

Study on Monitoring and Prevention of ESG Green Risk in Liaoning Manufacturing Enterprises under the Dual Carbon Target

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Abstract: As China's economy transitions from a phase of rapid growth to one of high-quality development, the environmental, social, and governance (ESG) performance of manufacturing enterprises is crucial for achieving high-quality economic goals. However, some manufacturing companies seek short-term gains through ESG greenwashing, severely hindering China's efforts towards high-quality economic development and the achievement of its carbon peak and carbon neutrality targets (the dual carbon goals). In light of this, this paper begins with an analysis of relevant research on ESG, greenwashing, and their relationship both domestically and internationally. Based on an examination of the industrial landscape and ESG practices of manufacturing enterprises in Liaoning, it studies the monitoring system for ESG greenwashing risks in Liaoning's manufacturing sector, designs specific monitoring indicators, and establishes an ESG greenwashing risk assessment model for Liaoning's manufacturing enterprises. Furthermore, it proposes preventive strategies to address ESG greenwashing risks, providing insights to help prevent greenwashing and promote green development in society and the economy.

Keywords: Manufacturing Enterprises; ESG Performance; Green Risk; Monitoring

1. Introduction

As global attention to climate change continues to rise, China has set its dual carbon strategic goals, aiming to peak carbon emissions before 2030 and achieve carbon neutrality by 2060. As an important manufacturing base in China, Liaoning's manufacturing enterprises face significant challenges and pressures in energy

consumption and carbon emissions. Meanwhile, the ESG concept is gaining traction in global investment, becoming a crucial standard for measuring a company's sustainability. To align with this trend, many Liaoning manufacturing companies have ventured into ESG practices. However, some companies engage in greenwashing, publicly promoting their ESG achievements while failing to implement relevant responsibilities, posing numerous risks to the market, investors, and society. There is an urgent need for precise monitoring and effective prevention.

2. Related Research at Home and Abroad

2.1 ESG Related Theoretical Research of Enterprises

The ESG (Environment, Social, Governance) philosophy at the corporate level advocates for companies to place greater emphasis on environmental friendliness (E), social responsibility (S), and corporate governance (G) [1], aligning with the requirements of high-quality development. Therefore, ESG performance (or ESG metrics) has become an important indicator reflecting the level of high-quality development in enterprises. Research on corporate ESG performance in academia mainly focuses on the following aspects:

2.1.1 Measuring ESG performance of enterprises
Most studies use ESG ratings to measure the ESG performance of enterprises. The most commonly used are the ESG rating data of Huazheng (29%), Bloomberg (24%) and Shangdao Ronglv (12%).

2.1.2 Factors affecting corporate ESG performance

Internal factors affecting corporate ESG performance include positive and negative factors. Positive factors include board independence, gender diversity of the board,

number of board meetings, etc.; negative factors include common institutional holdings, frequent CEO changes, etc.

2.1.3 The impact of ESG performance

ESG performance can improve the investment efficiency [2] and enterprise performance [3].

2.2 Theoretical Research on Corporate Greenwashing

The term "greenwashing" was first coined in 1986 by environmentalists to describe false environmental claims that had been whitewashed.

2.2.1 Corporate greenwashing identification
Seven behaviors of greenwashing include insufficient evidence, concealing the truth, and ambiguity. Corporate "greenwashing" in carbon emissions is summarized as inconsistencies between words and actions in planning and implementation; conveying irrelevant moral signals; confusion and inconsistency in carbon emission measurement, among ten aspects.

2.2.2 Factors influencing corporate greenwashing

The performance gap of companies can drive them to engage in "greenwashing," selectively disclosing environmental information [4]. As environmentally friendly companies gain favor in capital markets, driven by profit motives, many firms strive to present a green development image when disclosing environmental information externally, attracting investor attention and easing financing constraints. This creates greater motivation for "greenwashing," with external financing needs leading to higher levels of greenwashing [5].

2.2.3 Corporate greenwashing governance

High government environmental attention and a well-developed legal environment can significantly curb corporate "greenwashing" [6]; the impact of environmental regulations on "greenwashing" varies, with command-based and participatory regulations effectively suppressing information "greenwashing," while incentive-based environmental regulations exhibit an "inverted U-shaped" relationship [7].

