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The impact of voluntary carbon emission disclosures on strategic deviance: The moderating role of industry competition

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Abstract

Voluntary carbon emission disclosure has gained significance as corporations face increasing pressure to address environmental issues. This study examines the relationship between voluntary carbon emission disclosure and strategic deviance, framing the discussion within the natural-resource-based theory. Furthermore, it considers the moderating role of industry competition in shaping this relationship. Employing panel data from Korean stock-listed firms spanning 2014 to 2021, we conducted quantitative analyses to investigate the link between voluntary environmental disclosure and firms' strategic behavior. The study also incorporated competition-related metrics to evaluate moderating effects. The findings indicate that firms disclosing carbon emissions voluntarily are more likely to engage in strategic deviance, leveraging environmental transparency as a competitive advantage. However, in industries characterized by high competition, this positive relationship diminishes, as firms exhibit reluctance in sharing sensitive carbon-related information. This research highlights the dual function of voluntary carbon disclosure as both a strategic tool and a response to competitive pressures. It provides actionable insights for corporate managers in devising disclosure strategies and for policymakers in crafting regulations that account for industrial competition dynamics.

Keywords: Corporate strategy, Industry competition, Strategic deviance, Voluntary disclosure of carbon emissions.

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1. Introduction

This study seeks to investigate the relationship between voluntary carbon emission disclosure and strategic deviance while evaluating the moderating effect of industry competition on this interaction. Since the Industrial Revolution of the 18th and 19th centuries, greenhouse gas emissions have increased exponentially, leading to global warming emerging as a critical global issue by the 21st century [1]. It is beyond ecological disruption to include substantial risks to global business operations [2]. Without proactive measures, the economic cost of climate change could reach annual losses of 5-20% of global GDP [3], underscoring the urgency of addressing environmental risks. As global efforts intensify to mitigate these challenges,

environmental issues have evolved into a critical academic focus [4], while simultaneously garnering heightened interest from investors seeking to navigate climate-related risks and opportunities [1].

In this context, corporate responses to environmental pressures recognize climate change not only as an ecological concern but also as a strategic factor influencing financial performance and market positioning. The Carbon Disclosure Project (CDP) provides data that firms voluntarily disclose regarding their environmental status concerning carbon emissions, and such information is regarded as strategic intent [5].

This study builds on this foundation by exploring the effect of voluntary carbon emission disclosure on strategic deviance, which is defined as a firm's departure from industry norms in its strategic choices [6]. While prior research has established that voluntary disclosure can enhance corporate value and stakeholder trust [5, 7], less attention has been paid to how such actions reflect broader strategic differentiation. Furthermore, the role of external factors, such as industry competition, in shaping this relationship remains underexplored. In highly competitive industries, firms may weigh the risks of transparency against potential competitive disadvantages, potentially altering their propensity for strategic deviance [8].

This study, utilizing data from Korean stock-listed firms, investigates whether firms that voluntarily disclose carbon emissions exhibit strategic deviance and examines the moderating role of industry competition in this relationship. The findings indicate that the voluntary disclosure of carbon emissions represents a form of strategic deviance, as it involves revealing proprietary information in the market that competitors may withhold. This finding aligns with the natural-resource-based theory [9], which posits that a firm's essential resources and capabilities play a critical role in determining its capacity to maintain a competitive advantage.

However, in industries characterized by high levels of competition, firms exhibit a lower propensity to engage in such voluntary disclosures. The results suggest that revealing hidden information, while others do not, is a strategic action that deviates from the norm. However, under high competition, to secure their position in the market, firms are reluctant to reveal their information voluntarily in the market.

These findings provide valuable insights for corporate decision-makers on how to approach carbon disclosure strategically, considering both the potential benefits of differentiation and the risks associated with revealing sensitive information in competitive markets. For policymakers, our results suggest the need for tailored carbon disclosure policies that account for varying levels of industry competition.

