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Can ESG Improve Corporate Default Risk? Evidence from Taiwan's State-Owned Enterprises

[1]Hui-Chuan Liu, [2]Chih-Hsing Hung

[1]PhD Student, Dept. of Management, National Kaohsiung University of Science and Technology, Taiwan
[2]Professor, Department of Finance, National Kaohsiung University of Science and Technology, Taiwan
Email: [1]i111136106@nkust.edu.tw, [2]hunpeter65@nkust.edu.tw

Abstract- This study examines the impact of corporate environmental sustainability policies on default risk, focusing on how different ESG (Environmental, Social, and Governance) indicators affect Taiwanese state-owned enterprises (SOEs) in both manufacturing and non-manufacturing sectors. With ESG investing gaining global prominence as stakeholders increasingly emphasize sustainability alongside financial performance, this research uses the Altman Z-score model to assess whether improvements in overall ESG scores influence SOEs' default risk, and which ESG dimensions (E, S, G) have varying effects across industries. The results show that enhancing the total ESG score (TESG_score) significantly reduces default risk in non-manufacturing SOEs but has an adverse effect in manufacturing SOEs, likely due to the higher costs of implementing sustainability measures. Specifically, improvements in environmental (E) scores have a slight negative impact on default risk in both sectors, as environmental initiatives often require substantial investment with limited short-term returns. Social (S) and governance (G) improvements have less impact on default risk, possibly due to government oversight and regulatory constraints specific to SOEs. Overall, this study highlights the challenges faced by SOEs, especially in the manufacturing sector, in balancing ESG improvements with financial stability, providing insights for policymakers and managers striving to enhance sustainability while managing default risk.

Keywords: ESG, Default Risk, TESG Score, State-Owned Enterprises (SOEs), Altman Z-Score.

I. INTRODUCTION

This study examines the impact of corporate environmental sustainability policies on default risk, and how different ESG indicators affect various types of companies. Using Taiwanese state-owned enterprises (SOEs) as an example, we investigate whether policies to improve ESG indicator scores influence default risk in manufacturing and non-manufacturing SOEs, and which ESG indicators have distinct effects on default risk between these two sectors.

ESG, which stands for Environmental protection, Social responsibility, and corporate Governance, emerged as a significant concept in 2004 when the UN Global Compact highlighted its importance for corporate management. In 2015, the United Nations reinforced this with the "2030 Agenda for Sustainable Development." Over the past decade, ESG investments have grown rapidly in global markets, reflecting increased investor focus on sustainability alongside profits (Manescu, 2011).

Today, ESG has evolved into a major financial strategy, with trillions of dollars allocated to investments targeting environmental (e.g., carbon emissions), social (e.g., fair labor standards), and governance (e.g., internal controls) sustainability. ESG-related investments, now among the most popular forms of "sustainable" investing, emphasize long-term development over short-term profits, driving their rapid growth (Bekaert et al., 2023).

In Taiwan, the "Taiwan Sustainable Development Goals" launched in 2016, embedding ESG into national projects such as the "Sustainable Development Project for Listed Companies" by the Financial Supervisory Commission. New regulations and financial products tracking sustainability indicators have been well-received. The "Roadmap for Sustainable Development of Listed Companies," released in 2022, requires all listed companies to complete greenhouse gas inventories by 2027 and verification by 2029,

fostering a robust ESG ecosystem.

With ESG becoming a regulatory mandate, companies face challenges in allocating funds and resources for compliance. Differences in policy implementation across industries raise key questions: How do ESG requirements vary among companies, and what factors drive their success? Should all industries incorporate ESG indicators? What motivates adoption, and what benefits or costs arise from pursuing higher ESG scores? Exploring these factors is essential for understanding the impact of ESG on corporate operations.

Pursuing higher ESG ratings impacts default risk. For example, research by Tommaso and Thornton (2020) shows that while higher ESG scores reduce risks for banks, they may also lower overall financial value due to increased capital costs. Similarly, focusing on environmental scores often raises concerns among companies about weakened competitiveness and increased expenses, with limited short-term economic benefits (Nidumolu et al., 2009). ESG advocates highlight value creation, but the mechanisms linking ESG to shareholder value remain unclear. According to Abdallah et al. (2020), implicit claims connecting stakeholders to ESG may simultaneously create and destroy value.

Cornell (2020) suggests that companies with higher ESG ratings face trade-offs between reduced investment risks and lower expected returns. While ESG investments offer social benefits, they do not necessarily lead to higher financial returns, partly because of unresolved debates on whether ESG constitutes a risk factor.

