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Does Carbon Disclosure Matter? Corporate Finance and Bank Lending Evidence from Taiwan

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Abstract

This study examines the relationship between carbon emission disclosure, corporate financial performance, and bank loan terms using panel data from publicly listed firms in Taiwan from 2011 to 2020. Firm characteristics such as size, reputation, book-to-market ratio, and industry pollution level significantly influence the likelihood of disclosure. The findings reveal a positive association between carbon reporting and financial performance, suggesting that greater transparency may enhance investor confidence and future profitability. Furthermore, disclosing firms benefit from more favorable loan conditions, including lower interest spreads, larger loan amounts, longer maturities, and a reduced need for collateral. These results highlight the financial value of environmental transparency.

JEL classification numbers: G30, G32.
Keywords: Carbon disclosure, Corporate performance, Bank loan contract terms, ESG.

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1. Introduction

In recent years, carbon reduction has emerged as a paramount issue requiring the attention of all nations worldwide. Substantial carbon emissions have gradually resulted in global warming, severe weather events, and inconsistent agricultural outputs, necessitating a global agreement on carbon reduction. In response to the substantial increase in carbon emissions, the United Nations established the United Nations Framework Convention on Climate Change (UNFCCC). The Convention functions as a framework to attain agreement on combating climate change, reducing greenhouse gas emissions, and protecting the climate system from warming for the benefit of humanity and future generations. The 2021 United Nations Climate Change Conference of the Parties 26 says that energy transition and net zero emissions would be achieved by 2050, with a special climate agreement proposed to reduce coal usage to minimize the program's effects. The above mentioned development process of carbon reduction and net zero policy demonstrates that carbon reduction is an inevitable trend. This study investigates carbon netting and evaluates the impact of carbon reduction disclosure on the corporate performance and lending conditions of publicly traded enterprises in Taiwan.

In earlier years, companies primarily focused on improving production and increasing income, while largely disregarding changes in the Earth's biosphere. In light of heightened environmental awareness, governments are intensifying their examination of business carbon emissions and have enacted regulations to limit them. The trend of carbon reduction has prompted a gradual shift in the financial sector towards sustainable finance. In 2021, the General Manager of E.SUN Commercial Bank asserted, "Faced with the global challenge of climate change, we share a collective destiny as humanity, and no group, consortium, or individual can remain impervious to this issue." Achieving the formidable global goal of net-zero carbon emissions necessitates critical elements for success, including national policies, market systems, human behaviors, enterprises, and, importantly, collaboration across industries and nations (Deloitte Taiwan, 2021).

E.SUN Commercial Bank will be the first domestic bank in Taiwan to set the goal of achieving "zero-carbon for every dollar lent" by 2021, in accordance with carbon reduction initiatives, explicitly notifying companies that lending will be suspended until carbon emissions are reduced. Cathay United Commercial Bank, in conjunction with E.SUN Commercial Bank, has declared its intention to discontinue the issuance of new loans to coal importers upon the expiration of existing loans granted before November 2021. The bank is actively pursuing a "zero-carbon operational transformation" and plans to integrate carbon reduction into the annual KPIs for its senior executives. Likewise, China Development Financial Holding Corp. has put forth a policy to achieve net-zero emissions across its whole asset portfolio by 2045. Each year, it will conduct research on specified targets to assess the carbon emissions of certain industries and thereafter formulate investment strategies for those sectors. DBS Bank has sought the removal of all debts associated

with the coal business from its balance sheet. In June 2021, Fubon Financial Holding Company Limited (hereinafter "Fubon Financial") announced its plan to initiate conditional lending for five key carbon-emission-sensitive sectors: power generation, coal extraction, cement production, petrochemicals, and iron and steel manufacturing. The consensus among the aforementioned banks implies that corporate carbon emissions will definitively affect their borrowing rates and terms. Therefore, if companies do not sufficiently reduce carbon emissions in the future, the funding requirements from banks will progressively become more stringent.

Climate change constitutes a significant challenge of our day, capable of affecting the health and well-being of humans worldwide. Beginning with Nobel winner William Nordhaus' (1970) foundational research on the Earth's environment, scientists have investigated the relationship between climate change and the economy, asserting that fossil fuels are a primary source of increased greenhouse gas emissions. It has been established that economic expansion exacerbates greenhouse gas emissions, hence intensifying climate change, which may negatively impact future economic activities. These emissions lead to considerable climate change, perhaps impacting future economic activities significantly. Much of the current research on carbon emissions largely investigates the relationship between carbon emissions and corporate performance, with empirical evidence suggesting that decreased corporate carbon emissions improve firm performance (Chang, 2016). Recent work by Huang and Huang (2019) demonstrates an inverse relationship between carbon emissions and corporate performance. This study intends to utilize the disclosure of corporate carbon emissions as the principal variable to investigate the relationship between carbon emission-related information disclosure and the performance of publicly listed companies in Taiwan.

Furthermore, some scholars have suggested that the green credit lending strategy not only contributes to the attainment of society carbon emission reduction objectives but also promotes the enhancement of bank credit risk (Guan, Zheng, Hu, Fang, and Ren, 2017). The predominant focus of studies on carbon emissions is their effect on corporate performance. This study aims to investigate the impact of voluntary carbon emissions disclosure by Taiwanese enterprises on the borrowing conditions provided by domestic banks in Taiwan, and to clarify the performance differences between companies that disclose carbon emissions and those that do not. The aim is to urge investors and business leaders to evaluate the societal and investment ramifications of carbon emissions with more scrutiny. This study seeks to prompt investors and business leaders to contemplate the impact of carbon emissions on modern society and the investing environment. This study enhances the existing literature on carbon emission reduction by examining the impact of carbon emissions on bank lending practices.

2. Literature Review and Research Hypotheses

Carbon emissions affect corporate performance and financial institution lending terms, according to this study. To better evaluate robust configurations, the study examines the key elements affecting carbon disclosure in firms before addressing the issue. We expect future research to focus on firms' voluntary carbon emission declarations and their effects on company performance and borrowing conditions, using availability as a key criterion. ESG and CSR reports emphasize sustainable development with their extensive information. Du, Bhattacharya, and Sen (2010) suggest that corporate social responsibility can boost reputation and investment. Social responsibility can be shown by monetary gifts, material donations, or the use of firm resources including knowledge, human capital, and development capabilities. Continuous corporate social responsibility can also strengthen investor-company relations. In line with this, Ding, Guo, and Tsai (2024) find that ESG performance—particularly in the context of Taiwanese firms—can significantly reduce credit risk and financial distress, highlighting the strategic value of sustainability disclosures in strengthening financial resilience and promoting long-term competitiveness.

According to Matsumura, Prakash, and Vera-Muñoz (2014), the market will fine corporations for carbon emissions and penalize those who fail to disclose them. The size, reputation, and industry of corporations may affect their carbon emission disclosure. Fatemi, Glaum, and Kaiser (2018) explored the relationship between ESG disclosures and their evaluations, arguing that good ESG qualities increase a company's worth while bad ones decrease it. The report shows the company's environmental and social commitment by showing a decrease in carbon emissions this year.

Food, banking, chemicals, and enterprises with capital over $10 billion had to submit ESG Sustainability Reports to the Taiwan Stock Exchange in 2015. The exchange forecast a reduction in capital requirements from $5 billion to $2 billion by 2023, increasing the number of companies required to file these reports. This study suggests that enterprises should produce ESG reports to gain investor support and increase investment likelihood, reducing carbon emissions and enhancing ESG disclosure visibility. If scale and reputation stabilize, companies may be more likely to voluntarily disclose CO2 emissions. Firms with a high market value ratio may disclose less voluntarily. Pre-disclosure is likely to rise due to industry dynamics and 2015 legislation that affects corporate carbon emission reports. Therefore, the hypothesis is stated as follows:

H1: The size, reputation, industry and regulations of a company affect carbon disclosure.

