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Analysis of Eco-efficiency Based on Interactive Evaluation System of Environmental and Financial Performance

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Abstract. Green development is an important goal of enterprise strategic management. In the process of parallel development of environment and finance, is there an interactive relationship between the two? Taking enterprise A as an example, this paper constructs an interactive evaluation system of financial and environmental performance based on ecological efficiency index. Using the corresponding value-driven model, the key factors behind the change of enterprise value are explored through factor analysis, and the management activities in the future can be carried out according to local conditions.

1. The Index of Financial and Environmental Interaction Evaluation

In order to improve and harmonize the eco-efficiency index of enterprises, and to promote enterprises to report eco-efficiency in a standardized form which is more meaningful for decision makers, ISAR requires enterprises to construct eco-efficiency index which combines environmental performance and financial performance indicators from five aspects: water consumption, energy consumption, global climate warming, ozone depletion and waste. These indicators reflect the data that the enterprise should and can report, and are open targets for all industries. On this condition, Xu Xiao, Junli Wang (2006) and Ming Xie et al (2010) studied the selection of specific indicators [1]. Kun Xie (2011), Yonghong Liu et al (2012) and Qi Chen (2014) put forward a more detailed evaluation system of financial and environmental interaction according to the production characteristics of steel industry and the classification of eco-efficiency as resource efficiency, energy efficiency and environmental efficiency [2-4]. Based on previous studies and taking iron and steel enterprises as an example, this paper puts forward the eco-efficiency index system of financial and environmental performance interaction evaluation, which is shown in Table 1. Among them, the financial data take operating profit as the main evaluation index. The reason is that the influence of the ecological problem mainly comes from the process of production and operation, and the operating profit is the direct reflection of the value added in the process of production and operation. The selection of operating profit as the evaluation index of molecular financial performance is more conducive to comparability with denominator environmental performance indicators, and the selection of environmental data depends on the specific situation of ecological problems. The main ecological problems to be solved in iron and steel enterprises are the depletion of mineral and freshwater resources, the depletion of non-renewable energy sources, the global warming and other environmental pollution such as waste gas emissions. Therefore, mineral resource consumption (such as iron ore), water consumption as evaluation index, and primary energy consumption as evaluation indicators can be selected for

resource problems. Environmental problems can be selected as the evaluation index for the emissions of global warming gases (mainly CO_2), gas exhaust gas emissions and waste water emissions. Table 1 provides a framework for the interactive evaluation of finance and environment performance. Each enterprise can reasonably adjust the specific selection of each index according to its own production characteristics.

2. Models, Variable and Sample

2.1. Interpretation of Model and variable

Eco-efficiency is formally a ratio, the ratio of economic return to environmental impact, which is similar to the core element of DuPont's analysis of financial management-the return on net assets [5]. Therefore, following the model of DuPont analysis, Figge and Hahn (2013) proposed the "DuPont" model of eco-efficiency, that is, the financial and environmental interaction evaluation model [6]:

$$EE = SM \times TAT \times EL = ROA \times EL \quad (1)$$

The model decomposes eco-efficiency into three factors: sales profit margin (SM), total asset turnover ratio (TAT) and ecological leverage (EL). Sales profit margin is profit/income (SM) reflects the profitability of the enterprise, is the driving force of shareholder value. The total asset turnover ratio (TAT) is the sales income/total assets, reflecting the solvency of the enterprise and the driving force of the creditor's value. The combination of two factors reflects the efficiency of enterprise economic resources, that is, the rate of return on assets (ROA). The third factor is El, which are the total assets/ecological impact. From the perspective of sustainable development, the relationship between economic resources and environmental resources is the driving force of sustainable value. On the whole, this model describes the interaction between financial capital and environmental resources. Under the premise of relatively stable economic capital, low ecological efficiency will bring more resources consumption. Compared with the traditional DuPont model, the new DuPont model provides a common solution of economic and environmental factors to meet the needs of sustainable development. Further, through factor analysis, the main source of the improvement of enterprise ecological efficiency can be found.

2.2. Sample Selection and Data Processing

Considering the characteristics of industry pollution, environmental management system and the integrity of information disclosure, this paper chooses the relevant data of enterprise A as the research sample. The ratings cited from Runling's Global CSR rating system for the five-year period 2012-2016 are ranked first in the industry for the fifth year in a row.