Legal frameworks and regulations also play a crucial role in ESG adoption. Improved legal protections encourage better corporate systems, enhancing national financial and economic development (Allen et al., 2005). Understanding these institutional factors is critical for evaluating ESG implementation globally.

To assess default risk, this study employs the Altman Z-score, a widely recognized method based on five financial indicators: Working Capital/Total Assets (WC/TA), Retained Earnings/Total Assets (RE/TA), Earnings Before Interest and Taxes/Total Assets (EBIT/TA), Market Value of Equity/Book Value of Liabilities (MV/BV), and Sales/Total Assets (S/TA). A score below 1.23 signals bankruptcy risk, while scores above 2.90 indicate stability.

Empirical evidence supports the Z-score's effectiveness across industries and regions. Shi and Li (2023) demonstrated its predictive reliability in the European aviation industry, while Almary et al. (2016) showed its utility in assessing UK companies. Altman (2016) confirmed its broad applicability across multinational enterprises. These findings validate the Z-score as a robust tool for analyzing corporate default risk in diverse contexts.

Given this robust foundation, this study adopts the Altman Z-score to evaluate the relationship between ESG and default risk, focusing on its application to Taiwanese enterprises.

Taking Chinaas an example, where state-owned enterprises are prevalent, as an example, better-performing companies in China are more willing to disclose their efforts in corporate social responsibility (Li et al., 2013). Given the requirements of the central government, Chinese state-owned enterprises have become more proactive in disclosing corporate social responsibility reports. In 2000, PetroChina published its corporate health, safety and environment report. Baosteel published an environmental report as early as 2003. In March 2006, State Grid Corporation of China released China's first corporate social responsibility report. By the end of 2011, 76 out of 117 Chinese state-owned enterprises regularly published corporate social responsibility reports. (Zhu et al., 2016) According to research by Sun et al. (2002), there is a high positive correlation between government-owned equity and corporate performance in state-owned enterprises. This relationship applies to state-owned enterprises listed on the Shanghai and Shenzhen stock exchanges, regardless of whether the equity is held by the government or legal representatives. However, this relationship is non-linear. When state-owned enterprises begin to sell a small portion of their equity, the company's performance initially improves, but beyond a certain proportion, the enterprise's performance begins to deteriorate.

State-owned enterprises are a common form of corporate management in many countries. From a

regulatory perspective, according to OECD regulations in 2005, the term "state-owned enterprise" refers to enterprises or companies where the state has significant control through full, majority or minority ownership, with the main function of achieving public policy objectives (Cunningham, 2011). From a political perspective, state-owned enterprises are understood as political connections established by appointing individuals or bureaucrats with similar political views, who follow certain political interests (Boycko et al., 1996). The main goal of these appointees is to achieve personal and/or political interests that are inconsistent with the goal of maximizing enterprise value (La Porta et al., 2002; Shleifer and Vishny, 1994, 1997). What are the motivations and decision-making factors for state-owned enterprises when pursuing higher ESG score indicators and implementing ESG policies? Therefore, this study aims to explore whether state-owned enterprises in Taiwan, where many important livelihood necessities, raw materials, large banks and financial institutions, and public transportation are state-owned, are influenced by government policies in their decision-making motivations, thereby affecting the company's operating performance when pursuing ESG score indicators, and how state-owned enterprises affect their own default risk while pursuing higher ESG indicator scores.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

2.1 The Importance of State-Owned Enterprises and Sustainable Development for Social Development

Today, corporate social responsibility (CSR) based on sustainable development has attracted increasing attention worldwide. CSR is considered a comprehensive concept aimed at establishing business ethics, including economic, environmental and social objectives. CSR establishes a permanent relationship between companies and stakeholders (Saidane and Abdallah, 2021).In 2004, a report released by the UN Global Compact, joined by 20 financial institutions, advised the financial industry that environmental, social and corporate governance issues are crucial for promoting healthy financial markets. In the future global world, these issues are an important manifestation of a company's overall management results, and the returns from properly handling these issues are increasing. In 2015, the United Nations published "Transforming our world: the 2030 Agenda for Sustainable Development," which more detailed classified sustainable development goals, including categories such as poverty eradication, hunger elimination, gender friendliness and equality, sustainable consumption and production patterns, etc., and 169 specific targets, as the direction for countries worldwide to promote sustainable development before 2030. From this, it can be seen that the focus of international society has shifted from discussing the broader concept of corporate social responsibility (CSR) to ESG indicators that can be used to examine whether companies have implemented CSR. "ESG" investment is now popular, with trillions of dollars invested in products considering issues related to achieving sustainable development goals, such as environmental (e.g., carbon emissions), social (e.g., fair labor practices), and governance (e.g., internal corruption) issues. ESG investment is currently the most popular form of "sustainable" investment, growing in tandem with companies and focusing more on their long-term sustainability and the needs of all stakeholders. Therefore, whether a company provides credible information about its pursuit of ESG indicators and sustainable development will greatly affect investors' interest in investing in the company (Bekaert et al., 2023).

