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Construction of Enterprise Performance Evaluation System Based on Sustainable Development Perspective: Evidence from Heavily Polluting Listed Companies in China

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Abstract

The heavily polluting industry plays a crucial role in the industrial structure, and actively exploring green development methods and improving business performance is the only way for enterprises to develop in the future. This article selects a total of 1381 listed companies in heavy pollution industries listed in Shanghai and Shenzhen, China, from 2010 to 2021 as the research objects. Based on the characteristics of their production and operation, a sustainable development performance evaluation system is established that comprehensively reflects the overall performance of enterprises in three performance dimensions: financial performance, social responsibility, and risk control. Factor analysis is used to empirically evaluate the comprehensive performance of enterprises, Enabling enterprises to formulate and adjust their production and operation decisions based on performance evaluation results, achieving healthy and sustainable development of the company in a timely manner.

Keywords: *Heavy polluting listed companies; Sustainable development; Financial performance; Social responsibility; Risk Management.*

1. Introduction

Since the 21st century, China has gradually entered a critical phase of rapid development in industrialization, urbanization, and agricultural modernization. The traditional industrialization model with high investment, high energy consumption, high emissions, and high pollution has led to rapid economic development and the continuous strengthening of China's economic strength. But at the same time, it also brings adverse effects to society. Overexploitation of natural resources, low resource utilization rates, and the massive discharge of exhaust gas and wastewater have caused increasingly serious environmental pollution, seriously affecting people's lives and work. With the depletion of the earth's resources and the increasing prominence of environmental problems, this is not conducive to comprehensive and sustainable development of society. Therefore, environmental protection, low carbon, and environmental friendliness have become the focus of global attention.

Highly polluting industries play an important role in the industrial structure, and actively exploring environmentally friendly development methods and improving business performance is the only way for companies to develop in the future. Therefore, traditional performance evaluation systems can no longer meet the needs of modern enterprises for

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comprehensive performance evaluation. A scientifically comprehensive performance evaluation index system that reflects the sustainable development ability of enterprises is crucial for enterprises. Management can understand the problems that exist in the sustainable development process of the enterprise through the results of performance evaluation and take corresponding measures in a timely manner to solve them. However, the existing performance evaluation system for heavily polluting enterprises in our country often focuses on financial performance indicators, with a focus on evaluating the economic growth capacity of enterprises. This can easily lead to excessive emphasis on economic growth and neglect of environmental protection and social responsibility, which is not conducive to the healthy and sustainable development of enterprises.

2. Literature Review

Referring to the relevant scientific literature, the academic community currently chooses mainly single and comprehensive indicators to evaluate the performance of listed companies. By effectively controlling resources, enterprises can improve labor productivity, reduce production costs, and gain more profits, gradually enhancing their competitive advantage. The standard cost system introduces the concept of pre - and in-process control into cost management, changing the traditional feedback on production and operation costs only after the fact and replacing passive cost management with active cost management, which is more conducive to comprehensive control of enterprise production and operation costs, thereby maximizing enterprise profits. From then on, standard cost performance evaluation has been implemented (Brown, 1981). After extensive research, a performance evaluation system centered on economic value added can effectively evaluate the ability of business operators to use capital and create value for shareholders (Soumaya, 2013). A performance pyramid model was constructed by effectively linking the strategic goals of enterprises with financial and non-financial information, emphasizing the crucial role of organizational strategy in enterprise performance evaluation (Kelvin & Lynch, 1990). The balanced scorecard performance evaluation system includes four evaluation dimensions, namely finance, customers, internal processes, and learning and growth. It comprehensively considers the value demands of stakeholders such as shareholders, employees, and customers (Norton & Kaplan, 2001). British scholars have constructed a "performance prism" evaluation model, which focuses on stakeholders and evaluates them from five aspects: satisfaction, contribution, strategy, process, and capability. It is a relatively scientific and reasonable performance evaluation method (Neely & Adams, 2000). Sustainable development of enterprises emphasizes the coordinated development of the economy, society, and environment in the development process and takes into account factors affecting social benefits and environmental protection in the evaluation of enterprise performance (Molnar, 2001). We examined the regulatory framework for low-carbon efficiency across procurement, logistics, product, and process design using a stepwise empirical mixed method approach and examined the impact of low-carbon efficiency (Ali et al., 2020). Enterprises should establish a low-carbon management system led by departments to achieve green and low-carbon transformation (Yi et al., 2016). The enterprise performance evaluation system based on the balanced scorecard mainly starts from four perspectives: finance, customers, business processes, and learning and development. It is believed that the balanced scorecard can help improve the enterprise performance evaluation system (Zhang, 2013). Taking the Sun Paper Industry as an example, the factor analysis method was used to calculate the financial performance, including and excluding low-carbon capacity, and it was believed that low-carbon indicators would affect the financial performance of the enterprise (Chen et al., 2020). Introducing the Balanced Scorecard in traditional performance evaluation to compare financial and non-financial indicators, as well as internal and external indicators, can help meet the practical management needs of enterprises (Qin & Liu, 2013). Using big data as the background,