The findings of this study offer several important contributions to the field. First, voluntary disclosure of carbon emissions extends beyond mere regulatory compliance, representing a strategic decision. This supports the resource-based view, suggesting that environmental information disclosure can be a source of competitive advantage. Second, by examining the moderating effect of industry competition, the significance of external factors in shaping corporate disclosure strategies provides a more nuanced understanding of when and why firms choose to deviate from industry norms in their environmental reporting.

The subsequent sections of this manuscript are organized in the following manner. Section two encompasses a comprehensive review of pertinent literature and delineates the formulation of hypotheses. Section three elucidates the methodological approach, detailing the data acquisition procedures, operationalization of key variables, and the proposed research framework. Section four presents an analysis of the empirical results, while the final section offers concluding remarks and implications of the study.

2. Literature Review and Hypotheses Development

Climate change has emerged as a critical global concern, with the 2016 World Economic Forum identifying it as the foremost threat to the world economy. This phenomenon extends beyond ecological disruption, posing substantial risks to global business operations (Labatt and White [2]). Stern [3] projects that without preemptive action, climate change could result in annual losses of 5-20% of global GDP. Furthermore, Standard & Poor's has indicated that climate change-induced increases in government debt could lead to downgraded national credit ratings. Accordingly, companies and investors are now recognizing climate change issues as not merely an ecological threat, but also as a significant variable influencing economic and financial decisions [1]. The reliability and applicability of data related to carbon emissions have thus become more critical.

CDP, established in 2000, is an environmental organization that collects, analyzes, and disseminates climate change-related information from companies worldwide, supported by global financial institutions. CDP requests data from companies on greenhouse gas emissions, climate change strategies, and related information, evaluating these responses to provide investors with assessments of corporate climate risk levels. Companies voluntarily respond to CDP questionnaires, with responses evaluated on performance and disclosure aspects. Evaluation results are published on the CDP website and in reports, with top-performing companies included in the A List or Climate Disclosure Leadership Index. While CDP disclosure is not mandatory, the information is considered highly reliable due to market comparability, trends of consistent disclosure, and the high risks associated with providing false information Matsumura et al. [5]. Stanny [7] found that companies utilizing CDP data have strengthened long-term trust with investors, and according to Kim and Park [4], companies actively disclose information about carbon emissions, demonstrated global accomplishment. Importantly, CDP disclosure serves as a strategic signal to stakeholders, reflecting a firm’s commitment to environmental transparency and its ability to leverage climate-related risks into competitive advantages [9]. Consequently, despite its voluntary nature, CDP-reported information maintains a high level of credibility in the financial markets.

There are reasons why many firms are willing to disclose environmental information despite of the information itself carrying negative implications. Kim and Lyon [10] and Na, et al. [11] confirm that the companies’ adoption of climate change-related policies brings about alterations in their business environment, consequently having a significant impact on

attracting investments. Additionally, firms exposed to environmental risks face significant financial implications if they fail to take preemptive action. Without proactive measures, these firms may incur increased regulatory compliance costs and demands for environmental improvements, leading to substantial cash outflows [12]. Consequently, investors are becoming increasingly interested in companies' environmental management decisions, financial policies, and implementation of related policies [13]. From a natural-resource-based theory perspective [9] voluntary carbon disclosure represents a strategic resource that enhances a firm's ability to differentiate itself in the market. Therefore, voluntary disclosure of carbon emissions can be interpreted as a strategic action that goes beyond regulatory compliance to enhance long-term competitiveness through market differentiation.

This study examines the impact of voluntary carbon emission disclosure on firms' strategic deviance. Strategic deviance, as defined by Tang et al. [6] refers to the extent to which a firm's strategy differs from industry norms. Firms within the same industry tend to emulate the strategies of other firms that have demonstrated superior performance [14]. These strategies can become central within the industry due to their efficiency and effectiveness in generating positive outcomes. However, industry-wide strategies may lack sensitivity to change and may struggle to generate excess profits as competition intensifies. Consequently, firms may begin to pursue differentiation and deviate from industry norms, leading to strategic deviation [15, 16]. Such strategic differentiation, even if it entails short-term strategic risks, could potentially create new market opportunities and enable monopolistic competitive advantages in the long term [15].

