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Comprehensive ESG Score and Financial Performance of Carbon-Neutral Concept Enterprises

—Based on Entropy Weight-TOPSIS and Grey Relational Analysis

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Abstract

Based on entropy weight-TOPSIS and Grey Relational Analysis, the Bloomberg ESG indicator system is reconstructed, and the impact of the optimized ESG score on the financial performance of the carbon-neutral concept enterprise is studied. The results show as follows. 1) The relative importance of environment (E), society (S) and governance (G) will change with time and the objects being evaluated. Generally, society (S) has the highest importance. 2) There is a time-lag effect on the impact of ESG scores on financial performance. The latter worsens in the short term due to the high investment cost of ESG and improves in the long term due to the improvement of corporate image and reputation. 3) The results of heterogeneity analysis show that the impact of ESG score on the financial performance of an enterprise is related to the regional economic development level and the relative carbon emission intensity.

Keywords

Entropy Weight-TOPSIS, Grey Correlation Analysis, Carbon Neutralization, Comprehensive ESG Score, Financial Performance

1. Introduction

ESG (Environment, Social Responsibility, Corporate Governance) is the basis of socially responsible investment and an important part of the green finance. At present, the ESG concept has become a national consensus: from the perspective of the government, ESG has been included in the policy formulation process to

help the traditional industrial restructuring and carbon emission reduction; from the perspective of financial supervision, a unified ESG industry information disclosure standard is being constructed; from the perspective of financial institutions, ESG is being included in the whole credit process to promote financial support to lean towards low-carbon projects and enterprises. Therefore, the fulfillment of corporate ESG responsibilities is a key link in the achievement of China's "dual carbon goals" and the sustainable development of the whole society. Capital investment related to ESG will also have an impact on corporate market performance and financial performance.

At present, a number of domestic and foreign studies related to this topic have been carried out, and most of them focus on the three subdivision dimensions of E, S, and G. In terms of environment, Yin et al. (2020) used the data of 159 listed companies to analyze the impact of environmental performance on the financial performance of heavily polluting companies based on institutional theory and stakeholder theory and found that heavy polluting companies often choose to sacrifice the environment to improve financial performance, and the larger the enterprise scale, the smaller the negative impact of environmental performance on financial performance; Chang & Lee (2022) points out the importance of the industrial environment surrounding the company in enhancing firm value through ESG activities. In terms of society, by studying the data of 67 large American companies, Preston & O'Bannon (1997) pointed out that there is a significant positive correlation between corporate social responsibility performance and financial performance indicators; Mulchandani et al. (2022) find that timely information disclosures create long-term value for investors and build investors' confidence. In terms of governance, by constructing a CGI index system and a corporate value measurement model, Liu & Zhu (2011) proposed that the impact of corporate governance on the short-term performance of a company is more significant than the corporate value that reflects long-term performance; Wu et al. (2022) find that executive institutional ownership positively and significantly affect firm value. However, investment in environmental protection by enterprises is a manifestation of fulfilling their social responsibilities, and enterprises with sound governance structures and a strong sense of social responsibility tend to have higher environmental protection qualities. Therefore, the three subdimensions of the ESG evaluation system are interrelated and need to be viewed comprehensively (Gigante & Manglaviti, 2022; Wanday & Ajour El Zein, 2022; Wen et al., 2022; Wang & Hu, 2022; Wang et al., 2022).

Bloomberg is the world's leading provider of business and financial information. In terms of ESG ratings, it has a professional analyst team covering many companies and a wide range of data sources. It is authoritative to use the ESG data disclosed by it. Based on the Bloomberg ESG rating score, Li (2021) studies the impact of ESG performance on corporate idiosyncratic risks, Zhao (2021) conducts empirical research on a full-sample stock portfolio, etc. However, the Bloomberg ESG indicator system (shown in **Table 1**) assigns same weights (all

Table 1. Bloomberg ESG indicator system.

Pillar (Weight)	Main topics
Environmental (33%)	Air Quality
	Climate Change
	Ecological & Biodiversity Impacts
	Energy
	Materials & Waste
	Supply Chain
	Water
Social (33%)	Community & Customers
	Diversity
	Ethics & Compliance
	Health & Safety
	Human Capital
	Supply Chain
Governance (33%)	Audit Risk & Oversight
	Board Composition
	Compensation
	Diversity
	Independence
	Nominations & Governance Oversight
	Sustainability Governance
	Tenure

33%) to the three first-level indicators, which actually has a certain degree of subjectivity. Therefore, the weighting method needs to be optimized, and the relative importance of indicators should be adjusted according to changes in time and specific evaluation objects.