State-owned enterprises are a type of enterprise where government agencies own the property rights of the enterprise (Hu, 2017). State-owned enterprises (SOEs) are a common business model in various industries globally, with 25 out of the top 100 companies in the global Fortune rankings being SOEs (Du et al., 2018; Musacchio et al., 2015). In emerging economies, state-owned enterprises have made significant contributions to overall economic development and specific industry innovation (Wang, 2022). With the increasing integration of international trade and investment, state-owned enterprises are increasingly competing with general enterprises in the global market (Magubu, 2022). Over the past decade, many scholars have found that to address problems brought about by the Great Depression of the

1930s or the 2008 global financial crisis, many countries tend to adopt nationalization methods, using state-owned enterprises as an emergency tool to rescue national macroeconomic development (Fang et al., 2023). According to research by Millward (2005, 2011), in the 1940s, state-owned enterprises in most European countries accounted for 10% of national GDP, 20% of the country's total fixed asset investment, and provided 10% of employment opportunities.

The same author pointed out that the scale of European state-owned enterprises did not change much in the following 30 years. In other countries, state-owned enterprises have also played an extensive role in social development, especially in industries that the government considers important and strategic. For example, the oil sectors in Saudi Arabia, Norway, and Indonesia are dominated by state-owned enterprises. Although the importance of state-owned enterprises to social development in the United States is not very obvious, state-owned enterprises are very important to other countries (Canada and Mexico) in the North American Free Trade Agreement. Now, state-owned enterprises still play an important role in many economies, continuing to implement important national policies while facing the challenge of how to operate and compete in a liberalized international market (Bernier et al., 2018).

Although the importance of state-owned enterprises to the world economy is undeniable, people often believe that state-owned enterprises are less efficient than general private enterprises, and managers of state-owned enterprises often lack the motivation to improve performance. Research has found that the existence of ownership vacancies (Bradshaw et al., 2019; Gu et al., 2020; Wei, 2021), lack of power and responsibility delegation (Chen et al., 2011; Du et al., 2018; Fan et al., 2013; Xu, 2011) and "soft budget constraints" (see Lin & Li, 2008, etc.) lead to various moral hazards and agency problems in state-owned enterprises.

Therefore, how to improve the efficiency of state-owned enterprises has become a key issue faced by many economic researchers and practitioners. According to Chaudhry's (2023) research on the Indian market, state-owned enterprises have the function of balancing political uncertainty and attracting voters who hope for government investment. The impact of investment in private enterprises and state-owned enterprises in the market during election years is positive. The increase in state-owned enterprise investment and decrease in private enterprise investment during election years are associated with improved investment efficiency. State-owned enterprises in Taiwan still have a significant impact on Taiwan's socio-economic aspects, with state-owned enterprises occupying important positions in finance, important raw materials, and many important industrial sectors. Therefore, this study aims to explore what factors affect the effectiveness of ESG score indicators of state-owned enterprises and their impact on default risk.

2.2 Non-Manufacturing Enterprises Pursuing ESG Score Indicators and Default Risk

Regarding the assessment and analysis of corporate default risk, this study adopts the Altman Z-score to judge default risk. The Altman Z-score is an analysis method that considers the impact of five financial indicators from financial statements on default risk (Altman, 1968). It uses the following five indicators to assess a company's future default risk: Working Capital/Total Assets (WC/TA), Retained Earnings/Total Assets (RE/TA), Earnings Before Interest and Taxes/Total Assets (EBIT/TA), Market Value of Equity/Book Value of Total Liabilities (MV/BV), and Sales/Total Assets (S/TA). The resulting Altman Z-score is used to judge the chance of future default risk, with a score below 1.23 indicating potential bankruptcy risk, a score between 1.23 and 2.90 falling in the grey area, and a score above 2.90 indicating no bankruptcy risk. Therefore, this study uses the Altman Z-score to assess the default risk of Taiwanese state-owned enterprises.

According to research by Guo et al. (2023), higher stock prices help companies raise funds through equity financing and reduce dilution of equity. Driven by the above evidence, it is expected that improved ESG performance can build reputation and attract investor attention, especially for private enterprises and foreign companies in China. However, these companies can reduce financial policy constraints and raise more funds through equity rather than debt.