the balanced scorecard is used to study the low-carbon performance of enterprises and help them achieve green development (Li & Gu, 2022).

The influencing factors of sustainable development of enterprises include resource integration, organizational practices, and dynamic capabilities (Zott, 2003). Scholars have found through analysis of 100 sample enterprises that manager quality, unique characteristics of the company, business development models, and human resource management affect the sustainable development ability of the enterprise (Barringer et al., 2005). There is a certain connection between the social responsibility of a company and its value. Emphasizing the fulfillment of social responsibility in the business process will be beneficial for achieving sustainable development of the enterprise (Criso'stomo et al., 2011). Some scholars believe that the four major capabilities of technological collaboration, green human resources, ecological innovation culture, and environmental management system strategy are important factors for enterprises to achieve sustainable development (Rashid et al., 2014). Therefore, this article combines the characteristics of production and operation of enterprises in the heavily polluted industry to establish a sustainable development performance evaluation system that comprehensively reflects the overall performance of heavily polluted listed companies in three performance dimensions: financial performance, social responsibility, and risk control. Financial performance is quantified from five aspects: profitability, asset quality, debt risk, business growth, and cash flow. This enables enterprises to timely formulate and adjust their production and operation decisions based on the performance evaluation results, and achieve healthy and sustainable development of the company.

3. Constructing a comprehensive performance evaluation system for heavily polluting listed companies

3.1Data source

This article selects heavily polluting industry-listed companies in China's Shanghai and Shenzhen stock exchanges from 2010 to 2021 as the research objects. In order to control the quality of the research sample data and ensure the scientific validity of empirical research conclusions, this article excludes ST-listed companies and samples with outliers in the data. Finally, 1381 consecutive 12-year data were selected as the research sample. The data used in this article is sourced from the Wind database, and some missing data is supplemented by searching for annual financial reports, social responsibility reports, sustainable development reports, and other information on listed companies on websites such as the Shanghai and Shenzhen Stock Exchange, Sina Finance, and Juchao Information Network.

3.2 Indicator Selection

This article refers to the views of many scholars and ultimately chooses quantitative indicators representing financial performance capabilities, such as profitability, asset quality, debt risk, business growth, and cash flow. By selecting indicators representing non-financial performance capabilities such as social responsibility and risk control, a performance evaluation index system for heavily polluting listed companies was constructed from three dimensions and 17 variables. The specific analysis is as follows:

Table1 Comprehensive evaluation index system for the performance of heavily polluted listed companies

Primary indicators	Secondary indicators	Code	Indicator calculation
Profitability	Net profit margin of total assets	Y1	Net profit / total assets balance

