addressed using one-period lagged values of the relevant right-hand-side variables in the model. Because the future cannot cause the past, the right-hand-side-variables can be considered predetermined, thus alleviating the potential endogeneity problem. There may also be common third factors that are not controlled in a relation among the variables of interest. In our case, the common factors that can affect the relation between the dependent variable and the independent variables may be the unobservable firm and CEO characteristics, firm risk, executive compensation, and asset tangibility, among others. A range of techniques, such as instrumental variables, panel data models, difference-in-differences (DIDs), and regression discontinuity (RD) designs, can be considered to address the problem that arises from the presence of common factors and endogeneity. We employed a panel data model that included industry-fixed effects and year-fixed effects to do so. Fixed-effect models control for time-invariant unobservable variables by estimating the relation between variables within groups over time. This technique is particularly useful for panel data where observations are collected from the same individuals or units over time. By controlling time-invariant unobservable variables, fixed-effect models can help identify the causal effect of variables of interest. Note that more powerful tools such as DIDs and RD could not be implemented in the Korean setting because no structural changes in board independence occurred during the period that corporate carbon emissions were collected.

Hypothesis 2 examines the effect of board independence on the relation between GHG emissions and financial performance. To test the hypothesis, financial performance (*FP*) is regressed on carbon intensity (*CARBON*) and an interaction term of *CARBON* and *B_Dummy* is included, as in Equation (2):

$$FP_{i,t+1} = \beta_0 + \beta_1 CARBON_{i,t} + \beta_2 B\_Dummy_{i,t} + \beta_3 CARBON_{i,t} \times B\_Dummy_{i,t} + \gamma X + \text{year\_fixed\_effects} + \text{industry\_fixed\_effects} + \varepsilon_{i,t,} \quad (2)$$

where *B_Dummy* takes the value of 1 for the firms in which board independence is 0.4 or more and takes the value of 0 otherwise. Note that the statistical analysis shows that the median value for board independence (*B_IND*) is 0.4. Two different financial measures are employed for the financial performance (*FP*) measure. Return on equity (*ROE*) is an accounting-based measure, defined as the net income over the shareholder's equity, and *Tobin's q* is a market-based measure, defined as the sum of the book value of equity and the book value of total liabilities divided by the book value of total assets [36,51]. Total GHG emissions are divided by total asset (*GHG/TA*) and sales (*GHG/SALES*) for carbon performance (*CARBON*), as defined in Equation (1).

To alleviate endogeneity problems, the financial performance variable (*FP*) is advanced by one year (FP_{t+1}). Endogeneity may occur with the presence of simultaneous causality, which the slack resource theory explains. According to [77], improvement in environmental performance can be associated with an increase in financial performance, which implies that the relation's direction is unclear. In previous research [11,53,76], the independent variable of carbon performance was lagged by one year. In a similar manner, the dependent variable for this empirical research, financial performance (*FP*), is advanced by one year to address endogeneity issues according to [74]. Consequently, the reliability and robustness of the empirical analysis pertaining to the direction of the association can be enhanced. Further, the regression model includes year and industry dummy variables, as in Equation (1).

Leverage (*LEV*) and capital expenditure (*CAPEX*) are included as control variables, as in (1), as well as other variables known to affect financial performance, such as firm size (*SIZE*), advertisement intensity (*ADV*), R&D intensity (*R&D*), asset growth (*ASSETS GRWTH*), and sales growth (*SALES GRWTH*) [74]. *ADV* is calculated by dividing advertising expense by sales; *R&D*, by dividing research and development costs by sales; *ASSETS*

GRWTH, by dividing the current year's assets growth by the previous year's assets; and *SALES GRWTH*, by dividing the current year's sales growth by the previous year's sales [8,45,49]. *ASSETS GRWTH* is used in the regression model with the independent variable *GHG/TA*, while *SALES GRWTH* is used in one with *GHG/SALES*, consistent with [74].

4. Results

4.1. Descriptive Statistics

Descriptive statistics for the variables used in models (1) and (2) are presented in Table 1. All continuous variables employed in the analysis models are Winsorized at each end (i.e., 1st and 99th percentiles) to address outliers. The mean of board independence is 0.4260, indicating that the average ratio of independent directors is less than 50 percent. The *GHG/TA* variable, which is defined as GHG emissions over total assets, has a mean of 0.3725, demonstrating that companies produce an arithmetic mean of 0.3725 kg of carbon dioxide per assets measured in thousand KRW. Further, the mean of 0.5424 for *GHG/SALES* indicates that companies produce a mean of 0.5424 kg of carbon dioxide per sales measured in thousand KRW. The sample mean of the profitability ratio (*ROE and ROA*) is positive and the mean of *Tobin's q* is less than 1. This implies that the sample firms were predominantly profitable between 2011 and 2019, and that their market value is, on average, less than their book value.

Table 1. Descriptive Statistics.