(1) According to the index system in Table 1, the consumption of mineral resources in iron and steel enterprises is mainly iron ore, and the consumption of fresh water resources is the use of raw water. Energy consumption mainly includes coal, natural gas and electricity purchased out of the country, which are measured as primary energy consumption. Environmental impact on global warming is mainly measured by CO_2 emissions, other emissions are mainly SO_2 and smoke dust. Solid and liquid wastes are mainly pollutants discharged from wastewater, including codons, oils and ammonia nitrogen.

(2) With regard to the processing of specific sample data, environmental indicators refer to the general principles for the calculation of GB/T2589-2008 comprehensive energy consumption in China and the usage of natural gas, coal and electricity is converted into kilowatt-hour units, and natural gas and coal are converted according to European primary energy requirements. Conversion of electrical energy to non-renewable primary energy inputs (in kilowatt-hours) based on a factor of 1.27, 1.20, 3.07 and further conversion of carbon dioxide emissions (per kilogram) based on a factor of 0.069, 0.133, 0.14, based on primary energy, Furthermore, the sum of the enterprise as a whole, the primary energy consumption and carbon dioxide emissions. In the aspect of financial index, it comes from the

requirements of DuPont analysis model, and selects total assets, operating income and operating profit as indicators to observe the interaction between finance and environment.

Table 1. The Eco-efficiency Index system of Financial and Environmental interaction Evaluation.

Classification		Ecological Problems	Index
Ecological Efficiency	Resource	Mineral resource consumption	Operating profit / consumption of mineral resources (billions of yuan / 10,000 tons)
		Depletion of freshwater resources	Operating profit / water consumption (billions of yuan / 10,000 tons)
	Energy	Depletion of non-renewable energy sources	Net profit / operating profit / primary energy consumption (billions of yuan / billions of kWh)
	Environment	Global warming	Operating profit / global warming gas emissions (billions of yuan / 10,000 tons)
		Other emissions	Operating profit / other emissions (billions of yuan / ton)
		Solid and liquid waste disposal	Operating profit / pollutants in wastewater (billions of yuan / ton)

3. Results

Refer to the financial report and sustainable development report of a enterprise for 2013-2016, and obtain the basic data on financial and environmental indicators, which are summarized in Table 2. Based on the above mentioned indicator system, a corporate financial and environmental interaction evaluation system for 2013-2016 is obtained, as shown in Table 3. It should be noted that eco-efficiency indicators have units.

Table 2. Financial and Environmental indicators Enterprise A.

Year	2013	2014	2015	2016
Iron ore (10,000 tons)	3144.14	3440	3898	3301.6
Raw water (10,000 tons)	11500	10200	9200	9100
Natural gas usage (billions of kWh)	52.87	21.25	22.63	31.33
Coal usage (billions of kWh)	947.19	952.70	904.23	883.84
Electricity usage (billions of kWh)	230.56	202.27	219.05	204.90
Primary energy consumption (billions of kWh)	1911.59	1791.20	1786.28	1729.45
CO_2 emissions (10,000 tons)	1618.86	1612.73	1542.53	1504.60
SO_2 emissions (tonnes)	15099	11751	9410	8174
Smoke dust (tons)	12306	11035	10298	9790
Other emissions (tonnes)	27405	22786	19708	17964
COD emissions (tonnes)	699	636	591	579
Oil emissions (tonnes)	19	24	17	15
Ammonia nitrogen emissions (tonnes)	48	35	30	30
Pollutants in wastewater (tons)	766	695	638	624
Operating income (billions of dollars)	2225.05	1911.36	1896.88	1874.14
Operating profit (billions of dollars)	88.39	35.97	76.84	76.41
Total assets (billions of dollars)	2311.00	2143.57	2266.68	2286.53

Table 3. Financial and Environmental Interactive Assessment system for Enterprise A.