	Asset remuneration rate	Y2	(Total profit + financial expenses) / total assets
	Return on input capital.	Y3	(Net profit + financial expenses) / (assets-current liabilities + notes payable + short-term borrowing + non-current liabilities due within one year)
Asset quality status	Turnover of total capital	Y4	Operating income / total assets
	Turnover of current assets	Y5	Operating income / total current assets
Debt risk status	Asset-liability ratio	Y6	Total liabilities / total assets
	Equity multiplier	Y7	Total assets / Total owners' equity
Operating growth	Total asset growth rate	Y8	(Ending value of total assets - beginning value of total assets)/beginning value of total assets
	Capital value preservation and appreciation rate	Y9	Ending value of owner's equity/initial value of owner's equity
	Sustainable growth rate	Y10	Return on equity × Earnings retention ratio/(1- Return on equity) × Earnings retention rate)
Cash flow status	Quick ratio	Y11	(Current assets inventory)/Current liabilities
	Cash ratio	Y12	Cash and cash equivalents ending balance / current liabilities
	Total operating cash-liability ratio	Y13	Net cash flow from operating activities / total liabilities
Corporate social responsibility investment	ESG grade	Y14	ESG ratings are AAA, AA, A, BBB, BB, B, and CCC, with one assignment of 7-1.
Internal control index	Internal control index	Y15	Dibo database internal control composite index
	Financial leverage	Y16	(Net profit+income tax expenses+financial expenses)/(Net profit+income tax expenses)

1. Analysis of profitability indicators

Profitability status refers to the extent of a company's ability to make profits. This paper identifies three indicators: net profit margin of total assets, return on assets and return on invested capital to analyze the profitability of highly polluting listed companies.

(1) Net profit margin of total assets

The net profit margin from total assets is taken as a comparison of net profit to total assets, which is the potential profit that a company can obtain by utilizing assets. The larger it is, the higher the input-output efficiency of the enterprise's assets.

(2) Return on assets

The return on assets percentage is taken from the ratio of the company's advance interest and tax income to the total balance sheet, representing the profitability of the company's balance sheet. The higher the asset return rate, the higher the utilization rate of enterprise assets.

(3) Return on invested capital

Return on invested capital is the ratio of the sum of net profits and financial expenses to the total amount of assets minus current liabilities, notes payable, short-term loans and non-current liabilities that are due within one year. The return on invested capital represents the profitability of a company's capital.

2. Analysis of asset quality status indicators

Asset quality status refers to the turnover cycle and operational capacity of a company's assets, reflecting how quickly the company achieves profitability. This article establishes two indicators, total asset turnover rate, and current asset turnover rate, to analyze the asset quality status of listed companies with heavy pollution.

(1) Total asset turnover rate

The total asset turnover ratio is calculated from the ratio of operating income to total assets. The higher it is, the shorter the cycle of turnover of total assets of the enterprise, which means a higher degree of utilization of total assets.

(2) Current asset turnover rate

The current asset turnover rate is taken from the ratio of operating income to total current assets. The higher it is, the shorter the turnover cycle of a company's current assets, which means the higher the level of utilization of current assets.

3. Analysis of debt risk indicators

Debt risk profile refers to the ability of a company to resist financial risks. This article sets two indicators, asset-liability ratio, and equity multiplier, to analyze the debt risk situation of heavily polluting listed companies.

(1) Asset liability ratio

The asset-to-liability ratio is calculated from the ratio of total liabilities to total assets, representing the share of liabilities in the company's assets. The higher the ratio, the greater the company's debt and the higher the debt risk.

(2) Equity multiplier

The equity multiplier is calculated from the ratio of total assets to total equity. The equity multiplier represents the amount of financial leverage of a company. The larger it is, the lower the shareholder investment in the company's assets, the higher the debt, and the greater the financial leverage.

4. Analysis of business growth indicators

Business growth status refers to a company's growth potential and represents its future development potential. This article establishes three indicators: total asset growth rate, capital preservation and appreciation rate, and sustainable growth rate to analyze the operational growth status of listed companies with heavy pollution.

