Can ESG Performance Reduce the Credit Risk of Intelligent Manufacturing Enterprises? —— Theoretical Deduction and Preliminary Evidence Based on Green Innovation and Financing Constraints

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ABSTRACT

Amidst the global economic acceleration toward green, low-carbon, and digital transitions, this paper aims to explore the mechanism by which Environmental, Social, and Governance (ESG) performance affects the credit risk of intelligent manufacturing enterprises. Based on a core sample of A-share listed intelligent manufacturing enterprises selected in the Ministry of Industry and Information Technology's "Publicity List of Intelligent Manufacturing Standard Application Pilot Projects" from 2015 to 2023, this study conducts an exploratory empirical test using a panel two-way fixed effects model and the Distance to Default (DD) from the KMV model, built upon in-depth theoretical deduction. Theoretical logical deduction indicates that ESG performance primarily exerts its credit risk prevention function through the dual paths of "promoting green technological innovation (production side)" and "alleviating financing constraints (capital side)". Preliminary empirical results reveal that, constrained by the strictly screened sample size and the loss of degrees of freedom caused by two-way fixed effects, the continuous ESG indicator fails to fully pass the traditional statistical significance test; however, its positive coefficient characteristics are highly consistent with theoretical expectations. In the robustness tests where it is replaced with a categorical variable, good ESG performance demonstrates a significant effect of expanding the distance to default and reducing credit risk. Furthermore, combining the nature of property rights and R&D intensity, this paper conducts an in-depth theoretical discussion on the heterogeneous characteristics of this effect. By strengthening theoretical deduction and mechanism logic, this study provides theoretical support and preliminary empirical insights for promoting the sustainable transition and preventing and resolving credit risks within the specific micro-group of intelligent manufacturing enterprises.

Keywords: ESG Performance; Intelligent Manufacturing Enterprises; Credit Risk; Distance to Default (KMV); Green Technological Innovation; Financing Constraints

1. INTRODUCTION

As the global economy transitions toward green, low-carbon, and sustainable development, the Environmental, Social, and Governance (ESG) concept has gradually become a crucial benchmark for measuring high-quality corporate development and long-term value creation [1]. Concurrently, with the deepening of a new round of technological revolution and industrial transformation, the high-end, intelligent, and green development of the manufacturing sector has become a strategic pivot for optimizing China's economic structure and building a modern industrial system. As the micro-carriers of the deep integration of new-generation information technology and advanced manufacturing technology, intelligent manufacturing enterprises play an irreplaceable role in improving the quality and efficiency of the national economy. However, the transformational upgrade of intelligent manufacturing not only requires the introduction of cutting-edge underlying technologies but is also accompanied by long-cycle R&D investments, high capital expenditures, and substantial market uncertainty. This dual characteristic of being typically "technology-driven" and "capital-intensive" makes intelligent manufacturing enterprises highly susceptible to hidden dangers of capital chain ruptures when facing external shocks, thereby exposing them to more complex and volatile credit risks compared to traditional manufacturing enterprises [2]. How to effectively identify, assess, and mitigate the credit risk of intelligent manufacturing enterprises has become a core focus of both academia and practice.

Traditional credit risk assessment systems typically focus on the use of financial indicators; however, financial data often exhibit noticeable lag, making it difficult to comprehensively and dynamically reflect the potential risks brought about by technological iterations in intelligent manufacturing enterprises [3]. In recent years, the critical value of non-financial information in risk early warning has become increasingly prominent. As a comprehensive reflection of corporate non-financial information, ESG performance covers the practical achievements of enterprises across the three dimensions of environmental protection, social responsibility fulfillment, and internal governance efficacy, and is widely considered an important tool for reducing corporate idiosyncratic risk and alleviating information asymmetry [4]. A large body of literature confirms that proactive ESG performance can send positive signals to the capital market, effectively reducing corporate debt financing costs and curbing the probability of default [5][6]. Furthermore, ESG performance affects not only domestic operations but also serves as a vital barrier for enterprises in coping with external uncertainties and preventing major credit and investment risks [7].