In the context of environmental sustainability, voluntary carbon emission disclosure can be viewed as a form of strategic deviance that transforms environmental capabilities into a unique resource [9]. Firms that choose to disclose their carbon emissions may be seen as deviating from industry norms. For instance, Matsumura et al. [5] point out that carbon emission disclosure is associated with an increase in corporate market value, demonstrating that such strategic deviance can have a significant impact on corporate performance. This strategic shift can be interpreted as a response to increasing environmental pressures and societal demands for sustainability, rather than a result of managerial overconfidence or opportunistic behavior.

Therefore, this study aims to examine the relationship between voluntary disclosure of carbon emissions and strategic deviance, and the hypothesis is as follows.

Hypothesis 1: The firms that voluntarily disclose information on carbon emissions are more likely to engage in strategic deviance.

Managers' strategies entail their current situation for their outcomes, sustainable existence, growth, and development [17]. Additionally, firms' strategies involve ways of organizing, operating, and competing in product markets Simons [18]; Montemayor [19]; and Rajagopalan [20]. Wang [21] defined strategic deviation as departing from traditional strategies, which serves as a method for achieving competitive advantage [22]. In other words, as competition intensifies, firms may increasingly justify and pursue such strategic deviations. Consequently, factors such as the level of competition within the industry play a significant role in shaping managers' willingness to adopt strategic deviations, ultimately influencing the long-term sustainability of the organization.

Applying this concept to voluntary carbon emissions disclosure, firms operating in highly competitive industries are likely to adopt a more cautious and focused strategic approach [23]. Intense competition heightens the need for firms to balance the risks and benefits of disclosing internal information [8]. In highly competitive markets, smaller firms with high growth potential often face significant pressure to protect their competitive positioning. Managers in these environments may view voluntary carbon disclosure as a potential threat, as it could expose operational or strategic vulnerabilities to competitors. Consequently, firms in these industries are less likely to engage in voluntary carbon disclosures, perceiving the costs to outweigh the benefits [24]. This aligns with findings that firms in heightened competition tend to avoid voluntary information disclosure as a defensive strategy [25].

Due to these dynamics, the decision to disclose carbon emissions often coincides with a reduced tendency toward strategic deviation in such industries. In competitive markets, firms are inclined to adopt conservative strategies that prioritize risk minimization and predictable competitive positioning rather than pursue nontraditional initiatives such as voluntary carbon disclosure [8]. In contrast, firms in less competitive industries may experiment with strategic deviations, including sustainability disclosures, to enhance their reputation and stakeholder relationships. Overall, competitive pressures inhibit strategic deviations in industries with high competition, thereby shaping managers' reluctance to voluntarily disclose carbon emissions and pushing these firms toward traditional and risk-averse practices. With the reasoning above, the second hypothesis is established as follows.

Hypothesis 2: Industry competition has a significant impact on the relationship between voluntary disclosure of carbon emissions and strategic deviance.

3. Methodology

3.1. Data Collection Process

Table 1 delineates the methodological approach employed to derive the final sample for hypothesis testing. To maintain sample homogeneity, this study concentrates on non-financial industry firms over the period 2014-2021. Firms with non-December fiscal year-ends were excluded to ensure consistency in financial reporting periods. Data on voluntary carbon emissions disclosure was sourced from CDP reports, while financial data was extracted from the Fn-Guide database. Firms with incomplete financial data were omitted from the sample. To mitigate the influence of extreme values, the top and bottom 1% of observations for dependent and control variables were winsorized. Following these selection and data cleaning procedures, the final dataset comprised 1,556 firm-year observations.

Table 1.
The data description.

Firm-year observations from 2014 to 2021 with information on voluntary disclosure of carbon emissions, strategic deviance, and industry competition with a December fiscal year-end.	3,236
Less:	
Missing financial data for control variables	1,680
Final observation	1,556

3.2. Competition

The degree of competition is measured using industrial competition. In this study, industrial concentration is also employed to measure the degree of competition, taking into account factors consistent with previous studies. The measurement of industrial concentration uses the Herfindahl-Hirschman Index (HHI), which has been widely utilized in prior studies. Here, the variable COMP represents the measure of industrial concentration, and under the assumption that industrial concentration and competition within an industry are inversely correlated, a high industrial concentration in a specific industry can be interpreted as a low degree of competition.