ESG performance can reduce the cost of debt financing, and further research has found that S and G performance have a significant impact on reducing financing costs; the impact of ESG performance on reducing debt financing costs is significant during the owner-management stage, successor cultivation and development stage, and power handover stage (Kong et al. 2023).

According to research by Shi and Li (2023), the predictive ability of the updated Altman Z-score model (1983 and 2017) was evaluated using bankruptcy data of European airlines from 2009 to 2020. The results show that the Z-score (2017) of non-state-owned non-manufacturing enterprises demonstrates satisfactory predictive ability when applied to the European aviation industry. Based on the study by Gyarteng (2019), which utilized discrete variables from the Altman algorithm model to describe characteristics of companies approaching bankruptcy, empirical results indicate that when a company is on the verge of bankruptcy, the Altman Z-score, solvency, profitability, and asset productivity deteriorate significantly in statistical terms. In addition to considering financial factors, non-financial factors may also influence default risk. Therefore, this study proposes the following hypothesis:

Hypothesis 1.The implementation of policies to improve ESG indicator scores in non-manufacturing state-owned enterprises has a positive impact on reducing default risk.

2.3 Manufacturing Enterprises' Pursuit of ESG Score Indicators and Default Risk

This study uses a company's Altman Z-score as an indicator to determine corporate default risk. Numerous studies have demonstrated that the Altman Z-score can effectively predict a company's future bankruptcy probability. According to Tung and Phung's (2019) study on the default risk of Vietnamese enterprises, in addition to the original Altman (1968) model considering financial factors, they incorporated non-financial indicators such as company size and management education level into their analysis. The results indicate that both financial and non-financial factors significantly influence corporate default risk, suggesting that studying corporate default risk is not only an assessment of a company's financial condition but also a crucial observation indicator in corporate sustainable development. Regarding cross-national enterprise applications, Altman's (2016) research analyzed the performance of the Z-score model for enterprises from 31 European countries and 3 non-European countries. The study sample, aside from Chinese and American samples, primarily consisted of non-financial industrial types. This research provides evidence that the general Z-score model performs quite well for most countries, and using models incorporating other variables to predict enterprises in specific countries can further improve accuracy. Therefore, this study proposes the following hypothesis:

Hypothesis 2.The improvement of ESG score indicators in manufacturing state-owned enterprises has an impact on reducing default risk.

2.4 Environmental Dimension Score Indicators and Default Risk

According to research by Saidane and Abdallah (2021), most African countries have faced numerous crises and challenges in implementing economic development projects since gaining independence. The economic difficulties encountered have made the implementation of corporate social responsibility secondary for African countries. Both citizens and socio-economic actors are primarily concerned with their basic survival issues. Summarizing the aforementioned literature, it can be understood that while pursuing higher ESG indicator scores may bring better reputation and investment opportunities for companies, the fundamental pursuit of ESG indicators and corporate sustainable development must rely on the company's own operational status. The company itself must possess the ability to maintain stable profitability and operational capacity to have sufficient funds and resources to invest in ESG indicators and sustainable development. In terms of pursuing environmental dimension score indicators, many companies still believe that their market competitiveness will be weakened as they implement more environmentally friendly policy guidelines. Companies believe this will increase costs and not bring immediate, quantifiable economic benefits. After all, what matters to companies tend to prioritize visible, returns, but the implementation of environmentally friendly policy guidelines often cannot bring

immediate returns to companies (Nidumolu et al., 2009). Based on the above arguments, this study proposes the following hypothesis:

Hypothesis 3.The improvement of environmental dimension score indicators in state-owned enterprises has a negative impact on reducing default risk.

III. DATA AND METHODOLOGY

3.1 Sample

This study primarily focuses on the relationship between default risk and ESG-related performance indicators for state-owned enterprises listed on the Taiwan Stock Exchange from 2015 to 2021. Descriptions of all variables are provided in Table 1 below.