As a hot spot in China, ESG is compatible with the goal of carbon neutrality. On the one hand, it can guide the realization of carbon neutrality and satisfy huge financing needs. On the other hand, it can be transmitted from the investment level to the business operation level, forcing companies to decarbonize and reduce carbon emissions. At present, many traditional high-carbon enterprises start their green transformation, increasing ESG-related investment and improving their market presence. Shenzhen Energy has invested billions of yuan to carry out energy-saving and emission reduction technical transformation for existing coal-fired units, and has completed the goal of ultra-low emission transformation, making an important contribution to improving the quality of the atmospheric environment. Huaneng Power International is the world's largest listed thermal power enterprise. In recent years, its proportion of new energy invest-

ment has increased rapidly, and the installed capacity growth rate is leading in the industry. Chenming Paper has cooperated with professional institutions to develop carbon sinks on the basis of its own forest land, giving full play to the advantages of the whole industrial chain and taking the road of circular economy. However, previous studies have paid less attention to these companies.

Based on the above analysis, this article will reconstruct the Bloomberg ESG index system and study the impact of the optimized ESG comprehensive score on the financial performance of carbon-neutral concept companies, so as to evaluate the value of their green transformation.

2. Research Methods and Empirical Analysis

2.1. Sample Selection and Data Sources

To ensure the integrity of data and the reliability of research results, sample selection and data preprocessing mainly follow the following steps (summarized in Figure 1).

First of all, taking the carbon-neutral concept stocks in iFinD as the research object, 50 stocks with the highest average market capitalization in the past two years are selected to form a stock pool;

Secondly, from the Bloomberg ESG database, the historical data of the companies corresponding to the above stocks are screened out, companies with discontinuous scoring years and incomplete scoring data are eliminated, 16 companies were finally left as research samples;

Finally, the annual financial data (return on total assets, return on equity, etc.) of the above companies are obtained from iFinD database.

2.2. Reconstruction of the ESG Primary Indicator System

First of all, based on the above discussion, Bloomberg's weighting of the indicator system is subjective, so an objective weighting method is used. In the entropy weight method, entropy refers to the uncertainty of information. The greater the variance between the data within an indicator, the greater its impact on the comprehensive evaluation and its weight.

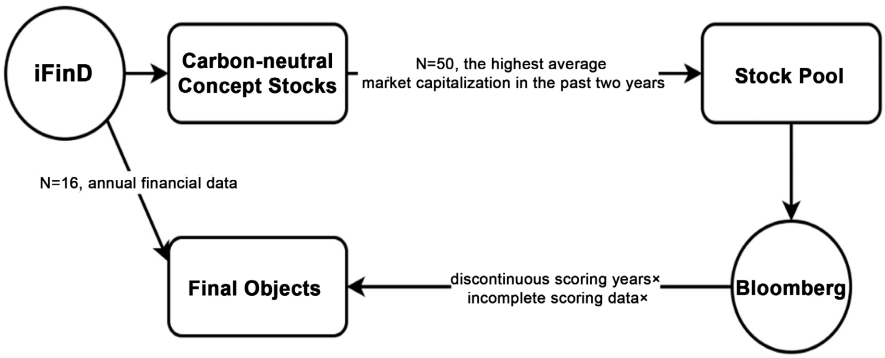

Figure 1. Funnel chart for data filtering.

1) The entropy weight method assumes that there is an m evaluation object, each object has n indicators, and x_{ij} is the actual value:

$$T = \left(x_{ij}\right)_{mn},\ i = 1, 2, \cdots, m;\ j = 1, 2, \cdots, n$$

2) Matrix T can be transformed to a standardized matrix S. The formula for positive indicators is the left, and that for negative indicators is the right.

$$S_{ij} = \frac{x_{ij} - x_{\min}}{x_{\max} - x_{\min}};\ S_{ij} = \frac{x_{\max} - x_{ij}}{x_{\max} - x_{\min}}$$

3) Matrix U can be transformed to a normalized matrix U. e is the entropy value of an indicator and W is it's the entropy weight.

$$e_j = \left(-\frac{1}{\ln m}\right)\sum_{i=1}^{m} U_{ij} \ln U_{ij};\ W = w_j = \frac{1 - e_j}{n - \sum_{j=1}^{n} e_j}$$