In this study, the HHI was calculated based on the Korean Standard Industrial Classification and included firms listed on the stock exchanges. The method for calculating the HHI is presented below.

$$COMP = \sum_{j=1}^{N} S_{ijt}^2 \qquad (1)$$

Where, Sales: sales of firm i in period t within j industry

First, the COMP is calculated by summing the squared market shares of all firms operating in the same industry. In Equation 1, S_{ijt} represents the market share of firm i within industry j. The market share of an individual firm is calculated by dividing the firm's sale by the total sales of the industry to which the firm belongs. Next, the COMP is obtained by squaring the market share of each individual firm and then summing up these values for each industry. In this study, the COMP was calculated by aggregating the values across industries and years [26-28]. A lower COMP indicates that the market is shared by a large number of competing firms, whereas a higher COMP signifies that the market is concentrated among a small number of large firms.

In this study, to facilitate the interpretation of the signs in the analysis results when examining the relationship between the level of competition within an industry and a firm's disclosure level, the COMP is multiplied by -1. Accordingly, a higher value of COMP indicates that the market share is divided among many firms, signifying intense competition within the industry, and vice versa.

3.3. Strategic Deviation

Strategic deviation is assessed by six measurements that are related to marketing and investment activities [6, 21, 29, 30].

Table 2.
Strategic deviance measurements

Measurements	**Calculation**
Research and development (R&D) activity	$\frac{R\&D\ expenditure}{Sales}$
Marketing activity	$\frac{Advertising\ expense}{Sales}$
Tangible asset reinvestment expenditure	$\frac{Investment\ in\ depreciable\ assets}{Tangible\ assets}$
Selling and administrative activity	$\frac{Selling\ and\ administrative\ expenses}{Sales}$
Financial leverage	$\frac{Total\ liabilities}{Total\ assets}$
Capital intensity	$\frac{Tangible\ assets}{Number\ of\ employees}$

First, the six strategic resource allocation variables in Table 2 are measured for each firm-year. The resulting measurements are then standardized by a mean value of 0 and a standard deviation of 1, by industry-year. Then, the absolute values of these six standardized measures are averaged arithmetically. The values obtained through this process reflect the

deviation of an individual firm's resource input method from the general resource input tendencies and norms pursued by firms within the industry. A higher measurement indicates a greater level of strategic deviation.

3.4. Research Model

The following Equation 1 is to assess the effect of voluntary disclosure of carbon emissions on strategic deviance and measures the first hypothesis.

$$SD_t = \beta_0 + \beta_1 DIS_t + \beta_2 Size_t + \beta_3 Lev_t + \beta_4 Roa_t + \beta_5 Growth_t + \beta_6 Loss_t + \beta_7 Da_t + \beta_8 Beta_t + \beta_9 Ocf_t + IndD + YrD + \varepsilon \quad (2)$$

Where,
SD = strategic deviation described in section 3.3; Size = natural logarithm of total assets; Lev = total debt divided by total assets; Roa = net income/total assets; Growth = (total assets in the current year – total assets in the previous year)/total assets in the current year; Loss = 1 if a company with loss, and 0 otherwise; Da = Discretionary accruals measured by the model in Kothari, et al. [31] described in Equation 2; Beta = systematic risk; Ocf = cash flow from operation/total assets; IndD = industry dummies; YrD = year dummies;
The variable, Da is based on the discretionary accruals as suggested by Kothari, et al. [31] as described in Equation 2.

$$\frac{Ta_t}{A_t} = \alpha_0 + \beta_1 \frac{1}{A_t} + \beta_2 \left(\frac{\Delta Sales_t - \Delta Ar_t}{\Delta Ar_t}\right) + \beta_3 \frac{Ppe_t}{A_t} + \beta_2 Roa_t + \varepsilon \quad (3)$$