Modern businesses must prioritize environmental and ecological integrity to succeed. Taiwanese and global businesses are prioritizing carbon disclosure and mitigation to achieve sustainable operations. By meeting social commitments

including lowering carbon emissions and protecting the environment, Alvarez (2015) claims that companies can boost investor interest in their corporate social responsibility. Sinkin, Wright, and Burnett (2008) found greater market relevance and lower costs than eco-efficiency-promoting companies. Eco-efficiency means using fewer resources to generate more. Company unreported carbon emissions and the effects of high and low emissions on company performance are examined in this article. As environmental consciousness rises and the government promotes zero-carbon emissions, investors will look at the company's carbon disclosure and emissions. Thus, we seek to assess if carbon disclosure and high emissions affect business performance.

H2: Companies that disclose their carbon emissions outperform those who do not disclose such information.

Carbon finance is a financial strategy used by financial institutions to reduce greenhouse gas emissions. It involves carbon emission rights, trading, investing in financial commodities, and financing low-carbon initiatives. The Financial Supervisory Board of the Republic of China has instructed the Banking Council of Taiwan to incorporate sustainable indicators into its credit guidelines, requiring banks to assess borrowers' adherence to sustainable development principles during loan approval. Banks may deny loan requests to corporations with a history of unethical behavior, potentially extending to enterprises responsible for major environmental disasters or elevated emissions.
Kacperczyk and Peydró (2021) found that banks influence companies' carbon emissions by modifying credit terms, rather than financing high-carbon firms to induce emission reductions. The disclosure of carbon emissions data might affect the favorable conditions for firms pursuing bank financing. Taiwanese banks have begun a shift towards green finance, inspired by Fubon Financial's precedent. Fubon Financial plans to extend conditional loans to five businesses with elevated carbon emissions. If a company fails to actively pursue carbon reduction, the bank may hesitate to provide credit. We put up the subsequent hypothesis to substantiate our argument:

H3: Having a loan condition to disclose the emissions of carbon will be better than the loan conditions of disclosing the emission of carbon.

3. Research Method

This study focuses on the impact of carbon disclosure on corporate performance and bank borrowing terms and conditions, and is based on data from Taiwan-listed companies' carbon discharge information and financial statements and bank loan information. In addition to using logistic regressions to examine the key factors that companies disclose carbon emissions, the study also uses a simple regression analysis for the effect of carbon exposure on enterprise performance and loan terms.

3.1 Data Description

Data about carbon emissions and bank borrowing of publicly listed companies will be sourced from the Taiwan Economic Journal (TEJ) database, encompassing roughly 44,857 carbon emission records for all listed enterprises throughout the period from 2011 to 2020. In the study sample, we selected company performance and bank lending conditions as the primary analytical focuses.

In order to understand whether the reasons for the disclosure of carbon emissions have an impact on the size, policy, industry, reputation and regulations of a company, we designed a logistical regression in Model (1) for predicting the choice of carbon disclosures, and introduced an indicator variable, DUMMY_DIS, which would be zero if the company i had disclosed carbon information in the year t.

$$\text{DUMMY\_DIS}_{i,t} = \beta_0 + \beta_1 \text{SIZE}_{i,t} + \beta_2 \text{REPUTATION}_{i,t} + \beta_3 \text{LOGBM}_{i,t} + \beta_4 \text{DUMMY\_DIS}_{i,t-1} + \beta_5 \text{HIGH\_CONTAMINATE}_{i,t} + \beta_6 \text{REGULATION}_{i,t} + \varepsilon_{i,t} \quad (1)$$

The relevant variable is measured as: carbon disclosure or not (DUMMY_DIS): as an indicator variable, if the company had carbon disclose information at the time of the year set, the value would be 1, otherwise it would be zero; Company size (SIZE): The size of the company, measured by the natural equivalent of the total assets at the end of the financial year; Reputation (REPUTATION): Reliability, this study uses the market share to measure, we measure the market share is calculated by dividing the sales revenue by total sales of products of the same industry; company account market value ratio (LOGBM): company account price ratio, we measured the account market rate ratio is calculated by dividing the account value of equity by number of outstanding shares in circulation time year-on-year closing price; carbon disclosure pre-period data (DUMMY_DIS_{t-1}): DUMMY_DIS previous period disclosures; High pollution industries (HIGH_CONTAMINATE): If the industry is high sweat painting (including: electronics, coal mining, cement, petrochemical and steel industries), then 1 is zero; the effect of regulation (REGULATION): A regulation in 2013 that encourages companies to disclose carbon emissions, if the year is 1 after 2013 or 2013, otherwise zero.

Next, in order to verify the relationship between company performance and corporate carbon emission disclosures (DUMMY_DIS), we established the empirical model (2) through a basic model. We assessed company financial

performance and market performance using return on assets (ROA), return on equity (ROE), earnings per share (EPS), and company value (Tobin's Q). The regression model in Model (2) for predicting company performance is expressed below:

$$\text{Firm Performance}_{i,t} = \beta_0 + \beta_1 \text{DUMMY\_DIS}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 \text{REPUTATION}_{i,t} + \beta_4 \text{LOGBM}_{i,t} + \varepsilon_{i,t} \quad (2)$$

where

$$\text{Firm Performance}_{i,t} \in \{\text{ROA}；\text{ROE}；\text{EPS}；\text{Tobin's Q}\}$$

In this regression equation for predicted company performance, the following explanatory variables are used: The return on assets (ROA) is primarily used to assess a company's operational performance and profitability. A higher return on assets indicates better asset utilization performance by the company. Therefore, the return on assets has always been regarded by businesses as one of the indicators of financial performance. The return on assets (ROA) is calculated by dividing the net income by average of assets; the shareholder return rate (ROE), like the asset return rate, is used to measure the operational performance of a company. We measure the shareholder return rate is calculated by dividing the net income by book value of equity; Earnings per share (EPS) is a profitability indicator for a company, and there is a certain correlation between earnings per share and the company's stock price. Therefore, this study considers it as one of the indicators for measuring a company's operational performance. The formula for calculating earnings per share is calculated by dividing the net income by number of outstanding shares; The Tobin's Q ratio (Tobin's Q), proposed by Tobin (1969), refers to the ratio of a company's market value to the replacement cost of its assets.

Finally, we use the spread (SPREAD) to measure the impact of carbon emissions on bank lending conditions. Based on Model (3), and additionally introduce variables such as loan amount (LOGAMOUNT), loan maturity (MATURITY), and whether collateral is secured (SECURED) as variables to examine whether the disclosure of carbon emissions affect the lending conditions of banks.

$$\text{TERMS}_{i,t} = \beta_0 + \beta_1 \text{DUMMY\_DIS}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 \text{REPUTATION}_{i,t} + \beta_4 \text{LOGBM}_{i,t} + \beta_5 \text{ALTMAN}_{i,t} + \beta_6 \text{SPREAD}_{i,t} + \beta_7 \text{LOGAMOUNT}_{i,t} + \beta_8 \text{MATURITY}_{i,t} + \beta_9 \text{SECURED}_{i,t} + \beta_{10} \text{SYNDICATED}_{i,t} + \varepsilon_{i,t} \quad (3)$$

where

$$\text{TERMS}_{i,t} \in \{\text{SPREAD}；\text{LOGAMOUNT}；\text{MATURITY}；\text{SECURED}\}$$

The measurement of the relevant variables are the loan contract terms and borrower's characteristics: Loan Interest Spread (SPREAD): The interest spread between loans and borrowings is calculated here by averaging the highest and lowest interest rates for each loan in the data; Loan Amount (LOGAMOUNT): for the loan amount, we use the loan limit to take the natural logarithm; Loan Maturity Date (MATURITY): We take the natural logarithm of the original maturity date of the company loan; Whether there is collateral (SECURED): this is a dummy variable, which we will obtain from the loan collateral. If the loan is secured, the binary variable equals 1; otherwise, it equals 0; Syndicated Loan (SYNDICATED): this is a dummy variable; if the company has a syndicated loan, the binary variable is 1; otherwise, it is 0; Company's Financial Condition (ALTMAN): Since this section takes into account the credit quality of the company when borrowing, this article utilizes the Z-score model proposed by Altman (1968) to assess the credit quality of enterprises. The smaller the company's Z-Score, the higher the probability of a financial crisis occurring; conversely, the larger the Z-Score, the healthier the company's financial condition.