Ecological problems	Ecological efficiency index	2013	2014	2015	2016
Mineral wealth	Operating profit / consumption of mineral resources (billions of yuan / 10,000 tons)	2.81%	1.05%	1.97%	2.31%
The depletion of fresh water resources	Operating profit / original water quantity (billions of yuan / 10,000 tons)	0.77%	0.35%	0.84%	0.84%
Non-renewable source	Operating profit / Primary Energy (billions of KWh)	4.62%	2.01%	4.30%	4.42%
Global warming	Operating profit / CO_2 emissions (billions of yuan / 10,000 tons)	5.46%	2.23%	4.98%	5.08%
Other emissions	Operating profit / other emissions (billions of yuan / ton)	0.32%	0.16%	0.39%	0.43%
Solid liquid waste disposal	Operating profit / pollutant in waste water (billion yuan / ton)	11.54%	5.17%	12.04%	12.24%

It can be found that eco-efficiency, an interactive evaluation index of financial and environmental performance is more comprehensive. In order to explore the deeper relationship between finance and environmental information, formula (1) is decomposed into the following model.

$$\text{Eco-Efficiency} = \frac{OP}{Emissions} = \frac{OP}{Sales} \times \frac{Sales}{T.A} \times \frac{T.A}{Emissions} \quad (2)$$

We use the model to compare and decompose the factors at the financial and environmental levels, and take the ecological problem of global warming as an example to illustrate its general method.

Table 4. Interactions-CO_2 efficiency.

Year	CO_2 efficiency	NPM	TAT	ROA	EL
2013	5.46%	3.97%	96.28%	3.82%	1.43
2014	2.23%	1.88%	89.17%	1.68%	1.33
2015	4.98%	4.05%	88.49%	3.58%	1.39
2016	5.08%	4.08%	81.96%	3.34%	1.52

Combined with the data from Table 2, global warming performed fairly well in 2013-2016, with poor economic performance. What are the causes? We explained by factor analysis.

Compared 2016 with 2015, the influence of factors on ecological efficiency can be quantitatively analyzed by the method of serial substitution. (1) Impact of changes in sales margins: CO_2 efficiency of 2015 based on sales margins on 2016=4.08%*88.49%*1.39=5.02% and the influence of CO_2 efficiency on sales profit margin=5.02%－4.98%=+0.04%; (2) Impact of changes in asset turnover: 2015 CO_2 efficiency calculated on the basis of sales margins on asset turnover of 2016=4.08%*81.96%*1.39=4.65% and the impact of changes in the turnover of assets=4.65%－5.02%=－0.37%; (3) Impact of carbon leverage changes: 5.08%－4.65%=+0.43%.

We found that the most negative factor is the reduction in asset turnover, the most favorable factor is the increase in carbon leverage, followed by the increase in sales margins which clearly outweighed the negative factor. Similarly, decompose CO_2 efficiency of 2014-2015, the most adverse factor is asset turnover, the most favorable factor is sales profit margin followed by the increase of carbon leverage; in 2013-2014, the most negative factor was the decline in sales margins, followed by lower asset turnover and lower carbon leverage. Overall, the performance of the assets turnover rate is not good which needs to be paid attention; CO_2 efficiency varies with sales margins; carbon leverage is relatively stable. Then the other ecological problems are decomposed one by one according to the

above method. The trends in the financial and environmental performance of the two ecological problems of mineral resources and non-renewable energy are consistent with those of global warming; Among the three ecological problems of freshwater resources, other exhaust emissions and solid and liquid waste disposal, the effects of changes in financial performance on ecological efficiency are similar to those in global warming, while environmental performance is better. Environmental leverage has a positive effect on ecological efficiency. Therefore, in the coming year, enterprise A needs to focus on the problem of insufficient turnover of assets in financial efficiency which is related to the possibility of a company's ability to repay its debts and maintain the stability of the profit margin of sales which is related to the stability of the profitability of the enterprise. At the same time, continue to take advantage of environmental lever.

4. Conclusion

In fact, it is not enough to disclose the enterprise management information only through the financial performance. The eco-efficiency index should be used to comprehensively reflect the business situation of the enterprise. It brings the financial information and the environmental information into the same quantitative scope. If the ecological efficiency is regarded as the original point, what this paper does is to prove the validity and feasibility of the origin and the scope of research around the origin is very wide in the future, such as the selection of eco-efficiency financial indicators, not all indicators in the financial statements are optional, which indicators are optional and what are the selection criteria.

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