Table 1: Variable Descriptions

Name	Item	Description	Data Period	Source
Dependent Variable				
Z_score	Altman Z-score	An indicator assessing the financial risk of a company calculated using financial ratios	Annual	Bloomberg data stream
Independent Variables				
TESG_score	TESG Score	Company TESG score (0-100), with 0 being the worst and 100 the best	Annual	TEJ database
E_score	Environmental Score	Company environmental score (0-100), with 0 being the worst and 100 the best	Annual	TEJ database
S_score	Social Score	Company social score (0-100), with 0 being the worst and 100 the best	Annual	TEJ database
G_score	Governance Score	Company governance score (0-100), with 0 being the worst and 100 the best	Annual	TEJ database
Control Variables				
EM	Energy Management Score	Environmental dimension energy management score, with 0 being the worst and 100 the best	Annual	TEJ database
EGG	Greenhouse Gas Emissions Score	Environmental dimension greenhouse gas emissions score, with 0 being the worst and 100 the best	Annual	TEJ database
HRCM	Human Rights and Community Relations Score	Social dimension human rights and community relations score, with 0 being the worst and 100 the best	Annual	TEJ database
EHS	Employee Health and Safety Score	Social dimension employee health and safety score, with 0 being the worst and 100 the best	Annual	TEJ database
TSF	Fair Treatment of Stakeholders Score	Governance dimension fair treatment of stakeholders score, with 0 being the worst and 100 the best	Annual	TEJ database
CO	Control of Ownership and Seats Score	Governance dimension control of ownership and seats score, with 0 being the worst and 100 the best	Annual	TEJ database

Note 1: This table includes descriptive statistics for the main variables. Except for Z_score, all other indicators are scores for the company ranging from 0 to 100, with 0 being the worst score and 100 being the best score. Scores have no units.

3.2. Research Methodology and Variables

Based on the research method in Guo et al. (2023), this study primarily uses Ordinary Least Squares (OLS) regression to examine whether the ESG performance indicators of Taiwan's state-owned enterprises influence the company's default risk. The OLS regression equations are as follows:

$$Z_{i,t} = \alpha + \beta_1 TESG_{i,t} + \sum_j \beta_j Controls_{j,i,t} + \gamma_k \sum_k FIRM_k + \gamma_l \sum_l YEAR_l + \varepsilon \quad (1)$$

$$Z_{i,t} = \alpha + \beta_1 E_{i,t} + \beta_2 S_{i,t} + \beta_3 G_{i,t} + \sum_j \beta_j Controls_{j,i,t} + + \gamma_k \sum_k FIRM_k + \gamma_l \sum_l YEAR_l + \varepsilon \quad (2)$$

Regression equation (1) serves as the basic regression equation, mainly testing the relationship between ESG-related indicators and default risk. The dependent variable $Z_{i,t}$ represents the default risk indicator score for state-owned enterprise i in period t, calculated using the Altman Z-score. The independent variable $TESG_{i,t}$ represents the TESG index score for state-owned enterprise i in period t, calculated based on the company's ESG information disclosure as evaluated by the TEJ database. Firm and year fixed effects are included based on the baseline regression model. To make the regression model more comprehensive, this study adds control variables to regression equation (1) and will separately examine the results with and without control variables. The control variable $Controls_{j,i,t}$ represents the indicator score of control variable j for the state-owned enterprise in period t.

The selection of indicator scores is made by extracting two indicator scores from each dimension of the ESG indicators as control variables: energy management and greenhouse gas emissions indicators for the environmental dimension, human rights and community concern and employee health and safety indicator scores for the social dimension, and fair treatment of stakeholders and control of ownership and seats indicator scores for the corporate governance dimension. In addition to the above indicator scores, whether the company is in the manufacturing industry is added as a control variable to examine firm and year fixed effects.

Regression equation (2) mainly examines the relationship between the environmental, social, and corporate governance dimensions and default risk.

IV. EMPIRICAL RESULTS

4.1. Descriptive Statistics and Correlation

According to Table 2, the mean values of TESG_score, E_score, S_score, and G_score are 66.4635, 68.0846, 71.1967, and 69.4325, respectively. As explained in Table 1, the values of these four variables range between 0 and 100, and the standard deviations of all four variables are smaller than their means, indicating no outliers in the sample.

Table 3 provides the correlation coefficients and significance levels between variables.

Table 2: Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std.Dev.	Observations
CO	56.3818	58.52	97.69	10.93	27.1345	147
E_SCORE	68.0846	69.63	73.02	56.22	4.5687	63
S_SCORE	71.1967	71.01	90.67	58.61	6.9445	67

G_SCORE	69.4325	70.9	72.66	58.61	3.5557	63
EM	74.2483	88.33	99.55	33.52	23.6136	147
EGG	53.1121	70.56	99.28	1.39	36.1114	147
HRCM	77.6286	92.74	99.46	36.96	23.5713	147
EHS	82.0420	88.87	99.86	0.4	20.5802	147
TSF	55.47367	56.52	94.68	2.4	12.3923	147
Z_SCORE	0.9810	0.4857	4.1332	-0.4829	1.0750	147
TESG_SCORE	66.4635	67.27	79.27	52.27	5.8783	147

Note 1: This table contains descriptive statistics for the main variables. Except for Z_score, all other indicators are scores for the company ranging from 0 to 100, where 0 is the worst score and 100 is the best score. The scores have no units.