4. Empirical Results and Analysis

This paper primarily studies the impact of carbon emission disclosures by listed companies on corporate performance and bank lending conditions. The following will present the empirical results.

4.1 Descriptive Statistical Analysis

Tables 1 and 2 present the descriptive statistics for this study. Table 1 shows the reasons for carbon emission disclosure and company performance. The mean value for DUMMY_DIS indicate that nearly half of the industries in the sample have engaged in carbon emission disclosure activities. HIGH_CONTAMINATE indicates that approximately half of the sampled industries are high-pollution industries. The average values for REPUTATION, LOGBM, and $DUMMY\_DIS_{i,t-1}$ indicate that there is not much difference in the number of companies disclosing carbon emissions before and during the disclosure year.

The descriptive statistics for firm performance show significant differences in financial performance and operational capabilities among different companies. Tobin's Q, an indicator of market performance, has an average value of 1.086, indicating that the market value of the sample companies exceeds their book value. These data points to significant differences in financial performance and operational capabilities among different companies.

Table 1: Descriptive Statistics of the Reasons for Carbon Emission Disclosure and Company Performance

Variables	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
DUMMY_DIS	8604	0.411	0.492	0.000	0.000	0.000	1.000	1.000
SIZE	8604	7.030	0.709	4.237	6.553	6.909	7.346	10.039
REPUTATION	8604	3.303	8.551	0.000	0.225	0.756	2.453	93.559
LOGBM	8604	6.297	1.536	-3.323	5.310	6.193	7.216	15.365
DUMMY_DIS$_{t-1}$	8603	0.411	0.492	0.000	0.000	0.000	1.000	1.000
HIGH_CONTAMINATE	8604	0.475	0.499	0.000	0.000	0.000	1.000	1.000
REGULATION	8604	0.629	0.483	0.000	0.000	1.000	1.000	1.000
ROA	8599	4.148	9.085	-438.860	1.070	3.920	7.550	95.780
ROE	8601	6.143	29.643	-2118.260	1.830	7.230	13.380	244.420
EPS	8603	2.472	6.696	-57.860	0.290	1.420	3.400	210.700
Tobin's Q	8598	1.086	0.884	0.020	0.660	0.870	1.230	19.370

Descriptive statistics on the reasons for carbon emissions disclosure and company performance. The variables are as follows: DUMMY_DIS is an indicator variable that takes the value of 1 if the company disclosed carbon emission information in the specified year, and 0 otherwise; SIZE refers to the size of the company; REPUTATION represents goodwill using market share; LOGBM is the logarithm of the ratio of book value to market value; DUMMY_DIS$_{t-1}$ refers to the disclosure data from the previous period of DUMMY_DIS; HIGH_CONTAMINATE distinguishes high-pollution industries, with a value of 1 if the industry is considered highly-pollution industries, and 0 otherwise; REGULATION distinguishes between emission reduction policies. In 2013, the government encouraged companies to disclose carbon emissions. If the year is 2013 or later, it is marked as 1; ROA is an indicator of a company's asset utilization performance; ROE is an indicator of a company's operational performance; EPS is an indicator of a company's profitability; Tobin's Q is an indicator for measuring a company's value.

Table 2 reveals the impact of carbon disclosure on loan contract terms. Key variables include loan spread (SPREAD), loan amount (LOGAMOUNT), maturity (MATURITY), secured status (SECURED), and syndicated (SYNDICATED). SPREAD represents the loan interest spread, LOGAMOUNT represents the loan amount, MATURITY indicates the loan maturity date, SECURED refers to the company's secured loans, and SYNDICATED refers to the borrowing contract. HIGH_CONTAMINATE indicates high-pollution industries, with an average value of 0.428. SIZE represents company size, while REPUTATION represents business

goodwill. LOGBM represents the logarithm of the book-to-market ratio, with an average value of 6.046. DUMMY_DIS refers to the previous period data of DUMMY_DIS, with an average value of 0.469. REGULATION distinguishes companies implementing emission reduction policies, with an average value of 0.605, indicating most companies disclosed their carbon emissions operations in 2013 or after.

Table 2: Descriptive Statistics of Loan Contract Conditions

Variables	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
SPREAD	44919	1.592	0.714	0.000	1.130	1.490	1.935	16.280
LOGAMOUNT	45596	11.717	1.639	0.000	10.797	11.689	12.766	18.299
MATURITY	45542	2.212	2.769	0.000	0.300	1.000	3.010	80.160
SECURED	45599	0.366	0.482	0.000	0.000	0.000	1.000	1.000
SYNDICATED	45599	0.096	0.295	0.000	0.000	0.000	0.000	1.000
SIZE	45599	7.272	0.665	5.301	6.778	7.162	7.732	9.565
REPUTATION	45599	6.045	12.402	0.000	0.435	1.397	4.787	93.475
LOGBM	45599	6.046	1.390	-3.323	5.160	5.948	6.873	12.079
ALTMAN	45599	1.839	0.992	-7.297	1.291	1.768	2.332	16.735
DUMMY_DIS$_{t-1}$	45593	0.469	0.499	0.000	0.000	0.000	1.000	1.000
HIGH_CONTAMINATE	45599	0.428	0.495	0.000	0.000	0.000	1.000	1.000
REGULATION	45599	0.605	0.489	0.000	0.000	1.000	1.000	1.000

This table presents descriptive statistics for the interest spread, carbon emissions, and the conditions of bank loans. The variables are as follows: SPREAD represents the interest margin on loans; LOGAMOUNT refers to prior data; MATURITY is the original maturity date of the company loan; SECURED is a dummy variable that determines whether the loan is secured; if the loan is secured, the binary variable equals 1; otherwise, it equals 0; SYNDICATED pertains to the loan agreement; HIGH_CONTAMINATE indicates whether the industry is a high-pollution industry, with a value of 1 if it is, and 0 otherwise; SIZE refers to the size of the company; REPUTATION represents goodwill using market share; LOGBM is the logarithm of the ratio of book value to market value; ALTMAN is a financial ratio, and this variable is established using the multivariate method proposed by Altman (1968); DUMMY_DIS$_{t-1}$ refers to the disclosure data from the previous period of DUMMY_DIS; HIGH_CONTAMINATE distinguishes high-pollution industries, with a value of 1 if the industry is considered highly-pollution industries, and 0 otherwise; REGULATION distinguishes between emission reduction policies. In 2013, the government encouraged companies to disclose carbon emissions. If the year is 2013 or later, it is marked as 1.

4.2 Correlation Coefficient Test

This section presents the correlation tests between the reasons for carbon emission disclosure, company performance, and loan contract conditions. Table 3 presents the correlation test between the reasons for carbon emission disclosure and company performance. The correlation analysis shows significant positive relationships between carbon emission disclosure (DUMMY_DIS) and various performance metrics, including ROA, ROE, and EPS. Specifically, larger firms with better reputations and lower book-to-market ratios are more likely to disclose carbon emissions, underscoring the role of firm characteristics in environmental reporting. The economic implication of Table 3, we shows that the positive correlations suggest that carbon emission disclosure may enhance corporate performance, potentially attracting investment and boosting market valuation. This finding emphasizes the strategic importance of sustainability disclosure as a tool for improving corporate competitiveness and financial performance.