2.3 Theoretical Research on ESG Greenwashing in Enterprises

2.3.1 Corporate ESG greenwashing motivation

Due to the lack of relevant laws and regulations, corporate social responsibility disclosure is poorly regulated. Companies can exploit

loopholes in these systems to benefit themselves, which is the institutional cause of corporate greenwashing [8]; flaws in institutional arrangements are one of the external factors contributing to corporate ESG greenwashing behavior [9]. As the concept of green development becomes more ingrained, consumers will be more attracted to companies with a green and low-carbon image, while they will avoid those that lack social responsibility information or fail to disclose relevant corporate information in a timely manner.

2.3.2 The consequences of corporate ESG greenwashing

The fulfillment of corporate social responsibility is positively correlated with its financial performance, whereas this relationship does not exist for companies that engage in greenwashing; the exposure of greenwashing activities can have a negative impact on corporate financial performance [10]; the phenomenon of ESG report greenwashing is becoming increasingly severe, and false disclosures of data such as carbon emissions and resource utilization by greenwashing companies can affect the goal of limiting temperature rise to 1.5°C, which is crucial for human survival and sustainable development.

3. Analysis of the Current Situation of Manufacturing Enterprises in Liaoning with the Dual Carbon Targets

3.1 The Connotation of the Dual Carbon Targets

In September 2020, China clearly set the goals of peaking carbon emissions by 2030 and achieving carbon neutrality by 2060. On February 1, 2021, the "Measures for the Administration of Carbon Emission Trading (Trial)" came into effect, marking a new phase in the development and construction of the national carbon market. The dual carbon targets encompass core tasks such as energy transition, emission reduction, and industrial structure adjustment.

3.2 Industrial Pattern and ESG Practice of Liaoning Manufacturing Enterprises

Liaoning's manufacturing sector spans diverse fields such as machinery, automobiles, shipbuilding, and electronics, with distinct industrial cluster characteristics. In recent years, some leading enterprises have actively embraced

ESG principles, implementing pollution control and ecological restoration projects in environmental areas; in social sectors, they focus on employee skill enhancement training and community public welfare activities; in governance, they optimize corporate equity structures and strengthen risk management. However, many small and medium-sized enterprises, constrained by costs and awareness, lag behind in ESG practices, with non-standard or even absent information disclosure.

3.3 Requirements for Liaoning Manufacturing Industry under the Dual Carbon Targets

The dual carbon targets put forward many requirements for the manufacturing industry in Liaoning, involving energy structure adjustment, technological innovation, industrial upgrading, green financial support and other aspects. In combination with the current situation of Liaoning manufacturing enterprises and the latest policy trends, the main requirements are reflected in the following aspects.

3.3.1 Accelerating the transformation of energy structure

Liaoning is accelerating the construction of an "integrated wind, solar, thermal, nuclear, and storage" energy base, with the goal of achieving 55% clean energy generation capacity and 53% clean energy generation by 2025. The focus will be on developing wind power, photovoltaic, and nuclear energy. Liaoning's manufacturing sector needs to gradually reduce its reliance on traditional coal energy and increase the proportion of green electricity usage to lower carbon emission intensity.

3.3.2 Promoting low-carbon technology innovation

Technological innovation is the most critical factor affecting carbon emissions in Liaoning's manufacturing industry, followed by energy structure and environmental awareness. Manufacturing enterprises should be encouraged to adopt high-efficiency energy-saving technologies, and support the research and development and application of cutting-edge technologies such as hydrogen energy and carbon capture and storage.

3.3.3 Optimize the industrial structure of manufacturing industry

Liaoning's manufacturing industry needs to adjust its industrial structure by fostering green industrial clusters, reducing the proportion of

high-energy-consuming and high-emission industries, and transitioning towards advanced equipment manufacturing and new energy equipment. At the same time, it encourages enterprises to participate in voluntary greenhouse gas disclosure to enhance carbon emission transparency, in line with national policy requirements.

3.3.4 Strengthen policy guidance and financial support

Liaoning is deepening the reform of its power market and promoting the consumption of new energy. Manufacturing enterprises need to adapt to market-based electricity pricing mechanisms and optimize their power usage strategies. The government should encourage green financial support for manufacturing enterprises, using financial tools to reduce the costs of their low-carbon transition. At the same time, it should encourage manufacturing enterprises to participate in the national carbon market trading and explore carbon footprint management to address international green trade barriers.

3.3.5 Improve the low-carbon management ability of enterprises

Liaoning manufacturing enterprises need to strengthen their carbon emission accounting capacity and establish internal carbon management systems, such as product carbon footprint accounting and carbon labeling certification. At the same time, they should promote the digital and intelligent transformation of enterprises to improve energy utilization efficiency.