Variable	Mean	SD	Min	Max	No. of Obs.
B_IND	0.4260	0.1593	0.0000	0.8333	1369
GHG/TA	0.3725	0.6758	0.0028	4.8704	1404
GHG/SALES	0.5424	1.2664	0.0041	8.6572	1404
ROE_f1	0.0035	0.2526	−1.8685	0.3896	1401
Tobin's Q_f1	0.9741	0.4076	0.4233	2.6721	1372
SIZE	21.1426	1.8125	18.2435	26.0672	1404
LEV	0.4942	0.2087	0.0926	0.9608	1404
ROA	0.0223	0.0584	−0.2239	0.1914	1404
MB	0.9450	0.8012	0.0000	4.6518	1404
ADV	0.0044	0.0102	0.0000	0.0663	1404
R&D	0.0061	0.0134	0.0000	0.0780	1404
CAPEX	0.0799	0.1065	0.0000	0.6457	1404
ASSETS GRWTH	0.0408	0.1363	−0.3455	0.6813	1398
SALES GRWTH	0.0366	0.1744	−0.4214	0.7980	1398

B_IND (Board Independence): The number of independent directors divided by the total number of directors; *GHG/TA* (Carbon Intensity): Total greenhouse gas emissions in kilograms divided by total assets in thousand Korean Won; *GHG/SALES* (Carbon Intensity): Total greenhouse gas emissions measured in kilograms divided by sales measured in thousand Korean Won; *ROE_f1* (Accounting-based Financial Performance): Year t + 1 net income divided by equity; *Tobin's q_f1* (Market-based Financial Performance): Year t + 1 market of equity and book value of total liabilities divided by book value of total assets; *SIZE* (Firm Size): The natural logarithm of total assets expressed in thousand Korean Won; *LEV* (Leverage): Total liabilities divided by total assets; *ROA* (Return on Assets): Net income divided by total assets; *MB* (Market to book value): Market value divided by book value of equity; *ADV* (Advertisement Expense): Expenses for advertising divided by sales; *R&D* (R&D Intensity): Research and Development expense divided by sales; *CAPEX* (Capital Intensity): Capital expenditure divided by sales; *ASSETS GRWTH* (Assets growth): Change in total assets divided by total assets at the beginning of the period; *SALES GRWTH* (Sales growth): Change in sales divided by sales during the current period.

4.2. Correlation Analysis

The correlation matrix between the variables is shown in Table 2. Significantly negative correlation coefficients were found between board independence (*B_IND*) and carbon intensity (*GHG/TA* and *GHG/SALES*). Thus, strong board independence appears to be associated with lower GHG emissions. Significantly positive correlation coefficients were found between carbon intensity and financial success as evaluated by *Tobin's q*. The positive correlation suggests that organizations with higher GHG emissions also have greater financial performance. However, if the financial performance is measured by ROE, the association is not significant. The variance inflation factors (VIFs) for all explanatory

variables are less than two (mean VIF = 1.46), indicating that the model is not vulnerable to multicollinearity.

Table 2. Correlation Matrix.

#	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	*B_IND*	1.00													
(2)	*GHG/TA*	−0.11 ***	1.00												
(3)	*GHG/SALES*	−0.09 ***	0.96 ***	1.00											
(4)	*ROE_f1*	−0.04	0.02	0.02	1.00										
(5)	*TQ_f1*	0.01	0.06 **	0.08 ***	0.08 ***	1.00									
(6)	*ROA*	−0.02	−0.01	−0.00	0.39 ***	0.20 ***	1.00								
(7)	*LEV*	0.19 ***	−0.01	−0.01	−0.30 ***	0.07 ***	−0.48 ***	1.00							
(8)	*MB*	0.01	0.05 *	0.05 *	−0.00	0.74 ***	0.17 ***	0.08 ***	1.00						
(9)	*CAPEX*	0.05 *	−0.04	0.04	0.08 ***	0.10 ***	0.11 ***	0.04	0.08 ***	1.00					
(10)	*SIZE*	0.57 ***	−0.22 ***	−0.17 ***	0.02	−0.02	0.02	0.26 ***	−0.04	0.18 ***	1.00				
(11)	*R&D*	0.16 ***	−0.08 ***	−0.06 **	0.08 ***	0.15 ***	0.10 ***	−0.05 *	0.11 ***	0.22 ***	0.27 ***	1.00			
(12)	*ADV*	0.19 ***	−0.16 ***	−0.13 ***	0.06 **	0.02	0.04	0.01	0.02	0.11 ***	0.27 ***	0.03	1.00		
(13)	*ASSETS GRWTH*	−0.01	−0.06 **	−0.03	0.14 ***	0.09 ***	0.33 ***	−0.08 ***	0.10 ***	0.59 ***	0.08 ***	0.06 **	0.05 **	1.00	
(14)	*SALES GRWTH*	−0.05 *	0.00	−0.00	0.09 ***	0.08 ***	0.24 ***	−0.01	0.10 ***	0.21 ***	0.03	0.02	0.03	0.43 ***	1.00

The symbols *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

4.3. Hypotheses Tests

Table 3 presents the results of the hypothesis test for Equation (1). The results of testing Hypothesis 1 indicate that board independence is related negatively with GHG emissions, and this supports Hypothesis 1. The negative association indicates that a higher proportion of independent directors helps reduce GHG emissions. The coefficients for the model are statistically significant regardless of whether industry-fixed effects are included. This negative correlation is consistent with the findings of [1], whose research suggested a positive correlation between independent directors and carbon performance. The findings contribute to the current body of knowledge by providing empirical evidence that board independence can affect GHG emissions. Previous research has demonstrated a favorable correlation between independent directors and carbon performance [1,30], but carbon performance was measured by participation in CDP, which is not a quantitative measure of GHG emissions. Thus, our research advances the understanding of the relation between board independence and carbon performance measured by quantitative indicators.

Table 3. Board Independence and Carbon Performance.

