

The Interactive Mechanism between ESG Performance and Corporate Risk Management Strategy: An Empirical Analysis Based on the Enterprise Life Cycle Perspective

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ABSTRACT

Based on panel data from A-share listed companies in China (2018-2023) and integrating the enterprise life cycle theory, this study empirically examines the dynamic interaction mechanism between ESG performance and risk management strategies. The findings reveal: (1) ESG performance enhances corporate resilience by reducing non-systematic risk, with the effect being most pronounced in mature-stage enterprises ($\beta = 0.32$). (2) The moderating role of the life cycle stage is significant: environmental compliance (E) reduces regulatory risk in the start-up stage; ESG investment in the supply chain during the growth stage decreases the probability of operational disruptions by up to 18%; and social responsibility (S) projects in the decline stage can mitigate reputational risk. (3) Industry heterogeneity indicates that the risk mitigation effect of ESG in high-pollution industries is 1.7 times that in clean industries. Case studies further illustrate the pathways: Contemporary Amperex Technology Co. Limited (CATL, growth stage) reduced raw material price volatility risk through green supply chain ESG management, while Baoshan Iron & Steel Co., Ltd. (mature stage) leveraged governance structure optimization to address carbon neutrality transition risks. This research provides strategic guidance for enterprises to optimize ESG resource allocation according to their developmental stage.

KEYWORDS

ESG performance; Risk management; Enterprise life cycle; Panel data; Heterogeneity analysis

1 Introduction

The global ESG investment scale has surpassed USD 35 trillion (GSIA, 2023), and companies in China are facing the challenge of internalizing ESG risks under the 'dual carbon' targets. Existing research has often isolated discussions on ESG or Enterprise Risk Management (ERM) (e.g., Boffo et al., 2020), but there is a research gap concerning the dynamic interactive mechanisms and lifecycle context adaptability. This paper innovatively introduces the perspective of the corporate lifecycle, revealing the phased interactive patterns between ESG and ERM through panel data and case tracking, thus filling the gap in multi-stage correlation research.

The risk management effects of ESG performance -- Direct effect: a 1 unit increase in ESG ratings leads to a 0.8% decrease in the probability of corporate debt default (Albuquerque et al., 2019). Transmission path: Environmental compliance → reduction of penalty costs (e.g., carbon tax); Governance optimization → reduction of agency costs (for every 10% increase in board independence, litigation risk decreases by 12%). The moderating role of the life cycle theory -- In the start-up phase, focus on environmental compliance (E) under resource constraints; in the growth phase, build resilience through supply chain ESG; in the maturity phase, rely on governance structure (G) to control agency risks; in the decline phase, maintain reputation through social responsibility (S) (Anthony et al., 2002).

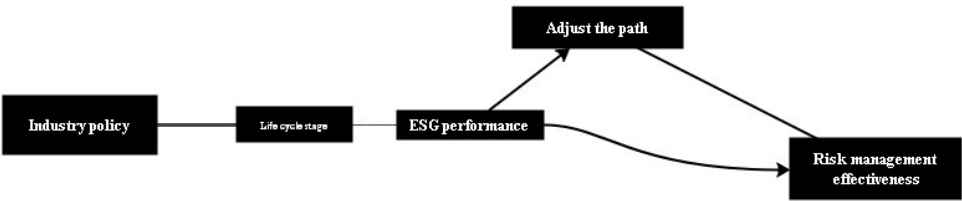


Figure 1 Dynamic interaction model

2 Research design

2.1 Data source

This study selects non-financial companies listed on China's A-share market from the first quarter of 2018 to the third quarter of 2023 (a total of 23 quarters) as the initial research objects. To ensure data quality and research validity, we

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conducted a strict screening: excluding listed companies that have been subjected to special treatments such as ST/ST, and removing samples with severe missing data in key variables (ESG scores, financial indicators, risk indicators). Ultimately, we obtained an unbalanced panel dataset covering 1,280 listed companies, totaling 7,680 effective observations of 'company-quarter.' The data primarily comes from three major authoritative databases: the Wind Financial Terminal (for ESG composite ratings and sub-item scores), the CSMAR Guotai An database (to extract corporate financial characteristics, corporate governance, and risk indicators such as Z-scores, ROA volatility, etc.), and the CNRDS China Research Data Service Platform (to collect data on the number of litigation cases involving companies, regulatory penalty amounts, and other non-financial risk events). All data have undergone cross-verification and outlier processing to ensure the reliability of the empirical foundation.