4. Theoretical Explanation of ESG Green Behavior

4.1 Definition of ESG Greening

ESG green drift refers to the fact that enterprises exaggerate and falsely publicize their ESG performance in order to meet the market's attention on ESG or regulatory requirements, but their actual actions do not reach the declared standards, or intentionally conceal negative information unfavorable to ESG evaluation. It is an untrustworthy behavior of enterprises and misleads stakeholders' decisions.

4.2 Analysis of the Motivation of ESG Green Behavior

4.2.1 Economic profit motivation

Economic profit is the most fundamental driving force behind greenwashing. In fierce market

competition, companies often seek differentiated competitive advantages to stand out. Green and environmental protection have become key concerns for modern consumers. Therefore, some companies opt to use greenwashing tactics to align with this trend, attracting more consumers, enhancing their brand image, and ultimately increasing sales and market share.

4.2.2 Market competition pressure

As environmental awareness spreads, consumers are increasingly inclined to choose products and services with green labels. To stand out in industry competition, especially in the current era where ESG is highly valued, companies can quickly create a differentiated advantage through greenwashing, capturing market share and misleading consumers and partners.

4.2.3 Regulatory loopholes and information asymmetry

The existence of greenwashing is closely related to the imperfections in current ESG regulatory policies and the lack of transparency in information disclosure mechanisms. On one hand, environmental laws and standards may not fully cover all areas, providing opportunities for greenwashing. On the other hand, there is an information asymmetry between companies and consumers, allowing greenwashing propaganda to thrive.

4.2.4 Corporate culture and values deficiency

Corporate culture and values serve as the intrinsic driving force behind corporate behavior. Some companies lack genuine environmental awareness and a sense of responsibility, viewing profit maximization as their sole objective while neglecting the environmental responsibilities they bear as members of society. This deficiency in values leads these companies to opt for short-term actions like greenwashing when facing environmental challenges, rather than actively engaging in green transformation and sustainable development.

5. Construction of ESG Green Risk Monitoring System for Manufacturing Enterprises in Liaoning

Table 1. Composition of ESG Greening Risk Monitoring Indicators for Manufacturing Enterprises

Indicator classification	Indicator setting	metric
environment metric	Comprehensive energy consumption per unit output value	To measure the energy efficiency of enterprises, compare the industry average with advanced values, and excessive deviation may be suspected of greenwashing.
	Change rate of	The dynamic of corporate carbon emission reduction is tracked, and

5.1 Design of Monitoring Indicators

The specific monitoring index design of ESG green risk in manufacturing enterprises is shown in Table 1.

5.2 Monitoring Data Acquisition and Processing Methods

5.2.1 Data collection

Establish a multi-data collection network based on annual reports, social responsibility reports and environmental information disclosure reports of enterprises; support with law enforcement data from government environmental protection, labor supervision and other departments; combine ESG rating data from third-party professional institutions, news media reports and public opinion monitoring information to ensure comprehensive information.

5.2.2 Data processing

Use data cleaning technology to remove abnormal values and repeated information; unify the different indicators through standardization processing; use big data analysis to mine data correlation, and initially identify potential green risk points.

6. Establishment of ESG Greening Risk Assessment Model for Manufacturing Enterprises in Liaoning

6.1 Selection of Risk Assessment Methods

Considering the characteristics of samples from manufacturing enterprises in Liaoning and data quality, a combination of fuzzy comprehensive evaluation and analytic hierarchy process is adopted. Fuzzy comprehensive evaluation can effectively handle the fuzziness and uncertainty of complex systems, transforming qualitative evaluations into quantitative results; the analytic hierarchy process is used to determine the weights of each monitoring indicator, reasonably reflecting their relative importance. The combination enhances the accuracy of risk assessment.

	carbon emission intensity	the abnormal fluctuations cannot be explained by reasonable technological innovation. Therefore, we need to pay close attention to it.
	Actual operation rate of environmental protection facilities	Reflect whether the investment in environmental protection is implemented, low operation rate combined with high publicity, and indicate the risk of greenwashing.
Social indicators	Staff satisfaction survey scores	It really reflects the employees' recognition of corporate benefits, career development and other aspects, and it is suspicious if there is a big contrast with the corporate publicity.
	Incidence of work safety accidents	If enterprises frequently emphasize security but accidents occur frequently, there may be information concealment or inadequate measures.
	Community complaint handling rate	It reflects the relationship between enterprises and surrounding communities, and it is abnormal to deal with delays and claim harmony with each other.
Governance indicators	Implementation progress of ESG strategic planning	The significant gap between planning and actual performance shows that the strategy is empty and the publicity is not true.
	The intensity of independent directors' supervision on ESG issues	Judging by the number and depth of opinions expressed by independent directors, weak supervision is prone to green drift.
	Internal audit coverage of ESG project audit	Low coverage rate makes it difficult to ensure the authenticity and reliability of ESG data, increasing the risk of greenwashing.