	Dependent Variable			
	GHG/TA		***GHG/SALES***	
Independent Variable				
B_IND	−0.4670 ***	−0.2330 **	−0.7441 ***	−0.3620 *
	(−4.00)	(−2.06)	(−3.56)	(−1.81)
ROA	−0.2130	−0.2517	−0.4516	−0.6459
	(−0.32)	(−0.48)	(−0.39)	(−0.73)
LEV	−0.0015	0.2926 **	−0.0115	0.5451 **
	(−0.01)	(2.33)	(−0.04)	(2.51)
MB	0.0509	0.0688 **	0.0875	0.0973 **
	(1.40)	(2.45)	(1.30)	(1.97)
CAPEX	−0.2912 **	−0.1944 *	0.2163	0.2301
	(−1.99)	(−1.82)	(0.62)	(1.06)
Industry fixed effects	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
p-value	0.0021	0.0279	0.1392	0.0297
R^2	0.0091	0.4156	0.0030	0.4701
Number of obs.	1369	1369	1369	1369

t-statistics are presented in parentheses. The symbols *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Among the control variables, *ROA* was related negatively with carbon intensity (*GHG/TA* and *GHG/SALES*), which is consistent with [6], who indicated that organiza-

tions with adequate financial resources are more likely to implement carbon initiatives. The negative sign indicates that firms with higher profitability have a low level of GHG emissions, although the negative relation is not statistically significant. The financial leverage (*LEV*) is related positively to GHG emissions when industry-fixed effects are included. This conclusion is consistent with the results in [7,30]. If enterprises have a larger debt-to-equity ratio, they incur a greater interest payment burden, which leads to a decrease in environmental activities [30]. In particular, debt holders encourage firms to focus on a short-term view and reduce their commitment to environmental protection activities [7]. Market-to-book value (*MB*) demonstrates a positive relation with GHG emissions, which is not consistent with [6], who stated that investment opportunities are expected to be greater for companies with a higher *MB* ratio. Thus, firms with higher *MB* are assumed to exhibit better environmental performance. However, this study demonstrates a substantial positive correlation between *MB* and GHG emissions. Because firms with high GHG emissions can outperform rivals that make a costly investment in carbon management initiatives [51], GHG emissions can be positively associated with *MB*, which captures the future stream of a firm's cash flow. Finally, *CAPEX* demonstrates a negative relation with *GHG/TA* and a positive relation with *GHG/SALES*. Companies with greater capital expenditures are known to adopt clean technology that enhances energy efficiency and carbon performance [1,6]. The negative sign shows that companies with greater *CAPEX* have a lower *GHG/TA*. In this result, the same relation is not observed when GHG emissions are deflated by sales (*GHG/SALES*).

Table 4 shows the results of testing Hypothesis 2, which addresses the different relation between GHG emissions and financial performance based on board independence. The table shows the relation between GHG emissions and financial performance in terms of both accounting-based financial performance (*ROE_f1*) and market-based financial performance (*Tobin's q_f1*). In addition, the interaction between *CARBON* and *B_Dummy* in this relation is provided. Positive coefficients for carbon intensity are observed for both financial performance measures. This positive relation demonstrates that firms that emit higher levels of GHG demonstrate superior financial performance. The relation is significantly positive for *Tobin's q*, a market-based financial metric. According to [61], market-based financial performance metrics are associated more positively with GHG emissions than accounting-based metrics such as return on equity (*ROE*) and return on assets (*ROA*). *Tobin's q* can be a proxy for investor trust and investor risk, as it is correlated with the firm value [49] and captures the firm's projected future stream of earnings [76]. In contrast, short-term accounting-based indicators may not represent the costs and benefits related to environmental protection actions instantly. Therefore, *Tobin's q* can serve as a main financial performance variable to measure the expected long-term benefits of increased carbon performance. The positive relation between GHG emissions and financial performance is consistent with previous studies on the investment costs of carbon management [50,65,67,68]. If firms do not engage in innovation to reduce GHG emissions, they can outperform rivals due to the benefits of avoiding expenditures. In particular, the initial costs for carbon-efficient investments can be substantial, while costs related to reputation or legitimacy losses from poor carbon performance may not be considerable. Such costs can be large only for highly visible firms and will be lower than the savings from avoiding carbon management [51]. This study shows that the coefficients of the interaction between *CARBON* and *B_Dummy* are statistically significant only for the market-based financial performance measure. The negative sign indicates that the relation between GHG emissions and financial performance under high board independence is weaker. As independent directors are more likely to appreciate the benefits of reducing adverse environmental effects and long-term financial performance, the positive association between GHG emissions and financial performance can be weakened in companies with a high proportion of independent directors, which is consistent with Hypothesis 2.

Table 4. Effect of Board Independence on the Relation Between GHG Emissions and Financial Performance.

	Dependent Variable: *ROE_f1*				**Dependent Variable: *Tobin's q_f1***			
	Model (A)		**Model (B)**		**Model (A)**		**Model (B)**	
Independent Variable								
CARBON	0.0148	0.0122	0.0039	0.0015	0.0780 ***	0.1408 ***	0.0437 ***	0.0779 ***
	(1.05)	(0.47)	(0.51)	(0.12)	(4.50)	(5.84)	(4.32)	(5.94)
B_Dummy		−0.0344 *		−0.0341 *		0.0196		0.0206
		(−1.81)		(−1.93)		(0.70)		(0.76)
CARBON × *B_Dummy*		0.0106		0.0076		−0.1102 ***		−0.0683 ***
		(0.42)		(0.64)		(−4.70)		(−5.31)
SIZE	0.0055	0.0105 ***	0.0060	0.0110 ***	−0.0488 ***	−0.0461 ***	−0.0492 ***	−0.0479 ***
	(1.35)	(2.59)	(1.47)	(2.69)	(−6.21)	(−5.53)	(−6.24)	(−5.72)
LEV	−0.3873 ***	−0.3951 ***	−0.3953 ***	−0.4048 ***	0.3221 ***	0.3123 ***	0.3029 ***	0.2973 ***
	(−6.24)	(−6.34)	(−6.23)	(−6.33)	(5.85)	(5.60)	(5.45)	(5.29)
ADV	−0.0871	0.0104	−0.1584	−0.0786	−1.0709	−1.1819	−1.0746	−1.1968
	(−0.20)	(0.02)	(−0.37)	(−0.17)	(−0.82)	(−0.92)	(−0.83)	(−0.93)
R&D	1.1411 *	1.2687 **	0.9724 *	1.0784 *	6.8532 ***	6.6488 ***	6.6515 ***	6.4529 ***
	(1.94)	(2.08)	(1.69)	(1.81)	(6.24)	(6.12)	(6.00)	(5.86)
CAPEX	−0.0124	−0.0335	0.0907	0.0872	0.1131	0.1199	0.2254 *	0.2379 **
	(−0.14)	(−0.38)	(1.49)	(1.39)	(0.70)	(0.75)	(1.93)	(2.07)
GRWTH	0.1566 *	0.1791 **	0.0767	0.0744	0.2422 *	0.2465 *	0.2017 ***	0.2111 ***
	(1.81)	(2.04)	(1.39)	(1.29)	(1.88)	(1.92)	(3.03)	(3.13)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.1356	0.1450	0.1334	0.1414	0.2724	0.2802	0.2749	0.2853
Number of obs.	1395	1362	1395	1362	1367	1360	1367	1360