Although discussions on the economic consequences of ESG are relatively abundant, there is still room for expansion in existing research: Firstly, most literature focuses on macro-level tests of large cross-industry samples, with few studies narrowing the perspective to the specific micro-group of "intelligent manufacturing enterprises". The formation mechanism of their credit risk differs from that of general enterprises, and the underlying theoretical logic of whether ESG performance can exert a risk mitigation effect in this group urgently needs to be clarified. Secondly, when exploring the mechanisms through which ESG reduces credit risk, existing research mostly focuses on macro perspectives such as information transparency, lacking an in-depth analysis that combines the "production side" and "capital side" characteristics of intelligent manufacturing enterprises.

Based on this, this paper selects A-share listed intelligent manufacturing enterprises from 2015 to 2023 as the sample, measures corporate credit risk based on the KMV model, and, on the basis of strengthened theoretical deduction, explores the impact of ESG performance on the credit risk of intelligent manufacturing enterprises and its mechanisms through empirical models. The marginal contributions of this paper are primarily: First, it expands the research on the economic consequences of ESG performance to the vertically segmented field of intelligent manufacturing enterprises; through rigorous theoretical logic deduction, it enriches the micro-foundation of credit risk prevention under specific industrial backgrounds. Second, in a small-sample context, it objectively reveals the limitations of two-way fixed effects on statistical inference and supplements quantitative evidence through robustness tests. Third, it deeply analyzes the intrinsic mechanisms from the dual perspectives of "green technological innovation" and "financing constraints," providing a theoretical basis for formulating relevant industrial upgrading and financial credit policies.

2. LITERATURE REVIEW

2.1 Causes and Measurement of Credit Risk in Intelligent Manufacturing Enterprises

The academic measurement of corporate credit risk has evolved from traditional accounting models to modern market models. Although the traditional Altman Z-score model is widely used, it struggles to capture the forward-looking dynamics of the capital market [8]. Subsequently, the KMV model, based on the Black-Scholes-Merton option pricing theory, has gradually become the mainstream. The KMV model treats corporate equity as a call option with the firm's assets as the underlying asset and debt as the strike price, measuring the probability that the asset value falls below the face value of the debt by calculating the Distance to Default (DD) [3]. Regarding intelligent manufacturing enterprises, Li Yang et al. (2025) point out that because such enterprises face high capital requirements and technological uncertainties, traditional financing channels struggle to meet their specific needs, leading to the hidden and sudden nature of their credit risks, and the dynamic KMV model can more accurately delineate the fluctuation characteristics of such risks [2].

2.2 Economic Consequences of ESG Performance

Regarding the economic consequences of ESG performance, existing literature mainly unfolds from three dimensions: firm value, financial performance, and cost of capital. Based on stakeholder theory, proactively fulfilling ESG responsibilities can help enterprises build good reputational capital, exerting an "insurance-like" effect during crises, thereby enhancing firm value [9] [10]. On the financing side, enterprises with excellent ESG performance can effectively alleviate information asymmetry with investors and reduce agency costs, thereby obtaining lower bank loan rates and bond issuance spreads [11]. Simultaneously, there is a close interactive relationship between intelligent manufacturing and ESG; the deepening of intelligent manufacturing can further improve the overall ESG performance of enterprises through channels such as supply chain spillover [12].

2.3 Research on the Association Between ESG Performance and Credit Risk

In recent years, the negative correlation between ESG and credit risk has gradually gained academic consensus. Atif and Ali (2021) found that high-level ESG information disclosure can significantly reduce corporate default risk [6]. Recent research also indicates that ESG performance has proven to be one of the important factors determining a firm's entity credit rating [13]. Domestic scholars Su Jinxia and Zhou Liguo (2024) further confirmed from a supply chain perspective that the default risk mitigation effect of corporate ESG performance can spill over to downstream clients [4]. However, existing research on ESG and credit risk consists mostly of cross-industry generalized analyses, ignoring the heterogeneity of different industries in terms of technology intensity and capital turnover characteristics. Especially for intelligent manufacturing enterprises bearing national strategic missions, how their high-risk, high-investment features interact with ESG practices still requires more solid theoretical analysis and preliminary data verification.

3. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

3.1 Main Effect Deduction of ESG Performance on the Credit Risk of Intelligent Manufacturing Enterprises

In the process of advancing digital and intelligent transformations, intelligent manufacturing enterprises face multiple risks, such as technological R&D failures and market demand fluctuations, which can easily induce debt defaults. Based on signaling theory and stakeholder theory [9, 14], proactive ESG performance can effectively curb such risks from the following dimensions, and its theoretical logic cannot be ignored: First, in the Environmental (E) dimension, environmentally conscious intelligent manufacturing enterprises face lower violation costs and transition risks, aligning with green finance policy orientations; they are less prone to sudden negative environmental events, thereby safeguarding the baseline of asset value. Second, in the Social (S) dimension, safeguarding employee rights and building a harmonious supply chain can enhance corporate operational resilience, ensuring the continuity of complex manufacturing systems when facing external shocks [4]. Finally, in the Governance (G) dimension, a transparent and efficient governance structure can restrain management's short-sighted behaviors and moral hazards regarding long-cycle R&D investments, improving long-term capital allocation efficiency. Based on the above rigorous logical deduction, this paper proposes:

Hypothesis H1: Theoretically, good ESG performance can expand the distance to default of intelligent manufacturing enterprises and reduce their credit risk.

3.2 Transmission Path Based on "Green Technological Innovation" (Production Side)

According to the Porter Hypothesis [15], reasonable environmental regulations and internal environmental governance (the E dimension in ESG) can stimulate enterprises to undertake innovation compensation. For intelligent manufacturing enterprises, practicing the ESG concept will retroactively compel them from an internal strategic level to increase investments in green technological innovation on the production side. From the perspective of theoretical evolution, green technological innovation not only helps enterprises break through traditional resource and energy consumption constraints but also enables the development of green, intelligent products with high added value and differentiated competitive advantages. Such technological barriers and product premiums established on the production side can bring the enterprise a continuous stream of stable cash flows throughout the product life cycle. Stable expected cash flows directly enrich the market value of corporate assets in the KMV model, fundamentally reducing the probability of default. Based on this, this paper proposes:

Hypothesis H2: ESG performance can prevent the credit risk of intelligent manufacturing enterprises on the production side through the mechanism of promoting green technological innovation.

3.3 Transmission Path Based on "Financing Constraints" (Capital Side)

Intelligent manufacturing upgrade projects often face the dilemmas of long payback periods and high upfront sunk costs; external financing constraints are the direct catalyst inducing capital chain ruptures and credit risks [2]. In credit markets with severe information asymmetry [14], ESG performance, as a high-quality and scarce non-financial "soft information," can effectively alleviate adverse selection problems. From the logic of the capital supply side, good ESG performance can significantly lower an enterprise's debt financing and equity financing costs [16]. When financial institutions conduct risk credit granting, they increasingly incorporate ESG risk premiums into their core pricing models, and outstanding enterprises can often secure external funds with more generous credit lines and lower interest rates [17]. The substantial alleviation of financing constraints directly replenishes the enterprise's working capital pool, enhancing its ability to withstand short-term debt repayment shocks. Based on this, this paper proposes:

Hypothesis H3: ESG performance can reduce the credit risk of intelligent manufacturing enterprises on the capital side through the mechanism of alleviating financing constraints.

4. RESEARCH DESIGN

4.1 Sample Selection and Data Sources

This paper selects A-share listed companies in Shanghai and Shenzhen from 2015 to 2023 as the initial research sample. To accurately define and ensure the purity of sample characteristics, this paper strictly and manually matched authoritative directories, such as the "2023 Publicity List of Intelligent Manufacturing Standard Application Pilot Projects" published by the Ministry of Industry and Information Technology. To ensure data validity, the following screening processes were sequentially conducted: excluding financial and real estate companies, as well as ST and *ST companies; excluding observations with missing financial data; and applying Winsorize treatment to continuous variables. Ultimately, 170 firm-year valid panel observations from 23 pure intelligent manufacturing listed enterprises were determined. Financial data and KMV distance to default are sourced from the CSMAR database, and ESG ratings are sourced from the Huazheng database.

4.2 Variable Definitions

(1) Dependent Variable: Credit Risk (DD)

The Distance to Default (DD) calculated using the KMV model is employed to measure corporate credit risk. Based on Merton's (1974) formula, a larger DD indicates a smaller likelihood that the asset value falls below the face value of the debt, and thus a lower credit risk.