Table 3: Pearson Correlation Coefficient Test

	CO	DV_MANUFACTURE	E_SCORE	S_SCORE	G_SCORE	EM	EGG	HRCM	EHS	TSF	Z_SCORE	TESG_SCORE
CO	1											
DV_MANUFACTURE	-0.4542***	1										
E_SCORE	-0.1155	0.2008	1									
S_SCORE	0.2015	-0.0912	0.0699	1								
G_SCORE	0.02196	0.2075	0.4026***	0.6300***	1							
EM	-0.1928**	-0.0139	0.3149**	-0.0668	0.2798**	1						
EGG	0.1281	-0.0402	-0.2282*	0.2130*	-0.0930	-0.2992***	1					
HRCM	-0.0294	-0.3395***	-0.0528*	0.2632**	0.0827	0.0306	-0.0492	1				
EHS	-0.0133	0.1842**	0.3857***	-0.1466	0.5561***	0.2177***	-0.3189***	-0.0700	1			
TSF	0.0185	-0.0122	-0.3254***	0.5299***	0.01669	0.0780	0.0413	0.0784	-0.1010	1		
Z_SCORE	-0.1078	0.2222***	-0.2524**	0.4223***	0.03282	-0.0282	0.1795**	0.0438	-0.2181***	0.2358***	1	
TESG_SCORE	0.3352***	-0.0837	0.2358*	0.2038*	0.5318***	0.4482***	0.1670**	0.0849	0.3451***	0.1939**	0.0698	1

*Note 1: In the following tables,*indicates the variables is significant at the 90% confidence level;**indicates significance at the 95%confidence level;and ***indicates significance at the 99%confidence level.*

4.2 Main Results

The empirical analysis begins with regression equation (1), and the results are presented in Table 4. Using the TESG sustainable development indicator database compiled in the Taiwan Economic Journal (TEJ) database, state-owned enterprises listed on the Taiwan Stock Exchange are selected as the main research subjects, with data from 2015 to 2021. The Altman Z-score, calculated using financial ratio data from Bloomberg data stream, is used as an indicator to explore default risk. The analysis method divides the sample of state-owned enterprises into manufacturing and non-manufacturing industries, using regression equation (1) for empirical analysis. Columns (1) to (2) consider non-manufacturing state-owned enterprises, while columns (3) to (4) consider manufacturing ones.

Column (1), without control variables and fixed effects, explores the impact of TESG_score on Z_score

for non-manufacturing state-owned enterprises. The results show a significant positive relationship between TESG_score and Z_score. Column (2), which includes time effects but no control variables, also shows a significant positive relationship between TESG_score and Z_score. Column (3), without control variables and fixed effects, shows a significant negative relationship between TESG_score and Z_score. Column (4), which includes control variables and time fixed effects, shows a significant positive relationship between TESG_score and Z_score.

Based on the results from columns (1) to (2), it can be concluded that for non-manufacturing industries, improving TESG_score has a significant positive impact on reducing default risk. While improving EHS score has a significant negative impact on reducing default risk, its coefficient is small, and the overall impact of TESG_score remains significantly positive. The reason might be that implementing policies to improve EHS generates additional expenses, but has limited effects on increasing company revenue, thereby increasing the company's default risk. According to the results from columns (3) to (4), for manufacturing industries, implementing policies to improve TESG_score increases the company's default risk, but the increase is not substantial and does not affect the company's overall default risk.

Linking the role and characteristics of Taiwan's state-owned enterprises in national political and economic development with the above results, it can be inferred that when state-owned enterprises improve their TESG_score, the resulting business income is relatively lower compared to non-state-owned enterprises. This is because they already have existing orders and income to promote national policies, but the required expenditures may also increase due to policy compliance. Especially for the environmental dimension indicator E_score, compared to the social and corporate governance dimensions which can improve indicator scores through changes in internal company regulations, remuneration systems, or other internal control systems, the cost required to improve environmental dimension indicator scores is substantial and ongoing. As shown in column (3) of Table 4, E_score has a significant negative relationship with company default risk. This result might be due to the limited increase in income brought by the company's implementation of policies to improve sustainable development indicator scores, while expenditures increase relative to income, causing a slight decline in financial indicator performance compared to before policy implementation.