Table 4 displays the correlation coefficient analyses for the terms of loan agreements. The data indicate that companies reporting carbon emissions receive more advantageous loan conditions, such as reduced interest rates and extended maturities. A substantial negative association exists between DUMMY_DIS and loan spreads, underscoring the notion that carbon disclosure mitigates perceived risk among lenders. The table indicates that the substantial correlation between carbon disclosure and enhanced loan terms highlights the financial advantages of openness. This indicates that banks provide favorable lending terms to environmentally responsible corporations, encouraging them to implement and uphold strong sustainability policies.

These tables collectively highlight the economic benefits of carbon emission disclosure for firms in terms of both enhanced corporate performance and improved access to capital. The findings underscore the strategic importance of integrating environmental transparency into business practices, aligning corporate sustainability with financial incentives from investors and creditors.

Table 3: Correlation Test between Reasons for Carbon Emission Disclosure and Company Performance

Variables	DUMMY_DIS	SIZE	REPUTATION	LOGBM	$DUMMY\_DIS_{t-1}$	HIGH_CONTAMINATE	REGULATION	ROA	ROE	EPS	Tobin's Q
DUMMY_DIS	1.000										
SIZE	0.440	1.000									
	(<.0001)										
REPUTATION	0.221	0.498	1.000								
	(<.0001)	(<.0001)									
LOGBM	0.144	0.270	0.185	1.000							
	(<.0001)	(<.0001)	(<.0001)								
$DUMMY\_DIS_{t-1}$	0.760	0.394	0.197	0.110	1.000						
	(<.0001)	(<.0001)	(<.0001)	(<.0001)							
HIGH_CONTAMINATE	-0.009	-0.080	-0.097	0.029	-0.012	1.000					
	(0.4128)	(<.0001)	(<.0001)	(0.0082)	(0.2681)						
REGULATION	0.245	0.021	-0.018	0.098	0.206	-0.012	1.000				
	(<.0001)	(0.0546)	(0.0897)	(<.0001)	(<.0001)	(0.2694)					
ROA	0.059	0.085	0.046	0.515	0.050	-0.021	-0.001	1.000			
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0501)	(0.9030)				
ROE	0.064	0.135	0.048	0.351	0.055	-0.025	0.002	0.832	1.000		
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0197)	(0.8421)	(<.0001)			
EPS	0.066	0.154	0.072	0.555	0.052	0.037	0.040	0.460	0.299	1.000	
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0006)	(0.0002)	(<.0001)	(<.0001)		
Tobin's Q	-0.030	-0.235	-0.016	0.365	-0.038	0.025	0.037	0.202	-0.003	0.300	1.000
	(0.0058)	(<.0001)	(0.1347)	(<.0001)	(0.0004)	(0.0220)	(0.0006)	(<.0001)	(0.7907)	(<.0001)	

This table examines the correlation between the reasons for carbon emission disclosure and company performance. The variables are as follows: DUMMY_DIS is an indicator variable that takes the value of 1 if the company disclosed carbon emission information in the specified year, and 0 otherwise; SIZE refers to the size of the company; REPUTATION represents goodwill using market share; LOGBM is the logarithm of the ratio of book value to market value; $DUMMY\_DIS_{t-1}$ refers to the disclosure data from the previous period of DUMMY_DIS; HIGH_CONTAMINATE distinguishes high-pollution industries, with a value of 1 if the industry is considered highly-pollution industries, and 0 otherwise; REGULATION distinguishes between emission reduction policies. In 2013, the government encouraged companies to disclose carbon emissions. If the year is 2013 or later, it is marked as 1; ROA is an indicator of a company's asset utilization performance; ROE is an indicator of a company's operational performance; EPS is an indicator of a company's profitability; Tobin's Q is an indicator for measuring a company's value.

Table 4: Correlation Coefficient Test of Loan Contract Conditions

Variables	SPREAD	LOGAMOUNT	MATURITY	SECURED	SYNDICATED	SIZE	REPUTATION	LOGBM	ALTMAN	$DUMMY\_DIS_{t-1}$	HIGH_CONTAMINATE	REGULATION
SPREAD	1.0000											
LOGAMOUNT	-0.1412	1.0000										
	(<.0001)											
MATURITY	0.1175	0.1872	1.0000									
	(<.0001)	(<.0001)										
SECURED	0.2999	-0.0285	0.3384	1.0000								
	(<.0001)	(<.0001)	(<.0001)									
SYNDICATED	0.1316	0.0986	0.1805	0.0672	1.0000							
	(<.0001)	(<.0001)	(<.0001)	(<.0001)								
SIZE	-0.1705	0.6008	0.0521	-0.2007	0.1008	1.0000						
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)							
REPUTATION	-0.1354	0.3506	0.0013	-0.1846	0.0983	0.6350	1.0000					
	(<.0001)	(<.0001)	(0.7754)	(<.0001)	(<.0001)	(<.0001)						
LOGBM	-0.3395	0.2507	-0.0209	-0.2389	-0.0536	0.3397	0.1718	1.0000				
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)					
ALTMAN	-0.2534	-0.0108	-0.0884	-0.1717	-0.0881	-0.0413	0.0278	0.4253	1.0000			
	(<.0001)	(0.0215)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)				
$DUMMY\_DIS_{t-1}$	-0.1480	0.2834	0.0351	-0.1637	0.0676	0.4463	0.2464	0.1105	0.0228	1.0000		
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)			
HIGH_CONTAMINATE	-0.0280	-0.0201	-0.0538	-0.0753	0.0926	-0.0505	-0.1345	0.0149	0.1372	0.0188	1.0000	
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0015)	(<.0001)	(<.0001)		
REGULATION	-0.0834	0.0177	-0.0848	-0.0734	-0.0766	0.0042	-0.0416	0.0675	-0.0533	0.2425	0.0055	1.0000
	(<.0001)	(0.0002)	(<.0001)	(<.0001)	(<.0001)	(0.3708)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.2403)	

SPREAD refers to the interest margin on loans; LOGAMOUNT represents data from the previous period; MATURITY is the original maturity date of the company loan; SECURED is a dummy variable that determines whether a loan is secured; if the loan is secured, the binary variable equals 1; otherwise, it equals 0; SYNDICATED refers to the loan agreement; SIZE refers to the size of the company; REPUTATION represents goodwill using market share; LOGBM is the logarithm of the ratio of book value to market value; ALTMAN is a financial ratio, and this variable is established using the multivariate method proposed by Altman (1968); $DUMMY\_DIS_{i,t-1}$ refers to the disclosure data from the previous period of DUMMY_DIS; HIGH_CONTAMINATE indicates whether the industry is a high-pollution industry, with a value of 1 if it is, and 0 otherwise; REGULATION distinguishes between emission reduction policies. In 2013, the government encouraged companies to disclose carbon emissions. If the year is 2013 or later, it is marked as 1.

4.3 Statistical Analysis of Carbon Emissions Disclose by Year

Figure 1 is a statistical line chart illustrating the extent of carbon emissions disclosure over different study years. The study shows that since 2011, the number of listed companies in the sample has consistently increased their public disclosure of carbon emissions, reaching its peak in 2018. This is due to the implementation of sustainable development practices recommendations by the Securities and Futures Bureau of the Financial Supervisory Commission, Executive Yuan. The Carbon Disclosure Project was initiated in 2012, encouraging firms to evaluate their carbon emissions. The Environmental Protection Administration promulgated the "Management Regulations for Greenhouse Gas Emission Reporting" in 2013, requiring significant domestic enterprises to adhere to these regulations. However, the revised ISO 14067:2018 carbon footprint international standard in 2018 made the disclosure of carbon emissions more stringent and prudent, resulting in a significant reduction in disclosure.