(2) Core Explanatory Variable: ESG Performance (ESG)

The Huazheng ESG rating composite score is used for measurement. The score is a continuous variable, where a larger value represents better ESG performance.

(3) Control Variables

Referring to existing literature [2, 4], this paper controls for operating revenue growth rate (Growth), operating cash flow (CFO), return on equity (ROE), ownership concentration (Top10), proportion of independent directors (Indep), CEO duality (Dual), proportion of fixed assets (PPE), audit opinion (Audit), return on assets (ROA), and macroeconomic GDP growth rate (GDP).

4.3 Model Construction

To explore the main effect, the following panel fixed effects model is constructed for preliminary data fitting:

$$DD_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \sum \lambda_k Controls_{k,i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

Where $DD_{i,t}$ is the distance to default, $ESG_{i,t}$ is the ESG score, $Controls_{k,i,t}$ represents control variables, and μ_i and δ_t represent individual and year fixed effects, respectively.

5. EMPIRICAL RESULTS AND ANALYSIS

5.1 Descriptive Statistics Analysis

Table 1 reports the descriptive statistics of the main variables. The mean of the dependent variable, credit risk (DD), is 0.877, with a standard deviation reaching 1.503, indicating that the credit risk varies significantly among different intelligent manufacturing enterprises in the sample. The mean of the core explanatory variable, ESG score, is 76.662, suggesting that the ESG practices of China's typical intelligent manufacturing enterprises are generally at a good level.

Table 1. Descriptive Statistics of Main Variables

Variable Name	Obs (N)	Mean	SD	Min	Max
DD	170	0.877	1.503	-5.145	3.558
ESG	170	76.662	5.301	63.800	92.100
Growth	170	0.152	0.268	-0.339	1.505
CFO	170	0.063	0.063	-0.078	0.304
ROE	170	0.087	0.103	-0.438	0.402
Top10	170	55.910	16.051	19.768	84.556
Indep	170	36.325	3.971	25.000	42.860
Dual	170	0.294	0.457	0.000	1.000
PPE	170	0.224	0.145	0.032	0.586
Audit	170	0.782	0.414	0.000	1.000
ROA	170	0.044	0.047	-0.130	0.231
GDP	170	8.877	0.334	8.232	9.420

5.2 Baseline Regression Discussion and Result Analysis

This paper adopts a strategy of sequentially adding fixed effects for preliminary regression fitting, and the results are shown in Table 2. Columns (1) to (4) report the results under different control conditions, respectively, and Columns (5) and (6) employ the most rigorous two-way fixed effects model.

Table 2. Preliminary Regression Results of ESG Performance on Credit Risk of Intelligent Manufacturing Enterprises

Variable	(1)	(2)	(3)	(4)	(5)	(6)
ESG	0.024	0.042	0.027	0.043	0.032	0.032
	(0.55)	(1.22)	(0.57)	(1.18)	(1.16)	(1.01)
Growth		0.829**		0.790*		0.186

Table 2. (continued) Preliminary Regression Results of ESG Performance on Credit Risk of Intelligent Manufacturing Enterprises

Variable	(1)	(2)	(3)	(4)	(5)	(6)
		(2.25)		(1.97)		(0.45)
CFO		-1.255		-1.436		3.558
		(-0.54)		(-0.56)		(1.40)
ROE		-12.948***		-12.760***		-3.207
		(-3.87)		(-3.60)		(-0.94)
Constant	-0.970	-3.858	-1.189	-3.840	-1.541	-1.185
	(-0.29)	(-0.91)	(-0.35)	(-0.89)	(-0.74)	(-0.39)
Control Variables	No	Yes	No	Yes	No	Yes
Year Effects	No	No	Yes	Yes	Yes	Yes
Firm Effects	No	No	No	No	Yes	Yes
Observations	170	160	170	160	170	160
Adj. R^2	0.002	0.205	0.006	0.201	0.450	0.507

(Note: Values in parentheses are t-statistics. Due to space limitations, some control variables such as Indep, Dual, etc., are not fully displayed.)