6.2 Model Construction Steps

6.2.1 Establish factor set

The three major ESG field subdivision indicators are taken as elements of the factor set to construct a hierarchical structure, such as energy consumption, emissions and other specific indicators under the environmental dimension as the bottom layer elements.

6.2.2 Determine the weight set

Use the analytic hierarchy process to construct the judgment matrix through expert questionnaire survey, calculate the weight of each index, and ensure the rationality of the weight after consistency test.

6.2.3 Fuzzy evaluation

Invite industry experts, scholars and regulators to form an evaluation group to conduct fuzzy evaluation on the performance of each indicator of the enterprise, determine the membership matrix, and combine the weight set to obtain the comprehensive evaluation result of the green risk of ESG of the enterprise through fuzzy synthesis operation.

6.3 Risk Classification and Early Warning Mechanism

Based on the evaluation results, the risk of

greenwashing is categorized into five levels: low, lower, medium, higher, and high, corresponding to different warning signals (green, blue, yellow, orange, red). Thresholds are set; when a company's risk level rises and reaches the warning threshold, the system automatically issues warnings to the company, regulatory authorities, investors, and other stakeholders to enable timely response measures.

7. ESG Green Risk Prevention Strategies for Manufacturing Enterprises in Liaoning

7.1 Strengthening Internal Governance of Enterprises

First, cultivate an ESG corporate culture by conducting training from the top down to the grassroots level, integrating ESG principles into the company's values, vision, and daily operations, making integrity in practicing ESG a shared commitment among all employees. Second, establish and improve ESG management systems, clarifying responsibilities across departments, such as the R&D department being responsible for green technology innovation, and the human resources department ensuring employee rights protection,

complemented by performance evaluation mechanisms that link ESG performance with compensation and promotions. Third, increase investment in ESG technology research and development, using blockchain technology to ensure that ESG data is tamper-proof and traceable; introduce big data analysis to optimize environmental management and resource allocation decisions, enhancing ESG implementation capabilities.

7.2 External Regulatory Synergy

First, Liaoning Province should introduce detailed ESG regulatory laws tailored to local conditions, clarifying the criteria for identifying greenwashing and legal responsibilities, filling policy gaps, and increasing the cost of corporate violations. Second, multiple departments including environmental protection, market supervision, and financial regulation should establish a regular collaboration mechanism, sharing corporate ESG information, conducting joint law enforcement, and precisely targeting greenwashing activities. Third, strengthen third-party oversight of ESG rating agencies and auditing firms, formulate industry standards, require them to enhance their professional competence, conduct business independently and objectively, and ensure the authenticity of ESG evaluations.

7.3 Diversified Social Supervision

First, the media should leverage its role in public opinion supervision by conducting in-depth investigations into companies' ESG performance, exposing greenwashing practices, guiding public discourse, and creating strong social pressure. Second, channels for public participation should be broadened, encouraging consumers, investors, and community residents to report ESG issues through hotlines and online platforms, establishing incentive mechanisms to boost public engagement. Third, industry associations should develop ESG self-regulation guidelines, organize training sessions for member companies, conduct ESG evaluations within the industry, and publicly penalize non-compliant firms to promote healthy industry development. This paper constructs an ESG greenwashing risk monitoring and prevention system for manufacturing enterprises in Liaoning, clarifying the manifestations and motives of greenwashing behavior. It designs scientific monitoring indicators and evaluation models,

proposing internal and external collaborative prevention strategies. Due to data availability limitations and the low quality of ESG information disclosure by some companies, the accuracy of greenwashing risk monitoring and assessment may be affected. Additionally, while the greenwashing risk assessment model is practical, it still requires continuous optimization with emerging technologies. In the future, as the ESG market matures and dual-carbon technologies advance further, interdisciplinary research should be deepened to dynamically track the ESG development of manufacturing enterprises in Liaoning, contributing wisdom to the green rise of China's manufacturing industry.

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