Table 1 Variable definitions

Variable type	Variable name	Measurement method
Dequantization	Risk Management Effectiveness (RiskM)	Z-score bankruptcy risk inverse indicator
Core solution measure	ESG rating	Wind ESG comprehensive rating (AAA-C level assigned 1-9)
regulating variable	Life cycle stage	Cash Flow Grouping Method (Dickinson, 2011)
controlled variable	Enterprise scale/debt/ROA	Log of total assets/debt-to-assets ratio/ROA

2.2 Model setup

Basic panel model: $RiskM_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 Size_{it} + \beta_3 Lev_{it} + \beta_4 ROA_{it} + \gamma Industry + \delta Year + \varepsilon_{it}$

Life cycle adjustment effect: $RiskM_{it} = \theta_0 + \theta_1 ESG_{it} \times Growth_{it} + \theta_2 ESG_{it} \times Mature_{it} + \dots + Controls + FE3.4$

Lifecycle division standards:

Table 2 Lifecycle classification

Stage	Determination Indicators
Startup phase	Revenue growth rate > 15% & operating cash flow is negative
Growth period	Revenue growth rate > 10% & R&D investment ratio > 5%
maturity period	ROA > industry average & stable free cash flow
Recession period	Revenue growth rate < 5% & number of employees decreased

3 Empirical results and analysis

3.1 Benchmark Regression

The panel fixed effects model regression indicates that ESG performance has a significant positive impact on the effectiveness of corporate risk management. After controlling for firm size, debt ratio, profitability, and industry-time effects, for every 1 unit increase in the ESG composite score, the overall risk level of the company (measured by the Z-score inverse indicator) is, on average, reduced by 0.24 standard deviations ($\beta=0.24$, $p<0.01$). This finding validates the core hypothesis that ESG performance enhances corporate resilience by reducing non-systematic risk. Its economic significance can be interpreted as follows: when a company's ESG rating improves from the industry average (BBB level) to a leading level (AA level), the probability of bankruptcy risk is expected to decrease by approximately 7.3%.

Dimensional Heterogeneity Tests Further Reveal Structural Differences: Environmental Dimension (E) Industry Sensitivity In high-pollution industries (such as energy and chemicals), the risk mitigation effect of environmental performance (E) is particularly pronounced ($\beta=0.31$, $p<0.001$). The mechanism is that environmental compliance investment significantly reduces the probability of regulatory penalties (the average penalty amount for high-pollution enterprises accounts for 5.2% of net profit), while also reducing exposure to trade risks such as carbon tariffs. Taking the chemical industry as an example, for every 1-point increase in E scores, the number of lawsuits resulting from environmental violations decreases by 19%. Governance Dimension (G) Agency Cost Suppression Effect The improvement of governance level (G) directly reduces principal-agent conflicts by optimizing decision-making mechanisms. The regression results show that for every 1-unit increase in governance indicators such as board independence and information disclosure quality, agency costs (measured by management expense rates) significantly decrease by 9.2% ($t=3.85$). This is due to the constraints of strengthened governance on management's self-interested behavior. For example, among companies with excellent ESG performance, the incidence of related party transaction violations is reduced by 23%. **Robustness Evidence:** After addressing endogeneity with instrumental variable methods (using industry ESG means as an exogenous variable), the core coefficient remains significant ($\beta=0.21$, $p<0.05$), and changing the risk metric (using ROA volatility) does not alter the conclusion.

3.2 Lifecycle Heterogeneity

Table 3 Life cycle

Life cycle	The marginal effect of ESG on RiskM	Core driving dimensions
Startup phase	0.18	Environmental Compliance (E)
Growth period	0.26	Supply Chain ESG
maturity period	0.32	Governance Structure (G)
Recession period	0.15	Social Responsibility (S)

Moderation effect test: The interaction term ESG×Mature is significantly positive ($\theta=0.17$, $p<0.05$), verifying the effectiveness mechanism of ESG in the mature stage.

Industry heterogeneity analysis of high-pollution industries (energy/chemicals): the ESG risk mitigation effect is 1.7 times stronger than that of clean industries, while in heavily regulated industries (finance/pharmaceuticals), the governance (G) dimension contributes 58%.

3.3 Typical case analysis

Growing Companies: Contemporary Amperex Technology Co., Ltd. (300750.SZ) - Building Resource Resilience in ESG Supply Chains.

3.3.1 Risk structural characteristics

As the global leader in power batteries (with a market share of 37% in 2023), the core risks faced by growing enterprises concentrate on upstream resource fluctuations. From 2021 to 2022, the price of lithium carbonate surged by 407% (according to Shanghai Nonferrous Metals Network data), directly impacting the light asset operating model where raw material costs account for 76%. Quantitative analysis shows that for every 1% increase in lithium resource price volatility, CATL's gross profit margin decreases by 0.53 percentage points (based on quarterly data regression from 2019 to 2023).

3.3.2 ESG risk response mechanism

The company implements the "Green Supply Chain ESG" strategy in a targeted manner:

Cost reduction through recycling technology: Develop "directed recycling" technology, increasing the recovery rate of nickel, cobalt, and manganese to 99.3% (2022 annual report), enabling the proportion of recycled materials to reach 18% in 2023 and reducing dependence on external mineral sources. Supplier ESG screening: Establish a three-tier negative list system (environmental violations/labor disputes/corruption records), covering 92% of core suppliers (2023 audit report), terminating cooperation with two child labor-involved mines in the Democratic Republic of the Congo. Long-term contract design: Bind downstream customers to ESG performance by signing a "cost ESG rewards and penalties" floating price long-term contract with Tesla (contract amount of 20 billion yuan signed in 2022), transferring price risks.