(1) Total asset growth rate

The growth rate of total assets is taken from the ratio of the increase in total assets for the current year to the initial value. The growth rate of total assets represents the growth of the total amount of the company's annual balance sheet, and the higher it is, the faster the growth of total assets and the better the development level of the company.

(2) Capital preservation and appreciation rate

The capital preservation and appreciation rate is taken from the ratio of the ending value of the owner's equity to the initial value. It represents the growth of capital invested by owners. The larger it is, the faster the capital growth of the enterprise, that is, the faster the growth rate of shareholder equity.

(3) Sustainable growth rate

The sustainable growth rate is taken as the ratio of the product of net asset return and earnings retention rate to the difference between 1 and the product of the two. The sustainable growth rate represents the company's maximum growth in accordance with the current operating and economic policy and is also the company's internal growth capacity at the moment.

5. Analysis of cash flow status indicators

The cash flow situation represents the strength of the enterprise's capital chain. This article sets three indicators: quick ratio, cash ratio, and total operating cash to debt ratio to analyze the cash flow situation of heavily polluting listed companies.

(1) The quick ratio is taken from the comparison of the difference between current assets and short-term liabilities. The quick ratio is usually seen as a manifestation of short-term solvency, and this article uses it as a representative indicator of cash flow status because the short-term solvency of a company represents its liquidity and reflects the strength of its capital chain. Usually, the quick ratio of a company is greater than 2.

(2) Cash ratio

The cash ratio is taken from the comparison of the ending balance of cash and cash equivalents to current liabilities. Like the quick ratio, the cash ratio reflects a company's cash flow ability better. Usually, a company's cash ratio is greater than 1.

(3) Total operating cash to liability ratio

The ratio of total operating cash to total liabilities is taken from the annual net cash flow ratio from operating activities to total liabilities. Usually, when the total operating cash-to-debt ratio of a company is more significant than 0.25, the cash flow possessed by the company has the ability to resist financial risks.

6. Corporate Social Responsibility Investment

ESG integrates factors such as environmental protection, social responsibility and corporate governance into the investment and decision-making process, covering a wide range of factors that are not traditionally part of Financial Analysis but that have financial relevance. It is an investment model that achieves a win-win situation for the economy, society, and environment and is crucial for promoting sustainable and high-quality enterprise development. The ESG rating selected in this article is assigned a value of 1- 7 from CCC to AA.

7. Analysis of Risk Control Status Indicators

(1) Internal Control Index

The internal control index of this article is taken from the DiBo Database Internal Control Comprehensive Index.

(2) Financial leverage

The enterprise has significant financial risks if the financial leverage is too considerable. If the financial leverage is too tiny, the utilization rate of debt by the enterprise is too low, which affects the benefits of financial leverage.

4. Results and Discussion

4.1 KMO test and Bartlett sphericity test

To build a performance evaluation system for issuers that have heavy pollution, it is first necessary to reduce the dimensions of the 16 secondary indicators and carry out suitability tests on factor analysis. Table 2 shows the KMO value of 0.734 is greater than 0.6 which indicates suitability for factor analysis. Bartlett's test of sphericity estimates the $\chi 2$ chi-square Value of 155010.379 and Sig. value 0.000, passes the significance test. Therefore, the 16 financial performance evaluation indicators selected in this article are suitable for factor analysis.

Table 2 KMO and Bartlett tests

KMO		.734
Bartlett sphericity test	$\chi 2$ chi-square	155010.379
	Degree of freedom	120
	Significance level	.000

4.2 Factor extraction

Table 3 shows that the cumulative variance contribution level of the 5 extraction factors with eigenvalues greater than 1 reaches 70.469%. When the cumulative contribution level of the K principal components exceeds 70%, the first K principal component can be extracted. Table 3 extracted five main factors from the total variance results, with weights of 20.705%, 20.094%, 11.277%, 9.749% and 8.644% for each main factor. The total explanatory power is 70.469%. Therefore, it shows that the first five extracted common factors are appropriate and have good interpretability, and these five common factors can well reflect the original indicator data.