Where, Ta = Net income – cash flow from operations; A = Total assets; Sales = Sales revenue; Ar = Accounts receivable; Ppe = Plant, property, and equipment; Roa = Return on assets, Net income / total assets

Additionally, year dummies are introduced to control volatility stemming from specific economic conditions within a given year. To address industry-specific effects, the model also incorporates industry dummies.
Equation 4 tests the second hypothesis. The variable DC represents the interaction term between DIS and COMP, measuring the impact of competition.

$$SD_t = \beta_0 + \beta_1 DIS_t + \beta_2 COMP_t + \beta_3 DC_t + \beta_4 Size_t + \beta_5 Lev_t + \beta_6 Roa_t + \beta_7 Growth_t + \beta_8 Loss_t + \beta_9 Da_t + \beta_{10} Beta_t + \beta_{11} Ocf_t + IndD + YrD + \varepsilon \quad (4)$$

Where, COMP = industry competition; DC = interaction term between voluntary disclosure of carbon emissions and industry competition; see Equation 2 for the definition of other variables

4. Results

4.1. Descriptive Statistics and Correlation Matrix

Table 3 presents the descriptive statistics of the key variables. The mean value of SD is 1.024, with standard deviation of 0.5333. The average values of DIS and COMP are 0.326 and -0.015, respectively.

Table 3.
Descriptive statistics.

Variables	Mean	Std	Q1	Median	Q3
SD	1.024	0.533	0.718	0.882	1.159
DIS	0.326	0.469	0.000	0.000	1.000
COMP	-0.015	0.087	-0.001	0.000	0.000

Note: Variable definition: See variable definitions in Equation 1.

Table 4.
A correlation matrix.

	(1)	(2)	(3)
(1) SD	1.000	0.078	-0.007
		0.001	0.316
(2) DIS		1.000	-0.194
			<.0001
(3) COMP			1.000

Note: Variable definition: See variable definitions in Equation 2.

Table 4 summarizes the Pearson correlation coefficients among the main variables: SD, DIS, and COMP. The results indicate that the correlation coefficient between SD and DIS is 0.078, showing statistical significance. On the other hand, the

correlation coefficient between SD and COMP is -0.007, which does not show statistical significance. This procedure was examined without considering other control variables that might affect the dependent variables, so the regression analysis with control variables was processed.

4.2 Results of regression Analysis

Table 5 presents the empirical findings on the association between voluntary disclosure of carbon emissions and strategic deviance. The results reveal that the variable DIS, representing voluntary disclosure of carbon emissions, exhibits a positive coefficient of 0.057, statistically significant at the 5% level. This supports Hypothesis 1, suggesting that firms engaging in voluntary carbon emissions disclosure tend to exhibit higher levels of strategic deviance.

This finding aligns with the natural-resource-based theory perspective [9], which posits that voluntary carbon disclosure can serve as a strategic resource, enhancing a firm's ability to differentiate itself in the market. The positive association between carbon disclosure and strategic deviance suggests that firms are leveraging environmental transparency as a means of strategic differentiation, potentially creating new market opportunities and competitive advantages [15]. Also, this result suggests that voluntarily disclosing information on carbon emissions is not merely a compliance measure but a proactive approach to addressing climate-related risks and capitalizing on emerging opportunities [2, 3].

The positive and significant relationship between voluntary carbon emissions disclosure and strategic deviance aligns. As highlighted by Matsumura et al. [5] voluntary carbon emissions disclosure is linked to increased corporate market value, suggesting that such actions represent a form of strategic differentiation. Additionally, it reflects a deliberate effort to address environmental risks and leverage emerging market opportunities, even if it entails short-term risks. Firms that choose to disclose their carbon emissions voluntarily are often taking a step that many other firms in their industry do not, thereby positioning themselves as outliers in terms of environmental transparency and responsibility [2, 3]. This proactive approach to disclosure can lead to the adoption of innovative or unconventional strategies that deviate from industry norms [6]. This underscores the interplay between environmental transparency and strategic decision-making, suggesting that firms leveraging voluntary disclosure as a strategic tool are more inclined to deviate from industry conventions and adopt innovative practices.