Table 4: Analysis of the Impact of Non-Manufacturing and Manufacturing Industries on Z_score Using Regression Equation (1)

	(1)	(2)	(3)	(4)
	Z_score	Z_score	Z_score	Z_score
TESG_score	0.0406**	0.0941***	-0.0376*	0.0703**
	(2.0333)	(2.8513)	(-1.9850)	(2.1098)
EM		-0.0080		-0.0063
		(-1.2834)		(-0.9839)
EGG		0.0092***		-0.0103
		(2.1474)		(-2.7379)
HRCM		-0.0076		0.01112**
		(-1.2523)		(2.1147)
EHS		-0.0209**		-0.0078
		(-2.5049)		(-1.5557)
TSF		0.0048		-0.0044
		(0.4660)		(-0.4877)
CO		0.0013		-0.0011
		(0.1863)		(-2.2324)
Constant	-1.9176	-3.4506	3.7609	-1.7585
	(-1.4317)	(-2.6416)	(3.0050)	(-0.9628)
Firm fixed effects	NO	NO	NO	NO

Year fixed effects	NO	YES	NO	YES
Observations	91	91	56	56
R-square	0.044	0.3865	0.068	0.4616
F-statistic	4.1344	3.7308	3.9404	4.5504

Note 1: The dependent variable is Z_score; the independent variable is TESG_score; control variables are: Energy Management score (EM), Greenhouse Gas Emissions score (EGG), Human Rights and Community Relations score (HRCM), Employee Health and Safety score (EHS), Fair Treatment of Stakeholders score (TSF), and Control of Ownership and Seats score (CO).

*Note 2: The values in parentheses represent t-values. Significance levels are denoted as *(90%), **(95%), ***(99%).*

The empirical analysis begins with regression equation (2), and the results are presented in Table 5. The analysis method divides the sample of state-owned enterprises into manufacturing and non-manufacturing industries, keeping other variables constant, and uses regression equation (2) for empirical analysis. Columns (1) to (2) consider non-manufacturing state-owned enterprises, while columns (3) to (4) consider manufacturing ones.

Column (1), without control variables and fixed effects, explores the impact of E_score, S_score, and G_score on Z_score for non-manufacturing state-owned enterprises. The results show a significant negative relationship between E_score and Z_score. Column (2), which includes time effects but no control variables, shows no significant relationship between the three indicators and Z_score, with only EGG showing a significant positive relationship. The reason for this might be the same as the result in column (4) of Table 4. Column (3), without control variables and fixed effects, shows a significant negative relationship between E_score and Z_score. Column (4), which includes control variables but no fixed effects, also shows a significant negative relationship between E_score and Z_score.

Summarizing the results from Table 5, it can be concluded that for both manufacturing and non-manufacturing industries, implementing policies to improve E_score has a significant negative impact on reducing default risk. The magnitude of the impact is slightly larger for non-manufacturing industries than for manufacturing industries, but the coefficients are small in both cases. Therefore, the increase in default risk is not substantial and does not affect the company's overall default risk.

Table 5: Analysis of the Impact of Non-Manufacturing and Manufacturing Industries on Z_score Using Regression Equation (2)

	(1) Z_score	(2) Z_score	(3) Z_score	(4) Z_score
E_score	-0.0774*	-0.0235	-0.0556**	-0.0712**
	(1.7238)	(-0.4217)	(-2.1859)	(-2.906)
S_score	0.0613	0.02285	-0.0772	-0.0384
	(1.6764)	(-0.4218)	(-0.9500)	(-0.5457)
G_score	-0.0127	-0.0262	-0.0835	0.0189
	(-0.2064)	(-0.2640)	(-0.5580)	(0.1349)
EM		0.0005		0.0019
		(0.4700)		(0.2886)
EGG		0.0156**		-0.0057
		(2.5637)		(-1.6478)
HRCM		-0.0168		0.0012
		(-1.6016)		(0.2497)
EHS		0.01246		0.0011
		(0.5355)		(0.2432)
TSF		0.0625		0.0053

		(1.0201)		(0.8788)
CO		0.0067		-0.0097
		(0.6820)		(-2.0353)
Constant	2.6196	-2.1288	16.4089	7.6625
	(0.8229)	(-1.5932)	(2.3113)	(1.2108)
Firm fixed effects	NO	NO	NO	NO
Year fixed effects	NO	YES	NO	NO
Observations	39	39	24	24
R-square	0.1906	0.4809	0.3281	0.7607
F-statistic	2.7476	2.2739	2.0118	4.9447

Note 1: The dependent variable is Z_score; the independent variable is TESG_score; control variables are: Energy Management score (EM), Greenhouse Gas Emissions score (EGG), Human Rights and Community Relations score (HRCM), Employee Health and Safety score (EHS), Fair Treatment of Stakeholders score (TSF), and Control of Ownership and Seats score (CO).