In Model A, Carbon Intensity (*CARBON*) is measured with *GHG/TA*, and in Model B, with *GHG/SALES*; t-statistics are presented in parentheses. The symbols *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

To study the role of board independence in the relation between board independence and financial performance further, the sample is split into two groups according to the median value of *B_Dummy*, as presented in Table 5. For firms below the median (*B_Dummy* = 0), *CARBON* is associated positively with *FP*, implying that companies that have more GHG emissions have better financial performance. However, for firms equal to or above the median (*B_Dummy* = 1), *CARBON* is associated negatively with *FP*. These findings suggest that companies with a high proportion of independent directors can obtain financial benefits by reducing their GHG emissions, which also supports Hypothesis 2. This argument is consistent with [1]'s conclusion that independent directors pursue sustainable development from a long-term perspective and recognize the advantages of reducing GHG emissions.

Table 5. Relation Between Carbon Emissions and Financial Performance Based on Board Independence.

	Dependent Variable: *Tobin's q_f1*			
	B_Dummy = 0		***B_Dummy = 1***	
	Model (A)	**Model (B)**	**Model (A)**	**Model (B)**
Independent Variable				
CARBON	0.1676 ***	0.0987 ***	−0.0059	−0.0156 **
	(6.24)	(6.79)	(−0.46)	(−2.16)
SIZE	−0.1019 ***	−0.1133 ***	−0.0352 ***	−0.0334 ***
	(−5.25)	(−5.70)	(−3.60)	(−3.48)
LEV	0.5142 ***	0.4909 ***	0.2104 ***	0.1909 **
	(7.33)	(6.89)	(2.66)	(2.41)
ADV	−5.3020 ***	−5.1594 ***	2.8978 **	2.7357 *
	(−2.95)	(−2.90)	(2.06)	(1.95)

Table 5. *Cont.*

	Dependent Variable: *Tobin's q_f1*			
	B_Dummy = 0		***B_Dummy = 1***	
	Model (A)	**Model (B)**	**Model (A)**	**Model (B)**
R&D	8.8997 ***	8.9384 ***	5.1984 ***	4.8695 ***
	(3.14)	(3.14)	(4.69)	(4.46)
CAPEX	0.4221	0.4942 ***	−0.0213	0.1425
	(1.53)	(2.74)	(−0.14)	(1.18)
GRWTH	0.2158	0.2370 ***	0.2702 **	0.2068 **
	(0.97)	(2.76)	(2.23)	(2.22)
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
p-value	0.0000	0.0000	0.0000	0.0000
R^2	0.3856	0.3952	0.2715	0.2762
Number of obs.	610	610	757	757

B_Dummy = 0 for *B_IND* < 0 and *B_Dummy* = 1 for *B_IND* ≥ 0.4. Note that the median for *B_IND* is 0.4; In Model A, Carbon Intensity (*CARBON*) is measured with *GHG/TA*, and in Model B with *GHG/SALES*; t-statistics are presented in parentheses. *, **, *** represent statistical significance at 10%, 5%, and 1%, respectively.

5. Discussion

In this study, we evaluate the effect of corporate governance, specifically the independence of the board, on GHG emissions and the relation between GHG emissions and financial performance. In contrast to existing research [36,37], we quantify environmental performance by focusing on the amount of GHG emissions at the firm level. This is based on a multivariate analysis of firm-level data from 156 South Korean listed enterprises over the nine-year period from 2011 to 2019. We find that board independence is related positively with the decrease in GHG emissions and has a negative effect on the relation between GHG emissions and financial performance. Our findings are consistent with the agency theory and stakeholder theory arguments [3,78] that outside directors are more likely to be accountable to a wider variety of stakeholders. According to the agency theory, an independent governing body can supervise agents' actions effectively [26]. According to the stakeholder theory, board independence influences environmental performance favorably because shareholders influence external directors less [1,28]. Our results imply that an effective internal governance framework may help businesses achieve both financial and nonfinancial performance.