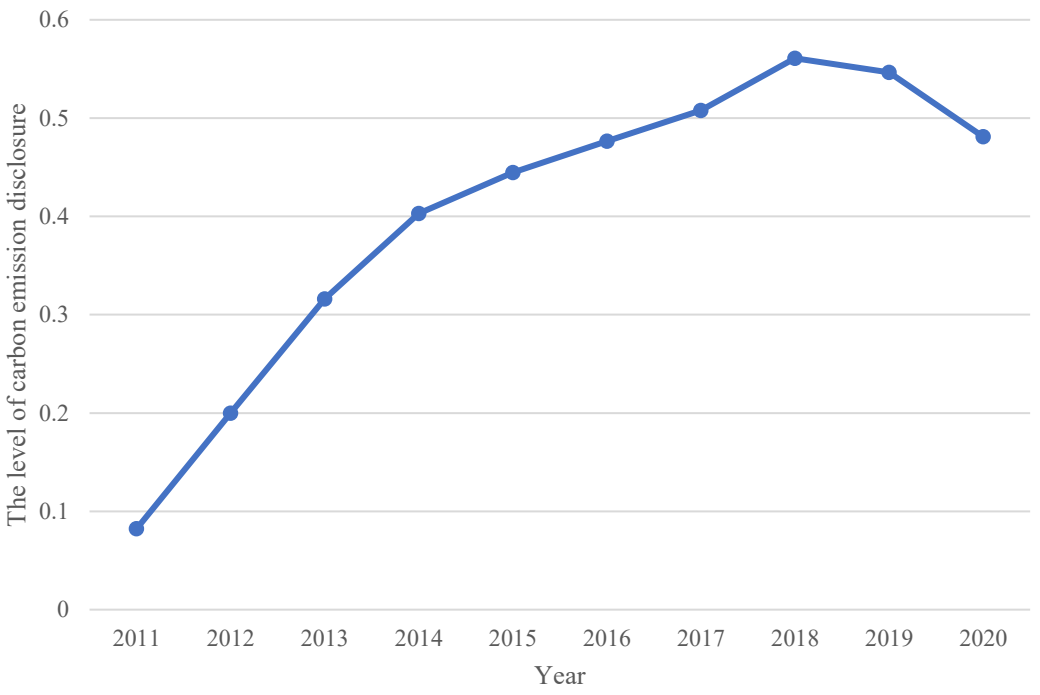

Figure 1: The level of carbon emission disclosure in Taiwan across different year

4.4 Empirical Analysis

This section presents the empirical findings of the study, analyzing the impact of carbon emission disclosure on corporate performance and bank loan conditions for publicly listed companies in Taiwan. The analysis utilizes logistic and general regression models to assess the relationships between carbon disclosure, firm characteristics, and financial outcomes, thereby highlighting the economic significance of environmental transparency.

4.4.1 Determinants of Carbon Emission Disclosure

Table 5 illustrates the logistic regression results examining the factors influencing the disclosure of carbon emissions among Taiwanese listed companies. This table presents the logistic regression analysis about the factors influencing carbon emission disclosure. The first and fourth regressions exclude year control factors, whereas the second and third regressions incorporate them. Key determinants include firm size (SIZE), reputation (REPUTATION), book-to-market ratio (LOGBM), previous disclosure behavior (DUMMY_DIS), industry type (HIGH_CONTAMINATE), and regulatory environment (REGULATION). The findings indicate that larger firms, those with better reputations, and those in high-pollution industries are more likely to disclose their carbon emissions. Regulatory policies significantly encourage disclosure, suggesting a strong influence of governmental pressure on corporate environmental transparency.

The results underscore the critical role of firm size and reputation in shaping carbon disclosure decisions, suggesting that larger, more reputable firms are better positioned to absorb the costs and reap the benefits of transparency. The positive impact of regulations emphasizes the importance of policy interventions in promoting sustainable business practices, providing evidence that regulatory frameworks can effectively drive corporate behavior toward greater environmental accountability.

Table 5: Logistic Regression Analysis of Carbon Emission Disclosure

Independent Variables	Dependent Variable: DUMMY_DIS			
	(1)	(2)	(3)	(4)
SIZE	1.471***	2.042***	1.767***	1.769***
	(0.035)	(0.060)	(0.049)	(0.038)
REPUTATION	0.000	0.011***	0.022***	0.008***
	(0.002)	(0.003)	(0.004)	(0.002)
LOGBM	-0.006	-0.100***	-0.115***	-0.074***
	(0.011)	(0.015)	(0.013)	(0.011)
DUMMY_DIS_{t-1}	3.713***	4.718***	4.877***	3.602***
	(0.031)	(0.054)	(0.053)	(0.032)
HIGH_CONTAMINATE			0.261***	0.109***
			(0.038)	(0.033)
REGULATION				1.616***
				(0.039)
_CONS	-12.575***	-20.628***	-18.613***	-15.295***
	(0.231)	(0.407)	(0.332)	(0.261)
Year Control	No	Yes	Yes	No
Industry Control	No	Yes	No	No
N	45593	45593	45593	45593
pseudo R^2	0.533	0.672	0.653	0.570

This paper discusses the key factors influencing the disclosure of carbon emission information by publicly listed companies in Taiwan using the following logistic regression settings:

$$\text{DUMMY\_DIS}_{i,t} = \beta_0 + \beta_1 \text{SIZE}_{i,t} + \beta_2 \text{REPUTATION}_{i,t} + \beta_3 \text{LOGBM}_{i,t} + \beta_4 \text{DUMMY\_DIS}_{i,t-1} + \beta_5 \text{HIGH\_CONTAMINATE}_{i,t} + \beta_6 \text{REGULATION}_{i,t} + \varepsilon_{i,t}$$

Standard errors in parentheses ; * p<0.1, ** p<0.05, *** p<0.01

This table is for studying whether the reasons for disclosing carbon emissions will affect the company's size, reputation, industry type, and regulations. The dependent variable is DUMMY_DIS, which is primarily an indicator variable. It takes the value of 1 if the company disclosed carbon emission information in the specified year, and 0 otherwise. The main explanatory variable SIZE represents the size of the company; REPUTATION represents goodwill using market share; LOGBM is the logarithm of the ratio of book value to market value; $\text{DUMMY\_DIS}_{i,t-1}$ refers to the disclosure data from the previous period of DUMMY_DIS; HIGH_CONTAMINATE distinguishes high-pollution industries, with a value of 1 if the industry is considered highly-pollution industries, and 0 otherwise; REGULATION distinguishes between emission reduction policies. In 2013, the government encouraged companies to disclose carbon emissions. If the year is 2013 or later, it is marked as 1.

4.4.2 Impact of Carbon Emission Disclosure on Corporate Performance

Table 6 presents the general regression analysis of the relationship between carbon emission disclosure and corporate performance metrics, including Return on Assets (ROA), Return on Equity (ROE), Earnings per Share (EPS), and Tobin's Q. The results reveal that firms disclosing carbon emissions consistently outperform those that do not, with significant positive effects observed across all performance indicators. Disclosure is positively associated with higher asset utilization, profitability, and market valuation, highlighting the economic advantages of environmental transparency.

The findings of Table 6 suggest that carbon disclosure enhances firm performance, potentially by attracting investor interest and improving market perception. This aligns with the notion that transparency in environmental practices can serve as a strategic asset, boosting financial outcomes and reinforcing the business case for sustainability. Firms that actively disclose emissions signal their commitment to responsible management, thereby gaining competitive advantages in both capital markets and operational efficiency.