Table 5.
The result of the relationship between voluntary disclosure of carbon emissions and strategic deviance.

Variables	**Coeff.**	**t-value**
Intercept	0.727	2.810***
DIS	0.057	2.080**
Size	0.015	1.560
Lev	0.006	1.830*
Roa	0.003	0.040
Growth	-0.072	-3.020***
Loss	0.086	2.260**
Da	-0.118	-1.180
Beta	-0.030	-1.280
Ocf	-0.334	-3.060***
IndD	included	
YrD	included	
F-value	3.36***	
Adj- R^2	0.021	

Note: 1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
2) See Equation 2 for variable definition.

Table 6 presents the results examining the moderating effect of industry competition on the relationship between voluntary carbon emissions disclosure and strategic deviance. The key variable of interest is the interaction term DC, which represents the interaction between DIS (voluntary disclosure of carbon emissions) and COMP (industry competition). The findings reveal that the coefficient of DC is -1.270, exhibiting statistical significance at the 1% level. This finding supports Hypothesis 2, confirming that industry competition significantly moderates the relationship between voluntary carbon emissions disclosure and strategic deviance. Specifically, the negative coefficient of DC indicates that as industry competition intensifies, the positive association between voluntary carbon emissions disclosure and strategic deviance weakens. This suggests that in highly competitive environments, firms are more cautious and less likely to engage in strategic deviations such as voluntary carbon disclosures, possibly due to concerns about revealing sensitive information to competitors.

Additionally, the results align with theoretical perspectives on competitive dynamics and managerial strategies. In highly competitive industries, firms tend to adopt risk-averse behaviors, reducing their willingness to engage in strategic deviations like voluntary carbon disclosures. This cautious approach stems from concerns about exposing sensitive information to competitors. These findings underscore the critical role of industry competition in shaping corporate disclosure behaviors. Competitive environments act as a moderating force, influencing firms' strategic decisions and reducing the likelihood of voluntary disclosures that deviate from traditional practices [32]. This insight contributes to a deeper understanding of how external market forces shape managerial decision-making and corporate transparency strategies.

Table 6.
The impact of industry competition on the relationship between voluntary disclosure of carbon emissions and strategic deviance.

Variables	Coeff.	t-value
Intercept	1.047	3.880***
DIS	0.038	1.380
COMP	0.140	0.720
DC	-1.270	-4.370***
Size	0.003	0.290
Lev	0.006	1.990*
Roa	0.005	0.060
Growth	-0.067	-2.840***
Loss	0.082	2.170**
Da	-0.107	-1.080
Beta	-0.022	-0.940
Ocf	-0.338	-3.120***
Ind	Included	
Yr	Included	
F-value	4.61***	
Adj- R^2	0.036	

Note: 1) *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.
2) See Equation 2 and 4 for variable definitions.

5. Conclusion

This study investigated the relationship between voluntary carbon emission disclosure and strategic deviance among Korean stock-listed firms, considering the moderating effect of industry competition. The findings reveal that voluntary carbon emission disclosure is indeed a form of strategic deviance, representing a departure from industry norms and aligning with the natural-resource-based theory. However, this propensity is significantly influenced by industry competition. Firms in highly competitive industries exhibit a lower likelihood of engaging in voluntary disclosures, suggesting a strategic hesitancy to reveal potentially sensitive information in intensely competitive environments.

These results offer valuable insights for both corporate decision-makers and policymakers. Companies must carefully weigh the benefits of strategic differentiation through carbon disclosure against the risks of information exposure, particularly in competitive markets. Policymakers should consider tailoring carbon disclosure policies to account for the varying levels of competition within different industries, recognizing that a uniform approach may not be effective.

This research contributes to the literature by demonstrating that voluntary carbon emission disclosure is not merely a matter of compliance but a strategic decision influenced by external competitive dynamics. It also highlights the importance of considering industry-specific contexts when examining corporate environmental strategies. Future research could explore the long-term performance implications of strategic deviance through carbon disclosure, as well as investigate the role of other external factors, such as regulatory pressures and stakeholder activism, in shaping this relationship.

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