Table 3 Interpretation of the total variance

No.	Initial eigenvalue			Extract the sum of squares of the load			Sum of squares of rotational load		
	Total	V	A	Total	V	A	Total	V	A
1	4.633	28.954	28.954	4.633	28.954	28.954	3.313	20.705	20.705
2	2.706	16.915	45.870	2.706	16.915	45.870	3.215	20.094	40.799
3	1.630	10.187	56.056	1.630	10.187	56.056	1.804	11.277	52.076
4	1.291	8.071	64.127	1.291	8.071	64.127	1.560	9.749	61.825
5	1.015	6.342	70.469	1.015	6.342	70.469	1.383	8.644	70.469
6	.942	5.886	76.355						
7	.924	5.773	82.128						

8	.712	4.452	86.580						
9	.667	4.172	90.752						
10	.537	3.354	94.105						
11	.442	2.763	96.869						
12	.260	1.626	98.495						
13	.130	.815	99.310						
14	.056	.351	99.661						
15	.043	.267	99.928						
16	.011	.072	100.000						

Extraction method: principal component analysis method.

"V"-Variance percentage% ; "V"-Accumulated%.

By observing the rotating component matrix in Table 4, it can be observed that common factor 1 has a higher load on Y11 quick ratio, Y12 cash ratio, Y13 total operating cash to liability ratio, Y6 asset liability ratio, Y7 equity multiplier, and Y16 financial leverage. This indicates that the information on the debt risk status of common factor 1 enterprises can be named as debt risk factor, represented by F1. The financial leverage representing the risk control status is also related to the company's debt risk capability, extracted to F1; Common factor 2 has a high load on Y1 total asset net profit margin, Y2 total asset return rate, Y3 total asset turnover rate, and Y10 sustainable growth rate, representing information on the profitability of the enterprise. It can be named profit factor and represented by F2; Common factor 3 has a high load on Y4 total asset turnover and Y5 current asset turnover, indicating that common factor 4 represents information on the quality of enterprise assets and can be named as asset quality factor, represented by F3; Common factor 4 has a high load on the total asset growth rate of Y8 and the asset preservation and appreciation rate of Y9, indicating that it represents information on the business growth status of the enterprise and can be named as the business growth factor, represented by F4; The common factor 5 has a high load on the Y16ESG rating and Y15 internal control index, indicating that internal control is closely related to the sustainable development of enterprises. It can be named the sustainable development factor and represented by F5.

Table 4 Composition matrix after rotation[a]

Code	Ingredient				
	F1	F2	F3	F4	F5
Y1	.267	.885	.106	.248	.134
Y2	.176	.907	.133	.245	.107
Y3	.091	.898	.129	.277	.094
Y4	.023	.117	.887	.054	.010
Y5	-.119	.057	.902	-.050	-.027
Y6	-.872	-.166	-.067	.010	-.070
Y7	-.679	-.133	-.176	-.033	-.216
Y8	-.029	.174	-.071	.807	.173
Y9	-.014	.175	.070	.786	-.150

Y10	-.016	.552	-.093	-.119	.355
Y11	.859	.124	-.198	-.040	-.131
Y12	.834	.135	-.195	-.048	-.132
Y13	.585	.498	.036	-.172	-.098
Y14	.010	.092	-.101	-.072	.751
Y15	.052	.214	.121	.119	.677
Y16	-.431	.199	.018	-.135	-.217

Extraction method: principal component analysis method.

Rotation method: Caesar normal maximum variance method.

a. The rotation has converged after 7 iterations.

4.3 Comprehensive Score Functions for Heavy Pollution Listed Companies

The matrix of scoring coefficients of the main components of the performance of heavily polluting listed companies is shown in Table 5.