Our findings provide evidence that firms that produce more GHG emissions have better financial performance, which is consistent with the neoclassical view [64]. Reducing GHG emissions is considered an additional financial burden that reduces a firm's financial performance [65,67]. However, firms with more independent directors have a different relation. As Ref. [6] showed, independent boards are more likely to care about the company's environmental performance and to appreciate the realization of long-term investments in environmental projects. Therefore, independent boards tend to support costly environmentally friendly decisions and appreciate long-term financial performance. Our empirical findings indicate that the effects of board independence on the relation between GHG emissions and financial performance is more pronounced when financial performance is assessed using a market-based metric, *Tobin's q*. It has been reported that costs and benefits associated with environmental initiatives are not reflected instantly in financial performance [61]. However, *Tobin's q* may be able to evaluate their predicted long-term effects [50]. Thus, it can be considered one of the main financial performance measures in a GHG-emissions-related analysis. Reducing GHG emissions requires considerable resources without providing immediate financial benefits [66], indicating a negative correlation between carbon and short-term financial success. Thus, a good corporate governance structure is expected to be more responsible in controlling GHG emissions.

The quantitative analysis in our research contributes to the current body of knowledge about the relation between GHG emissions and financial performance. Prior research on

environmental performance has concentrated on the relation between corporate governance and environmental disclosures [33,79,80] or CDP participation [1,30]. To the best of our knowledge, this is one of the first attempts to investigate the relation between corporate governance and actual amounts of GHG emissions at the firm level. By employing GHG emissions data to measure carbon performance, our study demonstrates the relation between corporate governance and environmental performance quantitatively. In addition, we extend the moderating analysis literature to evaluate the heterogeneous relation between environmental and financial performance by introducing a governance-related variable. Further, we extend the scope of empirical investigations by using a sample from South Korea, which is ranked as the country with the seventh largest carbon emissions as of 2019. Overall, our findings indicate the significance of the corporate governance structure in responses to climate change issues. As climate change affects everyone—corporate managers, shareholders, lawmakers, and consumers—it is important to have more independent directors to monitor firms' decisions and meet sustainable goals.

Our results are restricted to public corporations in South Korea; therefore, this research has certain limitations. The analysis of unlisted firms or those operating in other countries may yield different results. In addition, we employ industry-fixed effect panel regression models rather than firm-fixed effect panels because of the limited number of samples as well as the persistence of board independence. The research on the underlying mechanism of corporate governance's influence on environmental performance and its financial consequences may be more complex. Therefore, other research methods, such as case studies or survey methods, can provide a more in-depth understanding. We expect that future research on effective corporate governance mechanisms will be conducted to reduce GHG emissions and the potential damage attributable to climate change.

6. Conclusions

This study evaluates the effect of board independence on GHG emissions and their relation with financial performance in South Korean listed enterprises from 2011 to 2019. The study finds that board independence has a positive effect on decreasing GHG emissions and a negative effect on the relation between GHG emissions and financial performance. The results are consistent with agency theory and stakeholder theory arguments that outside directors are more accountable to a wider range of stakeholders. The study also suggests that firms with more independent directors tend to support environmentally-friendly decisions and appreciate long-term financial performance. The study contributes to the current knowledge of the relation between GHG emissions and financial performance and extends the scope of empirical investigation by using data from South Korea. The study's findings suggest the significance of corporate governance structure in relation to climate change issues. However, the study's results are limited to public corporations in South Korea, and other research methods may provide a more detailed understanding of the underlying mechanism of the influence of corporate governance on environmental performance and its financial consequences.

Author Contributions: Conceptualization, S.J.K.; Methodology, S.J.K.; Formal analysis, S.J.K.; Data curation, S.J.K.; Writing—original draft, S.J.K.; Writing—review & editing, H.K. and E.A.; Supervision, H.K. and E.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Publicly available datasets were analyzed in this study. GHG emissions data were sourced from the National GHG Emissions Information System of the Ministry of the Environment at: https://ngms.gir.go.kr/link.do?menuNo=30130103&link=/websquare/websquare.html%3Fw2xPath%3D/cm/bbs/OGCMBBS023V.xml%26menu%3D30130103. Data for financial variables are obtained from the DataGuide database at: https://www.dataguide.co.kr/DG5web/eng/index.asp.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Sample Selection Process

Criteria	Number of Firm-Year Observations	Number of Firms	Total Emissions in tons CO_2-eq
Designated entities (companies, plants, public institutes, etc.)	7312	951	645,400,722 (89% of nationwide emissions)
Listed companies among designated entities	2764	391	251,490,745 (35% of nationwide emissions)
Listed companies with 9-year emissions data	1404	156	222,562,867 (31% of nationwide emissions)

Nationwide GHG emissions in 2019 was 727,045 million tons CO_2-eq.

Appendix B. Industry Distribution of Samples

Industry	No. of Firms	Percent
Manufacture of chemicals and chemical products; except pharmaceuticals and medicinal chemicals	27	17%
Manufacture of basic metals	22	14%
Manufacture of pulp, paper and paper products	18	12%
Manufacture of electronic components, computers, visual, sounding and communication equipment	14	9%
Manufacture of motor vehicles, trailers and semitrailers	10	6%
Manufacture of food products	9	6%
Manufacture of other non-metallic mineral products	9	6%
Manufacture of other transport equipment	6	4%
Postal activities and telecommunications	4	3%
Manufacture of rubber and plastics products	4	3%
Manufacture of beverages	3	2%
Manufacture of textiles, except apparel	3	2%
Manufacture of other machinery and equipment	3	2%
Electricity, gas, steam and air conditioning supply	3	2%
Retail trade, except motor vehicles and motorcycles	3	2%
Manufacture of wood and of products of wood and cork; except furniture	2	1%
Manufacture of fabricated metal products, except machinery and furniture	2	1%
Manufacture of electrical equipment	2	1%
Waste collection, treatment and disposal activities; materials recovery	2	1%
Wholesale trade on own account or on a fee or contract basis	2	1%
Air transport	2	1%
Others	6	4%
Total	156	100%