Table 6: Regression Analysis of Company Performance with and without Disclosure of Carbon Emissions

Independent Variables	Dependent Variables			
	ROA	**ROE**	**EPS**	**TOBINS_Q**
	(1)	(2)	(3)	(4)
DUMMY_DIS$_{i,t-1}$	0.646***	1.068***	0.142***	0.070***
	(11.83)	(7.54)	(5.05)	(15.84)
SIZE	-0.912***	-0.892***	0.057*	-0.362***
	(-12.80)	(-4.21)	(1.73)	(-67.90)
REPUTATION	-0.019***	-0.085***	-0.019***	0.007***
	(-7.54)	(-8.24)	(-10.91)	(28.44)
LOGBM	2.842***	7.859***	1.923***	0.188***
	(86.51)	(35.36)	(68.38)	(67.66)
_CONS	-7.961***	-41.802***	-9.019***	2.203***
	(-14.70)	(-19.41)	(-30.52)	(63.58)
Year Control	Yes	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes	Yes
N	45593	45593	45589	45593
adj. R^2	0.346	0.329	0.464	0.375

This table will present the results of a simple linear regression, examining the relationship between the disclosure of carbon emission information by publicly listed companies in Taiwan and their corporate performance.

$$\text{Firm Performance}_{i,t} = \beta_0 + \beta_1 \text{DUMMY\_DIS}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 \text{REPUTATION}_{i,t} + \beta_4 \text{LOGBM}_{i,t} + \varepsilon_{i,t}$$

$\text{Firm Performance}_{i,t} \in$ {ROA ; ROE ; EPS ; Tobin's Q}

t statistics in parentheses ; * p<0.1, ** p<0.05, *** p<0.01

This table examines the relationship between a company's financial performance and its disclosure of carbon emissions. The dependent variables are ROA, ROE, EPS, and Tobin's Q. These variables are primarily used to assess a company's operational performance, profitability, and market value. The higher the ROA, ROE, EPS, and Tobin's Q, the better the company's asset utilization performance. The main explanatory variable is $\text{DUMMY\_DIS}_{i,t-1}$, which refers to the previous period's carbon disclosure data for DUMMY_DIS. The other explanatory variables are: SIZE represents the scale of the company; REPUTATION uses market share to represent goodwill; LOGBM is the logarithm of the ratio of book value to market value.

4.4.3 Carbon Emission Disclosure and Corporate Performance in High-Pollution Industries

Table 7 extends the analysis by distinguishing between high-pollution and non-high-pollution industries. The results show that the positive effects of carbon disclosure on performance metrics are particularly pronounced in high-pollution sectors. For firms in these industries, disclosure is associated with substantial improvements in ROA, ROE, EPS, and Tobin's Q, highlighting the reputational and operational benefits of transparency in sectors under greater scrutiny for their environmental impact. These findings indicate that carbon disclosure serves as a critical differentiator in high-pollution industries, where the pressure to mitigate environmental harm is more intense. By proactively disclosing emissions, firms in these sectors can enhance their legitimacy and mitigate potential regulatory or market penalties, ultimately improving their financial standing. The results support the argument that environmental disclosure is particularly valuable for firms facing high environmental risks, providing a pathway to better financial and reputational outcomes.

Table 7: Regression Analysis of Whether It Is a High Pollution Industry and Disclosure of Carbon Emissions

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variables							
	HIGH_CONTAMINATE = 0				HIGH_CONTAMINATE = 1			
	ROA	ROE	EPS	TOBINS_Q	ROA	ROE	EPS	TOBINS_Q
DUMMY_DIS$_{i,t-1}$	0.383***	-0.235	-0.264***	0.125***	0.768***	1.979***	0.255***	0.065***
	(5.40)	(-1.57)	(-7.23)	(20.37)	(8.04)	(7.17)	(4.85)	(9.61)
SIZE	-0.460***	0.398**	0.242***	-0.365***	-0.593***	-0.600*	0.197***	-0.264***
	(-5.93)	(2.38)	(6.48)	(-58.95)	(-6.38)	(-1.75)	(4.62)	(-34.88)
REPUTATION	-0.030***	-0.091***	-0.028***	0.002***	-0.003	-0.086***	-0.006**	0.007***
	(-10.68)	(-14.39)	(-18.85)	(14.28)	(-0.94)	(-5.62)	(-2.54)	(13.63)
LOGBM	2.924***	7.137***	1.898***	0.220***	2.541***	7.683***	1.879***	0.132***
	(72.16)	(63.46)	(80.49)	(57.33)	(63.07)	(22.59)	(42.93)	(44.53)
_CONS	-9.373***	-35.650***	-10.739***	2.171***	-8.893***	-38.727***	-11.420***	1.925***
	(-14.32)	(-24.27)	(-32.24)	(63.20)	(-13.55)	(-11.95)	(-29.45)	(40.36)
Year Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Control	No	No	No	No	No	No	No	No
N	26069	26069	26065	26069	19524	19524	19524	19524
adj. R^2	0.322	0.328	0.451	0.374	0.287	0.268	0.429	0.226

This section will study the samples classified by their industry into high-pollution industries and non-high-pollution industries, in order to explore the relationship between the disclosure of carbon emission information and corporate performance in the context of high-pollution industries.

$$\text{Firm Performance}_{i,t} = \beta_0 + \beta_1 \text{DUMMY\_DIS}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 \text{REPUTATION}_{i,t} + \beta_4 \text{LOGBM}_{i,t} + \varepsilon_{i,t}$$

$\text{Firm Performance}_{i,t} \in$ {ROA；ROE；EPS；Tobin's Q}

t statistics in parentheses；* p<0.1, ** p<0.05, *** p<0.01

This table examines the relationship between a company's financial performance and its disclosure of carbon emissions. In this table we divide our sample as two by HIGH_CONTAMINATE. This variable help us to distinguish high pollution industries or not. Thus, if the industry is a high pollution industry, it is coded as 1, otherwise it is 0. The dependent variables are ROA, ROE, EPS, and Tobin's Q. These variables are primarily used to assess a company's operational performance, profitability, and market value. The higher the ROA, ROE, EPS, and Tobin's Q, the better the company's asset utilization performance. The main explanatory variable is $\text{DUMMY\_DIS}_{i,t-1}$, which refers to the previous period's carbon disclosure data for DUMMY_DIS. The other explanatory variables are: SIZE represents the size of the company; REPUTATION uses market share to represent goodwill; LOGBM is the logarithm of the ratio of book value to market value.

4.4.4 Carbon Emission Disclosure and Bank Loan Conditions

Table 8 analyzes the impact of carbon emission disclosure on loan conditions, including loan spread, amount, maturity, and security requirements. The findings indicate that firms disclosing carbon emissions benefit from more favorable loan terms, such as lower interest spreads, larger loan amounts, longer maturities, and reduced collateral requirements. This suggests that banks perceive disclosing firms as less risky, likely due to their enhanced transparency and commitment to managing environmental impacts. The results of this table highlight the financial benefits of carbon disclosure beyond equity markets, extending to corporate debt financing. By demonstrating environmental responsibility, firms can improve their access to capital and secure more advantageous borrowing terms, reducing their overall cost of capital. This underscores the strategic importance of environmental disclosure not only for attracting investors but also for optimizing financing conditions, which can significantly impact a firm's long-term financial sustainability.

Table 8: Regression Analysis of Loan Conditions and Carbon Emission Disclosure

Independent Variables	Dependent Variables :			
	SPREAD	**LOGAMOUNT**	**MATURITY**	**SECURED**
	(1)	(2)	(3)	(4)
DUMMY_DIS$_{i,t-1}$	-0.036***	0.090***	0.363***	-0.060***
	(-5.01)	(6.08)	(11.17)	(-12.03)
SIZE	-0.034***	1.397***	-0.282***	-0.126***
	(-3.92)	(87.57)	(-7.96)	(-22.26)
REPUTATION	0.002***	-0.002**	0.002	-0.001***
	(6.52)	(-1.96)	(1.27)	(-3.89)
LOGBM	-0.106***	0.035***	0.153***	-0.030***
	(-34.74)	(5.62)	(13.16)	(-15.55)
ALTMAN	-0.090***	-0.025***	-0.037**	-0.019***
	(-20.43)	(-2.91)	(-2.52)	(-7.19)
SPREAD		-0.205***	0.168***	0.082***
		(-16.99)	(10.52)	(19.19)
LOGAMOUNT	-0.047***		0.282***	0.022***
	(-16.99)		(28.10)	(14.17)
MATURITY	0.010***	0.076***		0.050***
	(10.06)	(26.21)		(36.37)
SECURED	0.178***	0.212***	1.781***	
	(25.16)	(14.25)	(55.03)	
SYNDICATED	0.276***	0.314***	1.636***	0.061***
	(28.63)	(12.40)	(43.74)	(7.82)
_CONS	3.040***	1.504***	-1.383***	0.973***
	(52.65)	(13.43)	(-6.30)	(26.01)
Year Control	Yes	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes	Yes
N	44857	44857	44857	44857
adj. R^2	0.300	0.419	0.236	0.298