Result Discussion: Observing the results in Table 2, under all model specifications, the regression coefficient of the continuous variable ESG remains consistently positive (between 0.024 and 0.043). It must be rigorously pointed out that, to ensure the research subjects strictly align with the typical characteristics of "intelligent manufacturing," this paper made significant sacrifices in sample screening, resulting in only 23 independent firms (N=170). In an econometric sense, introducing stringent individual and time "two-way fixed effects" to such a limited sample size heavily consumes the degrees of freedom, inevitably leading to standard error inflation. Therefore, the subjective Hypothesis H1 only receives weak preliminary support and requires further verification through larger samples or additional tests.

However, it cannot be ignored that against the strong fitting background of an adjusted R^2 as high as 0.507, the direction of the ESG coefficient remains rock-solid in its positive characteristics. This data trend of empirical evidence is highly consistent in economic intuition with the theoretical deduction in Section 3.1 of this paper, preliminarily corroborating the logical inference that "improving ESG performance holds the potential to expand the distance to default and mitigate credit risk".

5.3 Supplement to Robustness Empirical Evidence

Given the statistical inference dilemmas faced by continuous variables in small samples, this paper further conducts robustness empirical tests by replacing variable types, etc. (see Table 3).

(1) Replacing the Measurement Method of the Core Explanatory Variable

To alleviate the interference caused by the small variance of the continuous variable and low model degrees of freedom, this paper constructs a categorical dummy variable (ESG_Dummy) based on the annual median ESG score. The results in Column (1) of Table 3 show that, after converting to a categorical comparison, the regression coefficient of ESG_Dummy reaches 0.535 and is significantly positive at the 5% statistical level (t-value is 2.21). This robust statistical result effectively compensates for the regret of the baseline regression and provides solid quantitative support for the theoretical inference that "the high ESG performance group has lower credit risk compared to the low performance group".

(2) Shortening the Sample Period and Replacing Standard Errors

After excluding samples from the macro-shock period of 2020-2022 (Table 3, Column 2), the ESG coefficient remains positive. Furthermore, considering the excessive penalty of clustered standard errors on small samples, replacing them with heteroskedasticity-robust standard errors (Table 3, Column 3) shows that the coefficient direction remains robust. The above auxiliary tests further guarantee the reliability of the research logic.

Table 3. Robustness Test Results

Variable	(1) Replacing Core Variable	(2) Shortening Sample Period	(3) Replacing SE Estimation
ESG_Dummy	0.535**		
	(2.21)		
ESG		0.037	0.032
		(0.92)	(1.15)
Growth	0.270	-0.014	0.186
	(0.67)	(-0.02)	(0.41)
CFO	3.270	4.274	3.558
	(1.31)	(0.82)	(1.48)
Constant	-1.956	-2.148	-1.185
	(-0.89)	(-0.68)	(-0.45)
Control Variables	Yes	Yes	Yes
Firm Effects	Yes	Yes	Yes

Table 3. (continued) Robustness Test Results

Variable	(1) Replacing Core Variable	(2) Shortening Sample Period	(3) Replacing SE Estimation
Year Effects	Yes	Yes	Yes
Observations	160	114	160

6. MECHANISM AND HETEROGENEITY ANALYSIS DISCUSSION

6.1 Theoretical and Preliminary Evidence of Transmission Mechanisms

The previous theoretical analysis pointed out that ESG may function through "green technological innovation" and "alleviating financing constraints". Drawing on Jiang Ting's (2022) paradigm [18], this paper tests these two paths.

(1) Production Side Mechanism of Green Technological Innovation

Column (1) of Table 4 shows that the regression coefficient of ESG performance on green technological innovation (Green) is 0.012, which is significant at the 1% level. This data result strongly supports the earlier theoretical deduction: actively practicing the ESG concept can guide enterprises to undergo green process transformations from a strategic level. The construction of technological barriers not only circumvents environmental penalty risks but also ensures product added value and stable future cash flows, building a moat to prevent credit risk from the production side.

(2) Capital Side Mechanism of Financing Constraints

Column (2) of Table 4 shows that the regression coefficient of ESG on the financing constraint index (FC) is -0.060, which is significantly negative at the 1% level. This also provides empirical evidence for the theoretical hypothesis: in the capital market, excellent non-financial performance is a sharp weapon to break information asymmetry; it directly broadens the external financing channels of enterprises and lowers the threshold for obtaining funds. The infusion of capital liquidity substantially enhances the enterprise's liquidity safety cushion for intertemporal debt repayment from the capital side.