References

1. Liao, L.; Luo, L.; Tang, Q. Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *Br. Account. Rev.* **2015**, *47*, 409–424. [CrossRef]
2. Velte, P.; Stawinoga, M.; Lueg, R. Carbon performance and disclosure: A systematic review of governance-related determinants and financial consequences. *J. Clean. Prod.* **2020**, *254*, 120063. [CrossRef]
3. Hussain, N.; Rigoni, U.; Orij, R.P. Corporate Governance and Sustainability Performance: Analysis of Triple Bottom Line Performance. *J. Bus. Ethics* **2016**, *149*, 411–432. [CrossRef]
4. Walls, J.L.; Berrone, P.; Phan, P.H. Corporate governance and environmental performance: Is there really a link? *Strateg. Manag. J.* **2012**, *33*, 885–913. [CrossRef]
5. Li, Z.F. A survey of corporate social responsibility and corporate governance. In *Research Handbook of Finance and Sustainability*; Edward Elgar Publishing: Cheltenham, UK, 2018; pp. 126–138.
6. De Villiers, C.; Naiker, V.; Van Staden, C.J. The effect of board characteristics on firm environmental performance. *J. Manag.* **2011**, *37*, 1636–1663. [CrossRef]
7. Haque, F. The effects of board characteristics and sustainable compensation policy on carbon performance of UK firms. *Br. Account. Rev.* **2017**, *49*, 347–364. [CrossRef]
8. Gallego-Álvarez, I.; Segura, L.; Martínez-Ferrero, J. Carbon emission reduction: The impact on the financial and operational performance of international companies. *J. Clean. Prod.* **2015**, *103*, 149–159. [CrossRef]

9. Makridou, G.; Doumpos, M.; Galariotis, E. The financial performance of firms participating in the EU emissions trading scheme. *Energy Policy* **2019**, *129*, 250–259. [CrossRef]
10. Adu, D.A.; Flynn, A.; Grey, C. Executive compensation and sustainable business practices: The moderating role of sustainability-based compensation. *Bus. Strategy Environ.* **2022**, *31*, 698–736. [CrossRef]
11. Busch, T.; Hoffmann, V.H. How hot is your bottom line? Linking carbon and financial performance. *Bus. Soc.* **2011**, *50*, 233–265. [CrossRef]
12. Hoffmann, V.H.; Busch, T. Corporate Carbon Performance Indicators. *J. Ind. Ecol.* **2008**, *12*, 505–520. [CrossRef]
13. Salehi, M.; Zimon, G.; Arianpoor, A.; Gholezoo, F.E. The impact of investment efficiency on firm value and moderating role of institutional ownership and board independence. *J. Risk Financ. Manag.* **2022**, *15*, 170. [CrossRef]
14. Lahouel, B.B.; Bruna, M.-G.; Zaied, Y.B. The curvilinear relationship between environmental performance and financial performance: An investigation of listed French firms using panel smooth transition model. *Financ. Res. Lett.* **2020**, *35*, 101455. [CrossRef]
15. Kim, S.J.; Kim, H. Corporate risk and greenhouse gas emissions: Evidence from Korea. *Appl. Econ. Lett.* **2022**, 1–7. [CrossRef]
16. Clemens, B. Economic incentives and small firms: Does it pay to be green? *J. Bus. Res.* **2006**, *59*, 492–500. [CrossRef]
17. Klassen, R.D.; McLaughlin, C.P. The Impact of Environmental Management on Firm Performance. *Manag. Sci.* **1996**, *42*, 1199–1214. [CrossRef]
18. Schreck, P. Reviewing the business case for corporate social responsibility: New evidence and analysis. *J. Bus. Ethics* **2011**, *103*, 167–188. [CrossRef]
19. Dixon-Fowler, H.R.; Slater, D.J.; Johnson, J.L.; Ellstrand, A.E.; Romi, A.M. Beyond "does it pay to be green?" A meta-analysis of moderators of the CEP–CFP relationship. *J. Bus. Ethics* **2013**, *112*, 353–366. [CrossRef]
20. Hart, S.L. A natural-resource-based view of the firm. *Acad. Manag. Rev.* **1995**, *20*, 986–1014. [CrossRef]
21. Lee, K.-H.; Cin, B.C.; Lee, E.Y. Environmental Responsibility and Firm Performance: The Application of an Environmental, Social and Governance Model. *Bus. Strategy Environ.* **2016**, *25*, 40–53. [CrossRef]
22. Oh, W.; Park, S. The Relationship Between Corporate Social Responsibility and Corporate Financial Performance in Korea. *Emerg. Mark. Financ. Trade* **2015**, *51*, 85–94. [CrossRef]
23. Jensen, M.C.; Meckling, W.H. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financ. Econ.* **1976**, *3*, 305–360. [CrossRef]
24. Aragón-Correa, J.A.; Sharma, S. A contingent resource-based view of proactive corporate environmental strategy. *Acad. Manag. Rev.* **2003**, *28*, 71–88. [CrossRef]
25. Singh, V.; Vinnicombe, S.; Johnson, P. Women directors on top UK boards. *Corp. Gov. Int. Rev.* **2001**, *9*, 206–216. [CrossRef]
26. Hillman, A.J.; Dalziel, T. Boards of directors and firm performance: Integrating agency and resource dependence perspectives. *Acad. Manag. Rev.* **2003**, *28*, 383–396. [CrossRef]
27. Ibrahim, N.A.; Angelidis, J.P. The corporate social responsiveness orientation of board members: Are there differences between inside and outside directors? *J. Bus. Ethics* **1995**, *14*, 405–410. [CrossRef]
28. Wang, J.; Dewhirst, H.D. Boards of directors and stakeholder orientation. *J. Bus. Ethics* **1992**, *11*, 115–123. [CrossRef]
29. Michelon, G.; Parbonetti, A. The effect of corporate governance on sustainability disclosure. *J. Manag. Gov.* **2012**, *16*, 477–509. [CrossRef]
30. Kılıç, M.; Kuzey, C. The effect of corporate governance on carbon emission disclosures. *Int. J. Clim. Change Strateg. Manag.* **2019**, *11*, 35–53. [CrossRef]
31. Jaggi, B.; Allini, A.; Macchioni, R.; Zagaria, C. The factors motivating voluntary disclosure of carbon information: Evidence based on Italian listed companies. *Organ. Environ.* **2018**, *31*, 178–202. [CrossRef]
32. Elsayih, J.; Tang, Q.; Lan, Y.-C. Corporate governance and carbon transparency: Australian experience. *Account. Res. J.* **2018**, *31*, 405–422. [CrossRef]
33. Akbaş, H.E.; Canikli, S. Determinants of voluntary greenhouse gas emission disclosure: An empirical investigation on Turkish firms. *Sustainability* **2018**, *11*, 107. [CrossRef]
34. Hang, M.; Geyer-Klingeberg, J.; Rathgeber, A.W. It is merely a matter of time: A meta-analysis of the causality between environmental performance and financial performance. *Bus. Strategy Environ.* **2019**, *28*, 257–273. [CrossRef]
35. Hart, S.L.; Ahuja, G. Does It Pay to Be Green? An Empirical Examination of the Relationship between Emission Reduction and Firm Performance. *Bus. Strategy Environ.* **1996**, *5*, 30–37. [CrossRef]
36. King, A.A.; Lenox, M.J. Does it really pay to be green? An empirical study of firm environmental and financial performance: An empirical study of firm environmental and financial performance. *J. Ind. Ecol.* **2001**, *5*, 105–116. [CrossRef]
37. Konar, S.; Cohen, M.A. Does the market value environmental performance? *Rev. Econ. Stat.* **2001**, *83*, 281–289. [CrossRef]
38. Ganda, F.; Milondzo, K.S. The impact of carbon emissions on corporate financial performance: Evidence from the South African firms. *Sustainability* **2018**, *10*, 2398. [CrossRef]
39. Saka, C.; Oshika, T. Disclosure effects, carbon emissions and corporate value. *Sustain. Account. Manag. Policy J.* **2014**, *5*, 22–45. [CrossRef]
40. Brzobohatý, T.; Janský, P. Impact of CO2 emissions reductions on firms' finance in an emerging economy: The case of the Czech Republic. *Transit. Stud. Rev.* **2010**, *17*, 725–736. [CrossRef]