Table 5 Component score coefficient matrix

Code	Ingredient				
	F1	F2	F3	F4	F5
Y1	-.016	.285	-.015	.017	-.032
Y2	-.051	.312	-.008	.003	-.060
Y3	-.079	.317	-.015	.023	-.071
Y4	.051	-.059	.510	.018	.004
Y5	.002	-.038	.515	-.057	-.019
Y6	-.291	.077	-.078	-.019	-.054
Y7	-.242	.108	-.136	-.045	-.172
Y8	.019	-.108	-.059	.567	.110
Y9	.022	-.066	.019	.551	-.144
Y10	-.097	.237	-.110	-.207	.186
Y11	.268	-.025	-.076	.003	-.104
Y12	.257	-.014	-.078	-.007	-.107
Y13	.118	.190	.002	-.195	-.145
Y14	-.001	-.059	-.056	-.069	.581
Y15	.021	-.062	.063	.051	.507
Y16	-.200	.225	-.043	-.174	-.219

Extraction method: principal component analysis method.

Rotation method: Caesar normal maximum variance method.

Component score.

The composition score coefficient matrix in the above table has been used to output the composite coefficients of each variable. The specific values of the five main factors can be obtained based on the score coefficients in the table. The calculation formula is as follows:

$$F1= -0.016\times Y1-0.051\times Y2-0.079\times Y3+.....-0.200\times Y16$$

$$F2= 0.285\times Y1+0.312\times Y2+0.313\times Y3+.....+0.225\times Y16$$

$$F3= -0.015\times Y1-0.008\times Y2-0.015\times Y3+.....-0.043\times Y16$$

$$F4= 0.017\times Y1+0.003\times Y2+0.023\times Y3+.....-0.174\times Y16$$

$$F5= -0.032\times Y1-0.060\times Y2-0.071\times Y3+.....-0.219\times Y16$$

According to the above formula, the specific data of the five main factors can be measured. Then, based on the weight of the five main factors, the final business performance can be calculated. The weights of the five main factors are 20.705%, 20.094%, 11.277%, 9.749%, and 8.644%. The formula for calculating business performance is as follows:

$$F=(20.705\%\times F1+20.094\times F2+11.277\%\times F3+9.749\%\times F4+8.644\%\times F5) / 70.469\%$$

By calculation, the highest comprehensive score for enterprise performance is 2.167, and the lowest score is -2.042. This article has a sample of 12006 observations, of which a total of 6072 observations have negative comprehensive scores, accounting for 50.6% of the total. Although the main businesses of enterprises in heavily polluting industries are different and the competition in segmented industries is not high, it can still be seen that there is a significant difference in the performance of the companies in the sector and there is a slight imbalance in the development.

5. Conclusion

Since the 21st century, sustainable development strategies have gradually become the focus of global attention. In order for heavily polluting enterprises to survive and develop in the long term, they need to shift from the traditional economic development model of "high input, high consumption, and low efficiency" to a new economic model of "low energy consumption, low pollution, and low emissions." While pursuing economic benefits, they should also consider the protection and expansion of the ecological environment and the fulfillment of social responsibilities. Incorporating the concept of sustainable development strategy into performance evaluation work and constructing a sustainable development performance evaluation system is conducive to guiding the long-term healthy development of enterprises.

In the context of sustainable development, establishing a good performance evaluation index system for industrial enterprises that produce heavy pollution can help establish integrated performance evaluation standards for economic development, energy conservation and emission reduction, and environmental protection in industry. This will guide highly polluting enterprises to pay more attention to environmentally friendly development and contribute to promoting environmentally friendly development and the construction of ecological civilization. At the same time, based on sustainable development, heavy-polluting enterprises have effectively supplemented the research on modern sustainable development performance evaluation systems by establishing performance evaluation index systems, and related research has further expanded the perspective and ideas of sustainable development for heavy-polluting enterprises.

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