Entropy weights of the indicators for each year are summarized in the **Table 2** below. It can be seen that, except for 2014 when the weight of environment was relatively low, the rest were around 30%; except for 2012 when the weight of society was relatively low, the rest were around 40%; except for 2012 and 2014 when the weight of governance was relatively high, the rest were around 30% and most of them were lower than the weight of environment. Therefore, it can be concluded that in the ESG comprehensive evaluation system based on carbon-neutral enterprises, the importance of the three dimensions (E, S and G) is different and will change over time. Historical data shows that the order of importance is generally S > E > G, indicating that companies with a strong sense of social responsibility often have a good governance structure and a strong awareness of environmental protection.

2.3. Calculation of the New ESG Score

After obtaining the weights, it is necessary to use evaluation methods to integrate the indicators so as to obtain a new ESG score. The following methods can be used.

First, the TOPSIS method, which is an effective multi-indicator evaluation method. the calculation steps are as follows.

1) The normalized matrix U and the weighting result are combined into a weighted matrix C;

2) The maximum value of each indicator form the optimal ideal solution $C_{+} = \left(c_1^{+}, c_2^{+}, \cdots, c_n^{+}\right)$;

3) The minimum value of each indicator form the worst ideal solution $C_{-} = \left(c_1^{-}, c_2^{-}, \cdots, c_n^{-}\right)$;

4) The distance of each object to the optimal and worst ideal solutions is calculated;

5) The relative proximity of each object to the best and worst solution is calculated.

Table 2. Weighting results of entropy weight method.

years	E.	S	G	years	E.	S	G
2011	0.2901	0.4427	0.2672	2016	0.3331	0.3485	0.3184
2012	0.3369	0.2903	0.3728	2017	0.2819	0.4532	0.2649
2013	0.2852	0.4089	0.3059	2018	0.3522	0.3939	0.2539
2014	0.2261	0.3769	0.3970	2019	0.3298	0.4302	0.2400
2015	0.2952	0.3762	0.3286	2020	0.3301	0.4300	0.2399

$$S_i^+ = \sqrt{\sum_{j=1}^{n}\left(C_{ij} - C_j^+\right)^2};\ S_i^- = \sqrt{\sum_{j=1}^{n}\left(C_{ij} - C_j^-\right)^2};\ E_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Second, the Gray Relational Analysis. The calculation steps are as follows.

1) Matrix T is carried out logarithm dimensionless to obtain matrix $D = \left(D_{ij}\right)_{nm}$, in which the maximum value of each indicator is 100, and the minimum value is 60;

2) Matrix T can be transformed to matrix K, the maximum value of each indicator is taken as the ideal value D_{ideal};

$$K_{ij} = \frac{D_{ij}}{D_{j_{ideal}}} \times 100\%$$

3) The difference sequence and the correlation coefficient matrix ξ are calculated, where ρ is the resolution coefficient (here is 0.5), the maximum difference $\Delta_{\max}$ is $|0.6-1| = 0.4$ and the minimum difference $\Delta_{\min}$ is $|1-1| = 0$;

$$\Delta_{ij} = \left|K_{ij} - K_{j_{ideal}}\right|;\ \xi_{ij} = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{ij} + \rho\Delta_{\max}}$$

4) Matrix ξ is combined with the entropy weighting result for final evaluation.

In addition, since two evaluation methods are used, together with the original Bloomberg ESG comprehensive score, a total of three scoring results are produced, so the consistency of the three methods should be further tested by using the Kendall synergy coefficient test method. The left and right are the calculation formulas for the number of evaluation objects less than and greater than 7, respectively, where m is the number of evaluation methods, n is the number of evaluation objects, and R refers to the sum of ranks of a certain evaluation object under all evaluation methods. The average synergy coefficient from 2011 to 2020 is 0.8774 (which is close to 1), indicating that the three evaluation results are statistically consistent.

$$W = \sum_{i=1}^{n} R_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} R_i\right)^2;\ W = \frac{12\sum_{i=1}^{n} R_i^2 - 3m^2 n\left(n+1\right)^2}{m^2 n\left(n^2-1\right)}$$

Due to space limitations, only the scoring and ranking results of 2020 are listed here (The ranking results of previous years are listed in the Table A1). As

can be seen from the Table 3 below, most of the companies with higher comprehensive scores are traditional high-carbon companies (For example, under the GRA method, Shenzhen Energy, Power Construction of China, Chenming Paper and Huaneng Power International rank first to fourth respectively), indicating that they have actively responded to the national policy of "double carbon" as well as increased environmental protection investment, improved the corporate governance structure and enhanced the sense of social responsibility.