41. Nishitani, K.; Kokubu, K. Why does the reduction of greenhouse gas emissions enhance firm value? The case of Japanese manufacturing firms. *Bus. Strategy Environ.* **2012**, *21*, 517–529. [CrossRef]
42. Hatakeda, T.; Kokubu, K.; Kajiwara, T.; Nishitani, K. Factors Influencing Corporate Environmental Protection Activities for Greenhouse Gas Emission Reductions: The Relationship Between Environmental and Financial Performance. *Environ. Resour. Econ.* **2012**, *53*, 455–481. [CrossRef]
43. Iwata, H.; Okada, K. How does environmental performance affect financial performance? Evidence from Japanese manufacturing firms. *Ecol. Econ.* **2011**, *70*, 1691–1700. [CrossRef]
44. Cordeiro, J.J.; Sarkis, J. Environmental proactivism and firm performance: Evidence from security analyst earnings forecasts. *Bus. Strategy Environ.* **1997**, *6*, 104–114. [CrossRef]
45. Wang, L.; Li, S.; Gao, S. Do Greenhouse Gas Emissions Affect Financial Performance?—An Empirical Examination of Australian Public Firms. *Bus. Strategy Environ.* **2014**, *23*, 505–519. [CrossRef]
46. Earnhart, D.; Lizal, L. Effect of pollution control on corporate financial performance in a transition economy. *Eur. Environ.* **2007**, *17*, 247–266. [CrossRef]
47. Delmas, M.A.; Nairn-Birch, N.; Lim, J. Dynamics of environmental and financial performance: The case of greenhouse gas emissions. *Organ. Environ.* **2015**, *28*, 374–393. [CrossRef]
48. Lannelongue, G.; Gonzalez-Benito, J.; Gonzalez-Benito, O. Input, output, and environmental management productivity: Effects on firm performance. *Bus. Strategy Environ.* **2015**, *24*, 145–158. [CrossRef]
49. Brouwers, R.; Schoubben, F.; Van Hulle, C. The influence of carbon cost pass through on the link between carbon emission and corporate financial performance in the context of the European Union Emission Trading Scheme. *Bus. Strategy Environ.* **2018**, *27*, 1422–1436. [CrossRef]
50. Fujii, H.; Iwata, K.; Kaneko, S.; Managi, S. Corporate environmental and economic performance of Japanese manufacturing firms: Empirical study for sustainable development. *Bus. Strategy Environ.* **2013**, *22*, 187–201. [CrossRef]
51. Misani, N.; Pogutz, S. Unraveling the effects of environmental outcomes and processes on financial performance: A non-linear approach. *Ecol. Econ.* **2015**, *109*, 150–160. [CrossRef]
52. Tatsuo, K. An analysis of the eco-efficiency and economic performance of Japanese companies. *Asian Bus. Manag.* **2010**, *9*, 209–222. [CrossRef]
53. Trumpp, C.; Guenther, T. Too Little or too much? Exploring U-shaped Relationships between Corporate Environmental Performance and Corporate Financial Performance. *Bus. Strategy Environ.* **2017**, *26*, 49–68. [CrossRef]
54. Freeman, R.E.; Wicks, A.C.; Parmar, B. Stakeholder Theory and "The Corporate Objective Revisited". *Organ. Sci.* **2004**, *15*, 364–369. [CrossRef]
55. Boakye, D.J.; Tingbani, I.; Ahinful, G.; Damoah, I.; Tauringana, V. Sustainable environmental practices and financial performance: Evidence from listed small and medium-sized enterprise in the United Kingdom. *Bus. Strategy Environ.* **2020**, *29*, 2583–2602. [CrossRef]
56. Darnall, N.; Henriques, I.; Sadorsky, P. Adopting proactive environmental strategy: The influence of stakeholders and firm size. *J. Manag. Stud.* **2010**, *47*, 1072–1094. [CrossRef]
57. Endrikat, J.; Guenther, E.; Hoppe, H. Making sense of conflicting empirical findings: A meta-analytic review of the relationship between corporate environmental and financial performance. *Eur. Manag. J.* **2014**, *32*, 735–751. [CrossRef]
58. Barney, J. Firm resources and sustained competitive advantage. *J. Manag.* **1991**, *17*, 99–120. [CrossRef]
59. Sharma, S.; Vredenburg, H. Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. *Strateg. Manag. J.* **1998**, *19*, 729–753. [CrossRef]
60. Berrone, P.; Gomez-Mejia, L.R. Environmental performance and executive compensation: An integrated agency-institutional perspective. *Acad. Manag. J.* **2009**, *52*, 103–126. [CrossRef]
61. Busch, T.; Lewandowski, S. Corporate carbon and financial performance: A meta-analysis. *J. Ind. Ecol.* **2018**, *22*, 745–759. [CrossRef]
62. Orsato, R.J. Competitive Environmental Strategies: When Does it Pay to Be Green? *Calif. Manag. Rev.* **2006**, *48*, 127–143. [CrossRef]
63. Ambec, S.; Lanoie, P. Does it pay to be green? A systematic overview. *Acad. Manag. Perspect.* **2008**, *22*, 45–62.
64. Palmer, K.; Oates, W.E.; Portney, P.R. Tightening environmental standards: The benefit-cost or the no-cost paradigm? *J. Econ. Perspect.* **1995**, *9*, 119–132. [CrossRef]
65. Pinkse, J.; Kolk, A. Challenges and trade-offs in corporate innovation for climate change. *Bus. Strategy Environ.* **2010**, *19*, 261–272. [CrossRef]
66. Margolis, J.D.; Walsh, J.P. Misery loves companies: Rethinking social initiatives by business. *Adm. Sci. Q.* **2003**, *48*, 268–305. [CrossRef]
67. Alexopoulos, I.; Kounetas, K.; Tzelepis, D. Environmental and financial performance. Is there a win-win or a win-loss situation? Evidence from the Greek manufacturing. *J. Clean. Prod.* **2018**, *197*, 1275–1283. [CrossRef]
68. Mahapatra, S. Investor reaction to a corporate social accounting. *J. Bus. Financ. Account.* **1984**, *11*, 29–40. [CrossRef]
69. d'Amboise, G.; Muldowney, M. Management theory for small business: Attempts and requirements. *Acad. Manag. Rev.* **1988**, *13*, 226–240. [CrossRef]
70. Eden, L.; Levitas, E.; Martinez, R.J. The production, transfer and spillover of technology: Comparing large and small multinationals as technology producers. *Small Bus. Econ.* **1997**, *9*, 53–66. [CrossRef]