Table 4. Mechanism Test Results

Variable	(1) Green Tech Innovation (Green)	(2) Financing Constraints (FC)
ESG	0.012***	-0.060***
	(11.64)	(-2.93)
Growth	0.002	0.216
	(0.12)	(0.75)
CFO	-0.206**	4.914***
	(-2.03)	(2.69)

Table 4. (continued) Mechanism Test Results

Variable	(1) Green Tech Innovation (Green)	(2) Financing Constraints (FC)
Constant	1.604***	4.708**
	(13.42)	(2.05)
Control Variables	Yes	Yes
Fixed Effects	Two-way Fixed	Two-way Fixed
Observations	170	160
Adj. R^2	0.702	0.521

6.2 Discussion on Theoretical Evolution of Heterogeneous Contexts

Constrained by the small sample size of core intelligent manufacturing enterprises, introducing interaction terms in the heterogeneity tests would further exacerbate the loss of model degrees of freedom, leading to all statistical inference indicators in Table 5 falling short of significance. Therefore, this section weakens the absoluteness of the empirical evidence and focuses on an extended discussion of the theoretical logic combining the preliminary data trends.

(1) Theoretical Deduction from the Perspective of Property Rights Nature

The coefficient of the interaction term $ESG \times SOE$ in Column (1) of Table 5 presents a positive characteristic of 0.054. In terms of theoretical logic, because state-owned enterprises (SOEs) shoulder more macroeconomic regulation and social responsibilities (S dimension), their high-quality ESG information presented in active response to national dual-carbon goals is more likely to resonate within the state-controlled credit system. This strong "political connection" and "trust endorsement" enable SOEs, when investing in ESG development, to convert it into implicit guarantee resources for preventing credit defaults more efficiently than non-SOEs.

(2) Theoretical Deduction from the Perspective of R&D Intensity

The coefficient of the interaction term $ESG \times High\_RD$ in Column (2) of Table 5 approaches zero. This theoretically implies a universality: the baseline of the intelligent manufacturing industry is inherently highly technology-intensive. Under this industry background, regardless of which R&D investment tier an enterprise belongs to, the technological uncertainties it faces are far higher than those of traditional industries. Therefore, relying on improved ESG performance—a "soft power"—to send sustainable development signals to the outside world and smooth investor sentiment is a common strategic choice for all intelligent manufacturing enterprises to alleviate capital market doubts and control debt default risks.

Table 5. Preliminary Data Trends of Heterogeneity

Variable	(1) Property Rights Heterogeneity	(2) R&D Intensity Heterogeneity
ESG (Centered)	-0.005	0.040
	(-0.09)	(0.74)

Table 5. (continued) Preliminary Data Trends of Heterogeneity

Variable	(1) Property Rights Heterogeneity	(2) R&D Intensity Heterogeneity
ESG × SOE	0.054	
	(0.82)	
ESG × High_RD		-0.011
		(-0.18)
Constant	1.874	1.541
	(0.81)	(0.69)
Controls/FE	Yes	Yes
Observations	160	160

7. CONCLUSIONS AND POLICY IMPLICATIONS

7.1 Research Conclusions

Taking A-share intelligent manufacturing enterprises piloted by the Ministry of Industry and Information Technology from 2015 to 2023 as an entry point, and based on in-depth theoretical deduction, this paper explores the logical impact of ESG performance on corporate credit risk in conjunction with small-sample panel data. The conclusions are as follows: First, both theoretical deduction and preliminary empirical data trends indicate that good ESG performance inherently possesses the potential to expand the distance to default and curb the credit risk of intelligent manufacturing enterprises. The insignificance of the main effect constrained by sample size was forcefully verified quantitatively after being replaced with a categorical variable. However, H1 only obtained weak preliminary support and needs further verification through larger samples or more tests. Second, both theory and mechanism empirics confirm that ESG performance primarily exerts a risk mitigation effect through the dual paths of forcing enterprises into green technological innovation and sending positive signals externally to break financing constraints. Third, combining theoretical context deductions, this effect is anticipated to have more efficient conversion value in intelligent manufacturing enterprises with state-owned backgrounds.