*Note 2: The values in parentheses represent t-values. Significance levels are denoted as *(90%), **(95%), ***(99%).*

4.3 Robustness Check

A robustness check is performed using regression equation (1), and the results are presented in Table 6. The sample data includes all non-manufacturing and manufacturing state-owned enterprises mentioned above, and the robustness check analysis is conducted using regression equation (1). Column (2) includes control variables, excludes firm fixed effects, and includes time fixed effects. The results show a significant positive relationship between TESG_score and Z_score, which is consistent with the previous findings. Using the regression analysis results from equation (2), column (3) of Table 4 shows a significant negative relationship between E_score and Z_score when control variables and firm and time fixed effects are not included, which is also consistent with the previous results.

According to the results in Table 6, when state-owned enterprises strive to improve their TESG_score, there is no direct impact on the company's default risk. However, after adding firm and time fixed effects, TESG_score shows a significant positive impact on the company's default risk. When state-owned enterprises strive to improve their E_score, it has a significant negative impact on the company's default risk, but the coefficient indicates only a slight negative impact. After adding control variables and firm and time fixed effects, EM and EGG show significant positive relationships with the company's default risk.

Table 6: Analysis of the Impact of Non-Manufacturing and Manufacturing Industries on Z_score Using Regression Equation (1)

	(1) Z_score	(2) Z_score	(3) Z_score	(4) Z_score
TESG_score	0.0128	0.0243*		
	(0.8429)	(1.910)		
E_score			-0.0568*	-0.0236
			(-1.8876)	(0.5134)
S_score			0.0493	-0.0137
			(1.5938)	(-0.3103)
G_score			-0.0071	-0.033
			(-0.1433)	(-0.5639)
EM				0.0399***
				(4.0640)
EGG				0.0087**
				(2.4475)

HRCM				-0.0004
				(-0.6172)
EHS				-0.0093
				(-1.3168)
TSF				0.0105
				(1.3368)
CO				-0.0011
				(-0.1560)
Constant	0.1322	-0.6318	1.8896	2.7737
	(0.1382)	(0.7474)	(0.7296)	(0.8151)
Firm fixed effects	No	No	No	No
Year fixed effects	No	Yes	No	Yes
Observations	147	147	147	147
R-square	0.0049	0.8443	0.1230	0.9165
F-statistic	0.7105	0.4460	2.7600	2.2061

Note 1: The dependent variable is Z_score; the independent variable is TESG_score; control variables are: Energy Management score (EM), Greenhouse Gas Emissions score (EGG), Human Rights and Community Relations score (HRCM), Employee Health and Safety score (EHS), Fair Treatment of Stakeholders score (TSF), and Control of Ownership and Seats score (CO).

*Note 2: The values in parentheses represent t-values. Significance levels are denoted as *(90%), **(95%), ***(99%).*

V. CONCLUSION

This study analyzes the relationship between ESG score indicators and default risk in manufacturing and non-manufacturing state-owned enterprises. The results show that for non-manufacturing enterprises, improving TESG_score has a significant positive impact on reducing default risk, while for manufacturing enterprises, it has a significant negative impact. The reason for this result may be due to the different costs required for manufacturing and non-manufacturing industries to improve their TESG_score.

Analysis of E_score, S_score, and G_score reveals that improving E_score has a significant negative impact on reducing default risk for both non-manufacturing and manufacturing enterprises. This result may be due to the fact that policies to improve E_score require substantial financial investment and have limited effects on increasing business income, thus having a slight negative impact on default risk.

We conducted an in-depth exploration of the impact of TESG_score, E_score, S_score, and G_score on default risk for state-owned enterprises. First, we found that when state-owned enterprises strive to improve their TESG_score, there is no direct impact on the company's default risk. However, after adding firm and time fixed effects, TESG_score shows a significant positive impact on reducing the company's default risk, which is beneficial for state-owned enterprises to lower their default risk. Second, when state-owned enterprises strive to improve their E_score, it has a significant negative impact on the company's default risk, but the coefficient indicates only a slight negative impact that does not affect the company's overall default risk. The reason for this situation may be that the internal control systems of state-owned enterprises are subject to government supervision and regulatory restrictions, so policies to improve S_score and G_score have less impact on default risk.

However, policies to improve E_score require additional substantial financial investment and have limited effects on increasing business income, thus having a slight negative impact on default risk. Finally, analyzing the impact of TESG_score, E_score, S_score, and G_score on default risk for state-owned enterprises shows that improving E_score has a significant negative impact on default risk.

In conclusion, this study has identified the impacts of improving different sustainable development indicator scores on default risk for state-owned enterprises.

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