2.4. Influence of ESG Comprehensive Score on Financial Performance

After obtaining the optimized ESG comprehensive score, the following steps can be followed to explore the impact of carbon-neutral companies' ESG performance on their financial performance.

First, variable selection. Select the comprehensive ESG score (obtained by the entropy weight-TOPSIS method) as the explanatory variable, the company's return on total assets (ROA) as the explained variable, and select the logarithm company's size LNV and logarithm macroeconomic conditions LNGDP as the control variables. The size of the company is usually positively correlated with the financial performance of the company. The larger the size of the company, the more its investment in ESG, the higher possibility can it refine its public image and improve its economic benefits.

Second, collinearity test. The calculated average value of the variance inflation factor VIF is 1.12, so there is no multicollinearity problem among variables.

Third, model building. Liu et al. (2022) point out that there is a complex relationship between environmental, social, and governance (ESG) and corporate financial performance (CFP). Qu (2022) finds that as companies invest more in ESG, their current ESG scores will increase, but there may be differences in short-term and long-term impacts on financial performance. In the short term, the increase in ESG investment will increase the total cost of the company in the current period, which may have a negative impact on its short-term ROA; in the

Table 3. Comparison of comprehensive evaluation results (2020).

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	**1**	**4**	**3**	Shaangu Power	11	12	12
Power Construction of China	**4**	**2**	**1**	**Chenming Paper**	**2**	**3**	**5**
Shenzhen Energy	**3**	**1**	**2**	Zhongtian Finance	13	16	16
Shanghai Construction Engineering	10	10	11	Financial Street	14	15	15
Yuntianhua	**5**	**5**	**6**	State Grid Yingda	7	8	8
Hainan Rubber	9	9	9	Tielong Logistics	7	6	4
Zhongtai Chemical	**6**	**7**	**7**	TEDA Business	12	11	10
CNPC	15	13	13	Urban Development Environment	15	14	14

long run, the increase in ESG investment can improve the market image of the company, enabling it to obtain more high-quality resources, which is conducive to improve financial situation. Therefore, the regression containing lagging periods of ESG is constructed.

$$ROA_{i,t} = \beta_0 + \beta_1 ESG_{i,t-k} + \beta_2 LNV_{i,t} + \beta_3 LNGDP_{i,t} + \varepsilon_{i,t},\ k = 0,1,2,\cdots$$

Fourth, robustness test. Return on net assets (ROE) is used to reconduct the above regression model to see if similar empirical conclusions are obtained.

Fifth, heterogeneity analysis. The 16 enterprises can be classified according to the following two aspects. On the one hand, according to their location, they can be divided into two categories: Beijing, Shanghai, Guangdong and other provinces; On the other hand, according to the relative intensity of carbon emissions of their traditional businesses, they can be divided into "low-carbon" group (finance, transportation, wholesale, etc.) and "high-carbon" group (thermal power, construction, chemical, etc.). By grouped regression, the relationship between the ESG scores of different types of enterprises and their financial performance can be examined.

Sixth, impulse response analysis. Furthermore, the 16 companies can be considered as a whole, and the VAR model can be built to explore the impact of their average ESG performance on their average financial performance in the past decade.

Steps 3 to 5 require regression analysis based on panel data. The Hausman test result shows that the P value is 0.0062, so the null hypothesis is rejected and the fixed effect model is used. The empirical results of the above modeling process are summarized in Table 4 (The values in the table are regression coefficients, and *, **, *** represent significance at the 1%, 5%, and 10% levels, respectively).

First, there is a significant negative correlation at the 10% level between the current ESG score and the current ROA. With the increase in the number of ESG lag periods, although the coefficient is not obvious, it starts to turn from negative to positive until the fourth period shows a significant positive correlation. The robustness test is performed by replacing ROA with ROE, and similar results are obtained. This proves the correctness of the assumptions of the original model, that is, there are time differences in the impact of ESG scores on financial performance: in the short term, companies' investment in ESG has improved their scores, but higher costs have also reduced profitability. In the long run, high ESG score has established a positive image of the company in the market and attracted investments, thereby improving financial performance.