71. Grewatsch, S.; Kleindienst, I. When does it pay to be good? Moderators and mediators in the corporate sustainability–corporate financial performance relationship: A critical review. *J. Bus. Ethics* **2017**, *145*, 383–416. [CrossRef]
72. Chakrabarty, S.; Wang, L. Climate Change Mitigation and Internationalization: The Competitiveness of Multinational Corporations. *Thunderbird Int. Bus. Rev.* **2013**, *55*, 673–688. [CrossRef]
73. Kim, Y.-B.; An, H.T.; Kim, J.D. The effect of carbon risk on the cost of equity capital. *J. Clean. Prod.* **2015**, *93*, 279–287. [CrossRef]
74. Kim, S.J.; Atukeren, E.; Kim, H. Does the market's reaction to greenhouse gas emissions differ between B2B and B2C? Evidence from South Korea. *Financ. Res. Lett.* 2023. [CrossRef]
75. Jung, J.; Herbohn, K.; Clarkson, P. Carbon risk, carbon risk awareness and the cost of debt financing. *J. Bus. Ethics* **2018**, *150*, 1151–1171. [CrossRef]
76. Lewandowski, S. Corporate Carbon and Financial Performance: The Role of Emission Reductions. *Bus. Strategy Environ.* **2017**, *26*, 1196–1211. [CrossRef]
77. Waddock, S.A.; Graves, S.B. The Corporate Social Performance-Financial Performance Link. *Strateg. Manag. J.* **1997**, *18*, 303–319. [CrossRef]
78. Jo, H.; Harjoto, M.A. Corporate Governance and Firm Value: The Impact of Corporate Social Responsibility. *J. Bus. Ethics* **2011**, *103*, 351–383. [CrossRef]
79. Brammer, S.; Pavelin, S. Voluntary environmental disclosures by large UK companies. *J. Bus. Financ. Account.* **2006**, *33*, 1168–1188. [CrossRef]
80. Rodrigue, M.; Magnan, M.; Cho, C.H. Is environmental governance substantive or symbolic? An empirical investigation. *J. Bus. Ethics* **2013**, *114*, 107–129. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.