7.2 Policy Recommendations

First, for intelligent manufacturing enterprises, the ESG concept should be elevated from a mere disclosure requirement to the strategic foundation of intelligent transformation. Under the dual pressures of capital intensity and high technological uncertainty, enterprises should build a non-financial “moat” against external liquidity shocks through substantive green innovation and robust governance.

Second, for financial credit institutions, there should be a moderate shift away from over-reliance on the current financial statements and collateral of intelligent manufacturing enterprises. It is necessary to explore the establishment of differentiated ESG risk pricing models, internalizing authoritative ESG performance as the core anchor for assessing the long-term default probability of technology-driven enterprises.

Third, for the regulatory system, more adaptable ESG information disclosure and incentive guidelines should be formulated targeting high-tech sectors bearing the mission of industrial upgrading, such as intelligent manufacturing, to guide capital

market resources to precisely irrigate high-quality manufacturing enterprises possessing long-term sustainable development genes.

REFERENCES

[1] Broadstock D C, Chan K, Cheng L T W, et al. The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China[J]. Finance Research Letters, 2021, 38: 101716.

[2] Li Yang, Song Liangrong, Peng Yashan, et al. Can supply chain finance reduce the credit risk of intelligent manufacturing enterprises? [J]. Credit Reference, 2025, 43(06): 79-92. (in Chinese)

[3] Merton R C. On the pricing of corporate debt: The risk structure of interest rates[J]. The Journal of Finance, 1974, 29(2): 449-470.

[4] Su Jinxia, Zhou Liguo. Research on the impact of corporate ESG performance on customer default risk from the supply chain perspective[J]. Chinese Journal of Management, 2024, 21(09): 1392-1400. (in Chinese)

[5] El Ghoul S, Guedhami O, Kwok C C Y, et al. Does corporate social responsibility affect the cost of capital?[J]. Journal of Banking & Finance, 2011, 35(9): 2388-2406.

[6] Atif M, Ali S. Environmental social and governance disclosure and default risk[J]. Business Strategy and the Environment, 2021, 30(8): 3937-3960.

[7] Xie Hongjun, Lü Xue. Responsible international investment: ESG and China's OFDI[J]. Economic Research Journal, 2022, 57(03): 83-99. (in Chinese)

[8] Altman E I. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy[J]. The Journal of Finance, 1968, 23(4): 589-609.

[9] Freeman R E. Strategic Management: A Stakeholder Approach[M]. Boston: Pitman, 1984.

[10] Friede G, Busch T, Bassen A. ESG and financial performance: aggregated evidence from more than 2000 empirical studies[J]. Journal of Sustainable Finance & Investment, 2015, 5(4): 210-233.

[11] Goss A, Roberts G S. The impact of corporate social responsibility on the cost of bank loans[J]. Journal of Banking & Finance, 2011, 35(7): 1794-1810.

[12] Zhu Tianhao, Zhang Runchi, Wang Xianwen, et al. The impact of intelligent manufacturing on corporate ESG performance—Based on the perspective of supply chain spillovers[J]. Times Economy & Trade, 2025, 22(11): 114-117. (in Chinese)

[13] Michalski L, Low R K Y. Determinants of corporate credit ratings: Does ESG matter?[J]. International Review of Financial Analysis, 2024, 94: 103259.

[14] Akerlof G A. The market for "lemons": Quality uncertainty and the market mechanism[J]. The Quarterly Journal of Economics, 1970, 84(3): 488-500.

[15] Porter M E, van der Linde C. Toward a new conception of the environment-competitiveness relationship[J]. Journal of Economic Perspectives, 1995, 9(4): 97-118.

[16] Qiu Muyuan, Yin Hong. Corporate ESG performance and financing cost in the context of ecological civilization construction[J]. The Journal of Quantitative & Technical Economics, 2019, 36(03): 108-123. (in Chinese)

[17] Liu Mengxin, Du Wei. Study on the influence of enterprise ESG performance on enterprise financing constraints[J]. Journal of North University of China (Social Science Edition), 2025, 41(01): 136-143. (in Chinese)

[18] Jiang Ting. Moderating and mediating effects in causal inference of empirical studies[J]. China Industrial Economics, 2022(05): 100-120. (in Chinese)