This table will present the results of a simple linear regression, examining the relationship between the carbon emission information disclosed by publicly listed companies in Taiwan and their borrowing conditions.

$$TERMS_{i,t} = \beta_0 + \beta_1 DUMMY\_DIS_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 REPUTATION_{i,t} + \beta_4 LOGBM_{i,t} + \beta_5 ALTMAN_{i,t} + \beta_6 SPREAD_{i,t} + \beta_7 LOGAMOUNT_{i,t} + \beta_8 MATURITY_{i,t} + \beta_9 SECURED_{i,t} + \beta_{10} SYNDICATED_{i,t} + \varepsilon_{i,t}$$

$$TERMS_{i,t} \in \{SPREAD\ ;\ LOGAMOUNT\ ;\ MATURITY\ ;\ SECURED\}$$

t statistics in parentheses ; * p<.1, ** p<0.05, *** p<0.01

This table measures the impact of carbon emission disclosure on bank loan conditions using the spread, log amount, maturity, and secured status. The dependent variable is the SPREAD, which is the interest rate difference for loans; we calculate the average of the highest and lowest interest rates for each loan in the data. LOGAMOUNT refers to the loan amount; MATURITY is the original maturity date of the company loan; SECURED is a dummy variable that determines whether the loan is secured; if the loan is secured, the binary variable equals 1; otherwise, it equals 0. The main explanatory variable is $DUMMY\_DIS_{i,t-1}$, which represents the prior disclosure data of DUMMY_DIS. Other explanatory variables include SIZE, which refers to the scale of the company; REPUTATION, represented by market share to indicate goodwill; LOGBM is the logarithm of the ratio of book value to market value; the ALTMAN variable reflects the company's financial condition, established using the multivariate method proposed by Altman (1968); SYNDICATED, this is a virtual variable that determines whether the company has a syndicated loan. If the company has a syndicated loan, the binary variable is 1; otherwise, it is 0.

4.4.5 Two-Stage Regression Analysis of Loan Conditions and Carbon Emission Disclosure

Table 9 and Table 10 further investigates the relationship between carbon disclosure and loan conditions using a two-stage regression model, which accounts for potential endogeneity between disclosure decisions and loan terms. The results confirm that carbon disclosure continues to be associated with more favorable loan conditions, reinforcing the robustness of the initial findings. The economic implications of this analysis strengthens the causal interpretation of the relationship between carbon disclosure and loan conditions, suggesting that the observed benefits are not merely correlational but reflect a direct economic impact. The two-stage approach provides additional confidence in the findings, demonstrating that carbon disclosure is a valuable tool for firms seeking to improve their financing outcomes.

Table 9: Two-Stage Regression Analysis of Loan Conditions and Carbon Emission Disclosure

Independent Variables	Dependent Variables			
	SPREAD	**LOGAMOUNT**	**MATURITY**	**SECURED**
	(1)	(2)	(3)	(4)
$\widehat{DUMMY}\_DIS_{i,t-1}$	-0.176***	0.069***	0.189***	-0.150***
	(-19.45)	(3.75)	(5.12)	(-24.87)
SIZE	0.071***	1.466***	-0.074**	-0.053***
	(8.55)	(95.92)	(-2.07)	(-9.84)
REPUTATION	-0.003***	-0.007***	-0.006***	-0.003***
	(-8.78)	(-9.05)	(-5.04)	(-17.88)
LOGBM	-0.112***	0.061***	0.104***	-0.040***
	(-40.88)	(10.94)	(9.74)	(-22.32)
ALTMAN	-0.077***	0.009	-0.105***	-0.022***
	(-18.85)	(1.07)	(-8.26)	(-8.76)
SPREAD		-0.145***	0.130***	0.120***
		(-13.17)	(8.34)	(25.74)
LOGAMOUNT	-0.035***		0.310***	0.026***
	(-12.49)		(31.16)	(16.12)
MATURITY	0.009***	0.082***		0.053***
	(8.17)	(28.66)		(39.15)
SECURED	0.278***	0.232***	1.875***	
	(37.75)	(15.73)	(59.29)	
SYNDICATED	0.247***	0.132***	1.327***	-0.014**
	(28.27)	(5.71)	(38.80)	(-2.05)
_CONS	2.263***	0.636***	-2.420***	0.518***
	(42.14)	(6.21)	(-11.71)	(15.36)
Year Control	Yes	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes	Yes
N	44857	44857	44857	44857
adj. R^2	0.200	0.394	0.179	0.243

This table presents the results of re-examining the relationship between carbon emission disclosure by publicly listed companies in Taiwan and corporate borrowing conditions using a two-stage model. The process of setting up the two stages is as follows:

The first stage: Estimate ($\widehat{DUMMY\_DIS}$) using key factors that reveal carbon emissions.

$$\text{DUMMY\_DIS}_{i,t} = \beta_0 + \beta_1\text{SIZE}_{i,t} + \beta_2\text{REPUTATION}_{i,t} + \beta_3\text{LOGBM}_{i,t} + \beta_4\text{DUMMY\_DIS}_{i,t-1} + \beta_5\text{HIGH\_CONTAMINATE}_{i,t} + \beta_6\text{REGULATION}_{i,t} + \varepsilon_{i,t}$$

The second stage: Substitute the estimated value ($\widehat{DUMMY\_DIS}$) into the following equation for analysis.

$$\text{TERMS}_{i,t} = \beta_0 + \beta_1\widehat{\text{DUMMY\_DIS}}_{i,t-1} + \beta_2\text{SIZE}_{i,t} + \beta_3\text{REPUTATION}_{i,t} + \beta_4\text{LOGBM}_{i,t} + \beta_5\text{ALTMAN}_{i,t} + \beta_6\text{SPREAD}_{i,t} + \beta_7\text{LOGAMOUNT}_{i,t} + \beta_8\text{MATURITY}_{i,t} + \beta_9\text{SECURED}_{i,t} + \beta_{10}\text{SYNDICATED}_{i,t} + \varepsilon_{i,t}$$

$\text{TERMS}_{i,t} \in \{\text{SPREAD}\ ;\ \text{LOGAMOUNT}\ ;\ \text{MATURITY}\ ;\ \text{SECURED}\}$

t statistics in parentheses ; * p<.1, ** p<0.05, *** p<0.01

This table measures the impact of carbon emission disclosure on bank lending conditions using a two-stage regression with the variables SPREAD, LOGAMOUNT, MATURITY, and SECURED. The dependent variable is the SPREAD, which is the interest rate difference for loans; we calculate the average of the highest and lowest interest rates for each loan in the data. LOGAMOUNT refers to the loan amount; MATURITY is the original maturity date of the company loan; SECURED is a dummy variable that determines whether the loan is secured; if the loan is secured, the binary variable equals 1; otherwise, it equals 0. The main explanatory variable is $\widehat{\text{DUMMY\_DIS}}_{i,t-1}$, which represents the prior disclosure data of DUMMY_DIS. Other explanatory variables include SIZE, which refers to the scale of the company; REPUTATION, represented by market share to indicate goodwill; LOGBM is the logarithm of the ratio of book value to market value; the ALTMAN variable reflects the company's financial condition, established using the multivariate method proposed by Altman (1968); SYNDICATED, this is a virtual variable that determines whether the company has a syndicated loan. If the company has a syndicated loan, the binary variable is 1; otherwise, it is 0.