Secondly, from the results of location heterogeneity analysis, with the increase of the lag period, the ESG coefficients of carbon-neutral enterprises in Beijing, Shanghai, and Guangdong turn from positive to negative, and the ESG coefficients of other enterprises change from negative to positive, indicating that the impact of ESG investment on financial performance is related to reginal economic development level. The ROA of carbon-neutral enterprises located in first-tier cities is affected by more factors, and the influence mechanism of investment

Table 4. Regression coefficients and significance.

Model		ESG	Model		ESG
ROA	t	−4.1340*	ROE	t	−11.6403
	t-1	−3.6728		t-1	−10.8381
	t-2	2.1648		t-2	21.9927
	t-3	1.0322		t-3	4.1828
	t-4	6.6320***		t-4	31.0345**
B, S, G	t	1.6115	other provinces	t	−6.6692*
	t-1	2.5719		t-1	−6.2573*
	t-2	2.0212		t-2	2.0483
	t-3	0.8441		t-3	0.4294
	t-4	−0.6752		t-4	10.8527***
low-carbon	t	−4.6889	high-carbon	t	−4.5683*
	t-1	−2.9497		t-1	−4.4066*
	t-2	−1.7727		t-2	3.0247
	t-3	4.7445		t-3	−0.4509
	t-4	3.8808		t-4	6.2485***
B, S, G + low-carbon		−2.1481	other provinces + low-carbon		−5.0675*
B, S, G + high-carbon		−3.1204	other provinces + high-carbon		−5.5443**

on ROA is more complex, so the effect of a single ESG investment on the improvement of financial performance is not obvious, too much emphasis on evaluating ESG score while ignoring other factors will have a negative impact on the long-term financial status of the company.

Finally, from the results of the heterogeneity analysis of corporate attributes, with the increase in the number of ESG lag periods, the coefficients of both "low-carbon" and "high-carbon" companies turn from positive to negative, but the former is not significant all the time, and the latter is significant in both the short term (current period + lag one period) and the long-run (lag four periods). This phenomenon indicates that the green transformation of relatively low-carbon enterprises is less difficult and requires less investment, so the short-term suppression and long-term improvement of ESG investment on financial performance are not as obvious as those of high-carbon enterprises.

Step six requires the construction of a vector autoregressive model for impulse response analysis.

First of all, the ADF test is used to test the stationarity of the two-time series. According to the test results, at the 10% level, the first-order difference of ESG and ROA series have passed the stationarity test, so the two are in the same order (Table 5).

Table 5. Unit root test results.

Variable	ADF statistic	p-value	Stationarity
DESG	−3.7784	0.0275	yes
DROA	−3.0703	0.0752	yes

Secondly, the co-integration of the two is tested, and the Johansen method is used. The p-value was 0.5737, which is not significant and means that there is no co-integration relationship.

Third, the Granger causality test shows that at the 10% level, DESG is the one-way Granger cause of DROA, indicating that changes in the average comprehensive ESG scores of carbon-neutral companies lead to changes in their average financial performance (Table 6).

Finally, the impulse response is plotted. It can be seen from Figure 2 that when the ESG score rises, ROA will decline in the short term after being impacted and then rise again, indicating that the improvement of ESG performance of carbon-neutral enterprises will worsen their financial status in the short term, but will improve their financial performance in the long run. It is consistent with the previous research conclusions.

3. Conclusion and Suggestions

3.1. Conclusion

This paper reconstructs the Bloomberg ESG index system based on entropy weight-TOPSIS and Gray Relational Analysis, and studies the impact of the optimized ESG comprehensive score on the financial performance of carbon-neutral companies. Conclusions are drawn as follows.

First, there is a time-lag effect on the impact of ESG scores on financial performance. In the short term, maintaining good ESG performance tends to worsen financial status due to increased costs, but in the long run, ESG investment will help companies improve their reputation, attract better resources and thereby improving financial performance.

Second, the impact of ESG investment on financial performance is related to the level of regional economic development. The ROA of enterprises in areas with high economic development level is affected by more factors, single ESG investment has no obvious effect on improving financial performance, and too much emphasis on ESG while ignoring other factors will actually affect the long-term financial performance.

Third, compared with "high-carbon" enterprises, the green transformation of relatively "low-carbon" enterprises is less difficult. Therefore, the short-term and long-term impacts of ESG investment on financial performance are not obvious.

3.2. Recommendations

Firstly, the government can promote the establishment of a comprehensive ESG-

Table 6. Granger causality test.