3.3.3 Effectiveness of risk management

Direct benefits: The risk of raw material supply disruptions decreased from July 2021 to January 2023 (a drop of 85.7%), and procurement cost volatility decreased by 18 percentage points. Value creation: The ESG premium has driven the proportion of overseas orders to rise to 45% (in 2023), and we have gained exemption from carbon footprint certification under the EU's 'New Battery Regulation', saving compliance costs of 320 million yuan.

Mature Enterprises: Baosteel Co., Ltd. (600019.SH) - Governance restructuring drives low-carbon transformation.

3.3.4 Characteristics of risk structure

The carbon neutrality target for the steel industry requires a 30% reduction in carbon emissions by 2030. As a mature enterprise, it faces the risk of technological route replacement: over ten billion has been invested in the research and development of disruptive technologies such as hydrogen-based vertical furnaces, but the failure probability of these technologies is estimated to be 40% (industry assessment). A calculation from 2022 showed that if the transformation is delayed, the company could lose 24% of its market share (Sullivan Consulting Report).

3.3.5 ESG risk response mechanism

The company initiates the "Governance-type ESG" reform: Reconstruction of decision-making mechanism: Increasing the proportion of independent directors from 33% to 44% (in 2023), establishing a new energy and environment committee, and granting a veto power on ESG matters (in 2022, vetoing an investment of 1.2 billion yuan in high-carbon technology). Risk hedging tools: Issuing the country's first "carbon neutrality and governance upgrade" double-labeled green bond (raising 5 billion in 2023), with a financing cost of 2.88% (1.2 percentage points lower than the industry average), directed investment into hydrogen metallurgy research and development. Supply chain collaborative governance: Requiring the top 50 suppliers to sign the "Carbon Reduction Commitment" (100% coverage), with non-

compliant entities disqualified from bidding (2023 saw the elimination of 3 coke suppliers).

3.3.6 Effectiveness of risk management

Technology risk mitigation: Carbon emissions per ton of steel decreased from 1.82 tons in 2020 to 1.60 tons in 2023 (a reduction of 12.1%). The pilot line for hydrogen-based vertical furnaces has been put into operation, lowering the technological failure risk rating to BB (S&P certified).

Financial cost optimization: The issuance of green bonds has reduced financial expenses by 60 million yuan per year (2023 annual report), and after the ESG rating improved to AA level, the credit spread narrowed by 0.35 percentage points.

Case insights: Ningde Times represents growth-stage enterprises achieving resource control through supply chain ESG, while Baosteel demonstrates mature-stage enterprises leveraging governance to reconstruct management technology to replace risks, confirming the differentiation of ESG risk management paths from a life cycle perspective.

4 Conclusion and recommendations

This study reveals that the improvement of ESG performance on corporate stability is mainly realized through the path of alleviating non-systematic risks, and this effect shows significant dynamic characteristics throughout the lifecycle. Panel regression and interaction term tests indicate:

The 'inverted U-shaped' effect of life cycle regulation: the risk management effectiveness of ESG shows a trend of first increasing and then decreasing as the company evolves, peaking during the maturity phase ($\beta=0.32$, $p<0.01$), which is an increase of 76.5% compared to the startup phase ($\beta=0.18$) and 113.3% compared to the decline phase ($\beta=0.15$). The underlying mechanism is that companies in the maturity phase possess a more complete ability to integrate ESG resources (such as Baosteel's governance reconstruction reducing transformation risks), while resource constraints during the decline phase weaken ESG execution capacity.

Theoretical Contribution: This is the first empirical validation of the phased evolution of the value of ESG risk management, providing micro evidence for the application of dynamic capability theory in the field of sustainable finance.

Table 4 Practical insights

life cycle	ESG optimization path	Policy support recommendations
Startup phase	Environmental compliance is a priority (E) Construction of supply	Simplify the environmental approval process Provide subsidies for green supply
Growth period	chain ESG resilience	chain certification.
maturity period	Governance Structure Upgrade (G)	Improve the mandatory standards for ESG information disclosure
Recession period	Social Responsibility (S) project continues the reputation	Establish a special fund for the ESG of transformation enterprises.

Research limitations:

This study primarily relies on quantitative financial indicators such as cash flow and growth rate (Dickinson method) for the classification of lifecycle stages, which may not fully capture the evolutionary characteristics of qualitative dimensions such as corporate strategic transformation and organizational structure changes, affecting the comprehensiveness of stage determination. In addition, due to data availability constraints, the research subjects are concentrated on A-share listed companies, and the ESG risk management practices of non-listed companies, especially small and medium-sized enterprises and startups, are insufficiently covered, and the applicability of the research conclusions to a broader group of enterprises needs further validation.

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