Table 10: Regression Analysis of Loan Conditions and Whether It Is a High Pollution Industry

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variables							
	DUMMY_DIS = 1 ; HIGH_CONTAMINATE=0				DUMMY_DIS = 1 ; HIGH_CONTAMINATE=1			
	SPREAD	LOGAMOUNT	MATURITY	SECURED	SPREAD	LOGAMOUNT	MATURITY	SECURED
$\widehat{DUMMY}\_DIS_{i,t-1}$	-0.152***	0.076***	0.394***	-0.110***	-0.014	0.049**	0.467***	-0.039***
	(-15.79)	(3.97)	(9.21)	(-16.42)	(-1.41)	(2.25)	(10.43)	(-5.29)
SIZE	-0.012	1.295***	-0.056	-0.038***	0.046***	1.587***	-0.288***	-0.124***
	(-1.16)	(64.73)	(-1.20)	(-5.51)	(3.69)	(78.51)	(-5.49)	(-15.79)
REPUTATION	-0.003***	-0.008***	-0.002	-0.007***	0.000	0.000	-0.012***	0.002***
	(-9.81)	(-7.73)	(-1.25)	(-27.50)	(0.70)	(0.16)	(-8.05)	(9.60)
LOGBM	-0.097***	0.104***	0.054***	-0.025***	-0.110***	-0.009	0.245***	-0.054***
	(-23.78)	(13.23)	(3.37)	(-9.11)	(-28.16)	(-1.11)	(16.25)	(-22.56)
ALTMAN	-0.115***	-0.091***	-0.008	-0.014***	-0.079***	0.073***	-0.189***	-0.011***
	(-18.71)	(-7.85)	(-0.45)	(-3.96)	(-13.25)	(6.70)	(-9.43)	(-2.89)
LOGAMOUNT	-0.048***		0.426***	0.037***	-0.038***		0.181***	0.007***
	(-12.26)		(31.21)	(17.39)	(-9.94)		(12.27)	(3.08)
MATURITY	0.014***	0.108***		0.048***	0.001	0.051***		0.055***
	(9.41)	(31.41)		(43.14)	(0.77)	(11.68)		(17.09)
SECURED	0.316***	0.327***	1.686***		0.206***	0.074***	1.918***	
	(32.13)	(17.48)	(41.33)		(20.60)	(3.09)	(36.84)	
SYNDICATED	0.229***	0.227***	0.421***	-0.090***	0.284***	0.249***	1.921***	0.107***
	(16.65)	(6.54)	(8.18)	(-9.87)	(23.39)	(7.47)	(36.81)	(8.48)
SPREAD		-0.190***	0.213***	0.139***		-0.176***	0.019	0.096***
		(-12.23)	(10.29)	(18.86)		(-10.52)	(0.77)	(17.13)
_CONS	2.988***	1.728***	-3.567***	0.238***	2.457***	0.121	-0.035	1.280***
	(40.91)	(12.09)	(-12.40)	(4.82)	(33.21)	(0.86)	(-0.13)	(27.15)
Year Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Control	No	No	No	No	No	No	No	No
N	25680	25680	25680	25680	19177	19177	19177	19177
adj. R^2	0.234	0.369	0.180	0.242	0.282	0.455	0.235	0.283

This section will categorize the research samples into high-pollution industries and non-high-pollution industries, while also utilizing a two-stage regression to explore the relationship between the disclosure of carbon emission information and corporate borrowing conditions in the context of high-pollution industries.

The first stage: Estimate ($\widehat{DUMMY\_DIS}$) using key factors that reveal carbon emissions.

$$\begin{aligned}\text{DUMMY\_DIS}_{i,t} = {} & \beta_0 + \beta_1 \text{SIZE}_{i,t} + \beta_2 \text{REPUTATION}_{i,t} + \beta_3 \text{LOGBM}_{i,t} + \beta_4 \text{DUMMY\_DIS}_{i,t-1} + \beta_5 \text{HIGH\_CONTAMINATE}_{i,t} \\ & + \beta_6 \text{REGULATION}_{i,t} + \varepsilon_{i,t}\end{aligned}$$

The second stage: Substitute the estimated value ($\widehat{DUMMY\_DIS}$) into the following equation for analysis.

$$\begin{aligned}\text{TERMS}_{i,t} = {} & \beta_0 + \beta_1 \widehat{\text{DUMMY\_DIS}}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 \text{REPUTATION}_{i,t} + \beta_4 \text{LOGBM}_{i,t} + \beta_5 \text{ALTMAN}_{i,t} + \beta_6 \text{SPREAD}_{i,t} + \beta_7 \text{LOGAMOUNT}_{i,t} \\ & + \beta_8 \text{MATURITY}_{i,t} + \beta_9 \text{SECURED}_{i,t} + \beta_{10} \text{SYNDICATED}_{i,t} + \varepsilon_{i,t}\end{aligned}$$

$\text{TERMS}_{i,t} \in \{\text{SPREAD} ; \text{LOGAMOUNT} ; \text{MATURITY} ; \text{SECURED}\}$

t statistics in parentheses ; * p<.1, ** p<0.05, *** p<0.01

This table measures the impact of carbon emission disclosure on bank lending conditions using a two-stage regression with the variables SPREAD, LOGAMOUNT, MATURITY, and SECURED. In this table we divide our sample as two by HIGH_CONTAMINATE. This variable help us to distinguish high pollution industries or not. Thus, if the industry is a high pollution industry, it is coded as 1, otherwise it is 0. The dependent variable is the SPREAD, which is the interest rate difference for loans; we calculate the average of the highest and lowest interest rates for each loan in the data. LOGAMOUNT refers to the loan amount; MATURITY is the original maturity date of the company loan; SECURED is a dummy variable that determines whether the loan is secured; if the loan is secured, the binary variable equals 1; otherwise, it equals 0. The main explanatory variable is $\widehat{\text{DUMMY\_DIS}}_{i,t-1}$, which represents the prior disclosure data of DUMMY_DIS. Other explanatory variables include SIZE, which refers to the scale of the company; REPUTATION, represented by market share to indicate goodwill; LOGBM is the logarithm of the ratio of book value to market value; the ALTMAN variable reflects the company's financial condition, established using the multivariate method proposed by ALTMAN (1968); SYNDICATED, this is a virtual variable that determines whether the company has a syndicated loan. If the company has a syndicated loan, the binary variable is 1; otherwise, it is 0.

5. Conclusion

The factors that influence carbon emission disclosures among publicly listed companies in Taiwan from 2011 to 2020 are the focus of this study. It underscores the significance of regulatory changes, industry classification, and firm characteristics in shaping carbon disclosure decisions. Companies with higher book-to-market ratios are more hesitant to disclose, whereas larger firms with greater reputations are more likely to voluntarily disclose their carbon emissions. The research also discovered a substantial correlation between the probability of carbon reporting and the intensity of pollution, as well as regulatory interventions, such as the 2015 mandate.

The research corroborates the findings of Matsumura, Prakash, and Vera-Muñoz (2014), who discovered that companies that disclose emissions achieve favorable financial outcomes, suggesting that investors are drawn to transparency in environmental performance. The study also endorses the findings of Fatemi, Glaum, and Kaiser (2018), who discovered that the disclosure of carbon emissions can enhance the performance of firms, particularly in industries with a substantial environmental impact.

Our study also emphasizes the practical implications of carbon disclosure on the access of enterprises to capital. Companies that disclose their carbon emissions are granted more favorable loan terms, which implies that banks are increasingly taking environmental transparency into account when assessing credit risk. This shift toward green finance is indicative of a broader trend in the financial sector, in which sustainability is increasingly influencing lending decisions during the lending process.

In summary, the research underscores the dual importance of carbon disclosure in both equity and debt markets. Companies that disclose their environmental impact voluntarily are more likely to garner investment and secure favorable financing conditions. This research provides valuable insights for corporate managers, financial institutions, and policymakers in the evolving landscape of environmental finance.

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