Null hypothesis	F-statistic	p-value	Result
DROA is not the Granger reason for DESG	1.0339	0.3559	accept
DESG is not the Granger reason for DROA	6.5605	0.0506*	reject

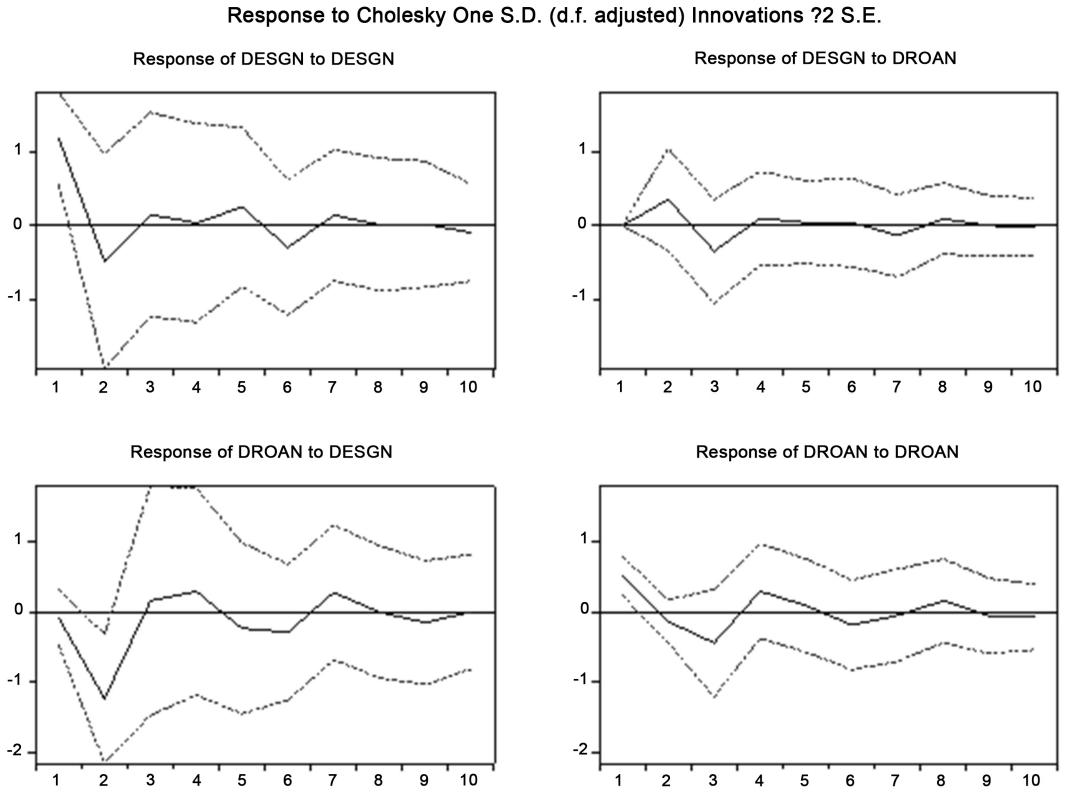

Figure 2. Impulse response analysis.

supporting reward and punishment mechanism. For example, according to the ESG performance of enterprises, incentive policies such as green credit concessions and tax reductions can be implemented for enterprises with good ESG performance, and credit for enterprises with poor performance can be reduced. The government needs to compensate companies for the short-term losses caused by green transformation and ESG investment, so that companies will be more motivated to ESG investment and more willing to adhere to sustainable development strategies.

Secondly, enterprises need to pay attention to the coordination between the external economic environment and their internal development, improve the ability to use reginal advantages and learn from comprehensive risk management ideas to better integrate the ESG framework into the corporate strategic decision-making.

Finally, enterprises should increase their enthusiasm for green transformation and awareness of ESG information disclosure. On the one hand, "low-carbon"

enterprises have fewer difficulties in green transformation than "high-carbon" ones, so they are able to obtain financing advantages at a lower cost by disclosing their good performance in the environment, social responsibility and corporate governance. On the other hand, although the green transformation of "high-carbon" enterprises is more difficult, actively improving the transparency of ESG information disclosure can demonstrate their consistent ESG efforts to shareholders, which is of great help to improve market image and social reputation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Chang, Y. J., & Lee, B. H. (2022). The Impact of ESG Activities on Firm Value: Multi-Level Analysis of Industrial Characteristics. *Sustainability, 14,* Article 14444. https://doi.org/10.3390/su142114444

Gigante, G., & Manglaviti, D. (2022). The ESG Effect on the Cost of Debt Financing: A Sharp RD Analysis. *International Review of Financial Analysis, 84,* Article ID: 102382. https://doi.org/10.1016/j.irfa.2022.102382

Li, B. J. (2021). *Research on the Impact of ESG Performance on Corporate Idiosyncratic Risk*. Master's Thesis, Harbin Institute of Technology. (In Chinese) https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202201&filename=1021901756.nh

Liu, P. D., Zhu, B. Y., Yang, M. Y. & Chu, X. (2022). ESG and Financial Performance: A Qualitative Comparative Analysis in China's New Energy Companies. *Journal of Cleaner Production, 379,* Article ID: 134721. https://doi.org/10.1016/j.jclepro.2022.134721

Liu, Y. G., & Zhu, L. (2011). An Empirical Study of Correlation between Corporate Governance and Corporate Value. *Management Review, 23,* 45-52. (In Chinese) https://doi.org/10.14120/j.cnki.cn11-5057/f.2011.02.006

Mulchandani, K., Mulchandani, K., Iyer, G., & Lonare, A. (2022). Do Equity Investors Care about Environment, Social and Governance (ESG) Disclosure Performance? Evidence from India. *Global Business Review, 23,* 1336-1352. https://doi.org/10.1177/09721509221129910

Preston, L. E., & O'Bannon, D. P. (1997). The Corporate Social-Financial Performance Relationship. *Business & Society, 36,* 419-429. https://doi.org/10.1177/000765039703600406

Qu, H. X. (2022). *Research on the Impact of Environment, Society and Corporate Governance (ESG) on the Financial Performance of Commercial Banks*. Master's Thesis, Inner Mongolia University of Finance and Economics. (In Chinese) https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202202&filename=1022514045.nh

Wanday, J., & Ajour El Zein, S. A. (2022). Higher Expected Returns for Investors in the Energy Sector in Europe Using an ESG Strategy. *Frontiers in Environmental Science, 10,* Article ID: 1031827. https://doi.org/10.3389/fenvs.2022.1031827

Wang, W. B., Yu, Y. Y., & Li, X. (2022). ESG Performance, Auditing Quality, and Investment Efficiency: Empirical Evidence from China. *Frontiers in Psychology, 13,* Article

ID: 948674. https://doi.org/10.3389/fpsyg.2022.948674

Wang, X. P., & Hu, S. C. (2022). Can Performance-Based Budgeting Reform Improve Corporate Environment in ESG? Evidence from Chinese-Listed Firms. *Frontiers in Environmental Science, 10,* Article ID: 982160. https://doi.org/10.3389/fenvs.2022.982160

Wen, H., Ho, K.C., Gao, J. J., & Yu, L. (2022). The Fundamental Effects of ESG Disclosure Quality in Boosting the Growth of ESG Investing. *Journal of International Financial Markets, Institutions & Money, 81,* Article ID: 101655. https://doi.org/10.1016/j.intfin.2022.101655

Wu, S. Y., Li, X. Y., Du, X. S., & Li, Z. X. (2022). The Impact of ESG Performance on Firm Value: The Moderating Role of Ownership Structure. *Sustainability, 14,* Article 14507. https://doi.org/10.3390/su142114507

Yin, J. H., Wang, S., & Gong, L. D. (2020). Research on the Relationship between Environmental Performance and Financial Performance of Heavily Polluting Firms: The Joint Moderating Effects of Firm Characteristics and Environmental Information Disclosure Scientific. *Research Management, 41,* 202-212. (In Chinese) https://doi.org/10.19571/j.cnki.1000-2995.2020.05.021

Zhao, S. T. (2021). *ESG Responsible Investment Research in China's Stock Market*. PhD Thesis, Graduate School of Chinese Academy of Social Sciences. (In Chinese) https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CDFDLAST2021&filename=1021615459.nh

Appendix

Table A1. Comparison of comprehensive evaluation results (2011-2019).

2011

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	2	3	3	Shaangu Power	4	4	4
Power Construction of China	6	7	10	Chenming Paper	16	8	7
Shenzhen Energy	8	10	9	Zhongtian Finance	15	16	16
Shanghai Construction Engineering	6	11	11	Financial Street	9	8	7
Yuntianhua	1	2	1	State Grid Yingda	5	5	5
Hainan Rubber	10	12	13	Tielong Logistics	13	14	14
Zhongtai Chemical	3	1	2	TEDA Business	12	6	6
CNPC	14	15	15	Urban Development Environment	11	13	12

2012

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	2	2	2	Shaangu Power	4	5	4
Power Construction of China	6	4	5	Chenming Paper	15	10	10
Shenzhen Energy	11	13	13	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	7	9	9	Financial Street	9	11	11
Yuntianhua	7	7	7	State Grid Yingda	5	6	6
Hainan Rubber	1	3	1	Tielong Logistics	11	8	8
Zhongtai Chemical	2	1	3	TEDA Business	13	12	14
CNPC	14	15	15	Urban Development Environment	10	14	12

2013

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	3	5	5	Shaangu Power	7	7	8
Power Construction of China	5	4	4	Chenming Paper	12	13	13
Shenzhen Energy	8	9	9	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	8	11	12	Financial Street	11	12	11
Yuntianhua	6	6	6	State Grid Yingda	4	3	3
Hainan Rubber	1	2	2	Tielong Logistics	12	14	14
Zhongtai Chemical	2	1	1	TEDA Business	14	8	7
CNPC	15	15	15	Urban Development Environment	8	10	10

2014

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	4	4	5	Shaangu Power	6	5	6
Power Construction of China	2	1	2	Chenming Paper	10	6	7

Continued

Shenzhen Energy	7	12	11	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	11	14	14	Financial Street	14	15	15
Yuntianhua	7	9	10	State Grid Yingda	3	3	3
Hainan Rubber	1	2	1	Tielong Logistics	14	13	13
Zhongtai Chemical	5	7	4	TEDA Business	12	10	9
CNPC	13	11	12	Urban Development Environment	7	8	8

2015

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	8	10	9	Shaangu Power	6	6	6
Power Construction of China	1	1	1	Chenming Paper	8	7	8
Shenzhen Energy	7	11	11	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	8	8	10	Financial Street	15	15	15
Yuntianhua	5	3	4	State Grid Yingda	3	4	3
Hainan Rubber	2	2	2	Tielong Logistics	11	13	13
Zhongtai Chemical	4	5	5	TEDA Business	11	9	7
CNPC	11	12	12	Urban Development Environment	11	14	14

2016

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	1	3	4	Shaangu Power	9	11	10
Power Construction of China	3	2	2	Chenming Paper	11	12	12
Shenzhen Energy	10	14	14	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	8	8	8	Financial Street	15	15	15
Yuntianhua	2	1	1	State Grid Yingda	6	5	5
Hainan Rubber	5	7	6	Tielong Logistics	7	6	7
Zhongtai Chemical	4	4	3	TEDA Business	13	10	9
CNPC	11	9	11	Urban Development Environment	13	13	13

2017

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	1	3	4	Shaangu Power	9	12	12
Power Construction of China	3	2	2	Chenming Paper	9	12	12
Shenzhen Energy	12	14	14	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	8	9	9	Financial Street	14	15	15
Yuntianhua	2	1	1	State Grid Yingda	5	5	5
Hainan Rubber	4	6	6	Tielong Logistics	6	4	3
Zhongtai Chemical	7	7	7	TEDA Business	12	8	8
CNPC	14	10	10	Urban Development Environment	11	11	11

2018

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	2	4	3	Shaangu Power	11	13	13
Power Construction of China	4	1	2	Chenming Paper	1	3	4
Shenzhen Energy	10	5	5	Zhongtian Finance	16	16	16
Shanghai Construction Engineering	9	9	10	Financial Street	14	15	15
Yuntianhua	3	2	1	State Grid Yingda	6	6	6
Hainan Rubber	5	8	8	Tielong Logistics	7	7	7
Zhongtai Chemical	7	10	9	TEDA Business	12	11	11
CNPC	14	12	12	Urban Development Environment	13	14	14

2019

Name	Original	GRA	TOPSIS	Name	Original	GRA	TOPSIS
Huaneng Power International	1	4	3	Shaangu Power	11	12	12
Power Construction of China	4	2	2	Chenming Paper	2	3	5
Shenzhen Energy	3	1	1	Zhongtian Finance	13	16	16
Shanghai Construction Engineering	10	10	11	Financial Street	14	15	15
Yuntianhua	5	5	6	State Grid Yingda	8	8	8
Hainan Rubber	9	9	9	Tielong Logistics	6	6	4
Zhongtai Chemical	6	7	7	TEDA Business	12	11	10
CNPC	15	13	13	Urban Development Environment	15	14	14