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Research on improving the key indicators of enterprise ESG rating

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Abstract

ESG ratings, as a metric for assessing corporate social responsibility, have garnered escalating interest from both domestic and international investors within China. However, critical indicators for augmenting ESG scores remain underexplored. Utilizing data from 2017 to 2020 on CSI 300 and CSI 500 constituent stocks, this study employs advanced machine learning algorithms, including XGBoost (XGB), LightGBM (LGB), and Random Forest (RF), to conduct a quantitative analysis of corporate feature values and their correlation with institutional rating outcomes. The findings indicate a predominant influence of corporate governance indicators, particularly in the realm of information disclosure, followed by social responsibility and environmental metrics. The paper further delineates specific, actionable short-term and long-term strategies that corporations can adopt across environmental, social, and governance dimensions, tailored to the nuances of various sub-indicators.

Keywords: ESG rating system; machine learning; indicator importance; Chinese enterprises

1. Introduction

ESG, the acronym for Environment, Social Responsibility, and Corporate Governance, represents the multifaceted responsibilities of enterprises towards environmental stewardship, societal contribution, and governance during their operational processes. The spotlight on corporate ESG performance has been intensifying globally, attracting attention from governments, regulatory bodies, and investors. Increasingly, major international

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investors are favoring enterprises that generate a substantial portion of green revenue or that contribute to achieving sustainable development goals[1,2]. Evidence indicates that sustainable investment is expanding rapidly, marked by significant inflows into ESG-rated mutual funds[3]. To some degree, ESG performance is directly linked to corporate value and can influence asset prices through investor preferences[4]. This shift has prompted a notable increase in international regulations that mandate the disclosure of ESG information by listed companies, leading to the gradual development of a comprehensive system for information disclosure and performance assessment. Christensen et al. (2019) examined the impact of ESG/CSR reporting on accounting and finance and observed that enhanced disclosure of ESG/CSR information improves both the quantity and quality of corporate social responsibility information, thereby supporting the healthy development of capital markets[5].

In China, the Shanghai Stock Exchange and Shenzhen Stock Exchange issued guidelines on social responsibility information disclosure in 2008 and 2006, respectively. In 2015, the General Administration of Quality Supervision, Inspection and Quarantine, along with the Standardization Administration of the People's Republic of China, released Social Responsibility Guidelines and Guidelines for Compiling Social Responsibility Reports, thereby establishing preliminary norms for corporate social responsibility reports. Nevertheless, the evolution of ESG concepts in China remains nascent, lacking a unified and mature disclosure and evaluation system. Both enterprises and investors may not be well-acquainted with the content and methodologies of ESG ratings, possibly overlooking subtle ESG details and responding inadequately[6,7]. Thus, research on the framework and underlying indicators of China's ESG rating system is critical, as it assists companies in identifying strategic focal points for excelling in social responsibility fields and aids investors in assessing companies more intuitively from an ESG perspective.

This paper undertakes a quantitative analysis of the correlation between enterprise-related characteristic values and corresponding institutional rating outcomes by employing a machine learning model, identifying key indicators in ESG ratings, and proposing strategies for rapid ESG rating enhancement. The structure of the paper is as follows: Section 1 discusses the current developmental status and research background of ESG; Section 2 contrasts the evaluation methodologies and indicator systems of ESG rating agencies in China and internationally; Section 3 details the data and machine learning models used in this empirical analysis; Section 4 evaluates the significance of indicators within the CSI ESG indicator system and corporate response strategies; Section 5 presents conclusions and recommendations.

2. Evaluation system of China and international ESG rating agencies

Both Chinese and international rating agencies place significant emphasis on assessing substantive industry issues, typically employing methods such as unique issue identification, and differentiated weighting to account for industry-specific characteristics. However, notable disparities exist in the specific implementations of these methods:

2.1. International rating system

Research into ESG evaluation by international rating agencies is well-established, culminating in a relatively comprehensive methodological system. An examination of the logical structures and characteristics of ESG evaluation methodologies employed by prominent agencies such as MSCI, FTSE, Refinitiv, Sustainalytics, and Moody’s reveals several key points:

- Western countries have unified ESG values, and rating agencies follow the sustainable development with international consensus. The framework design ESG evaluation system and the topic settings are relatively consistent.
- International rating agencies focus on the logic of ESG evaluation methods, with clear logical structure of indicator settings and strong economic implications. But they have a low degree of disclosure of evaluation algorithms, and relative ranking algorithms and expert scoring algorithms are used by institutions that have disclosed ESG evaluation algorithms.
- International rating agencies incorporate regular and voluntary reports such as corporate ESG reports and non-regular and involuntary information such as controversial events into the rating system to comprehensively examine corporate ESG levels.

- The main ESG risk opportunities faced by different industries are quite different, and the focus of ESG evaluation should also be different.

2.2. China rating system

China's approach to ESG evaluation is currently in a developmental phase, primarily focused on adapting international systems to local contexts. An analysis of the methodologies employed by Chinese institutions such as SynTao Green Finance, Huazheng, Wind, and the Central Finance Green Finance Institute reveals several distinctive practices:

- Chinese rating agencies concentrate on the adaptation of international ESG frameworks to suit China's unique economic and social landscape. This involves the creation of idiosyncratic indicators and differentiated evaluation rules specifically designed to capture the ESG risks and opportunities pertinent to Chinese listed companies accurately.
- In terms of information sources for ratings, Chinese agencies place a significant emphasis on incorporating data related to controversial events. Some agencies enhance their evaluations with risk warnings that are directly tied to corporate controversies, thereby providing investors with critical insights into potential ESG-related vulnerabilities.
- Recognizing the diverse nature of industries within China, rating agencies meticulously tailor their evaluations to reflect key sector-specific issues. This is achieved through the establishment of industry-specific topics, indicators, and differentiated weighting schemes. Such tailored approaches ensure that the ESG evaluations are relevant and provide a true reflection of the industry characteristics and the associated risks and opportunities.

2.3. CSI rating system

CSI ESG evaluation System was officially released by China Securities Index Co., Ltd. on December 3, 2020, including three dimensions of environment (E), society (S) and corporate governance (G), consisting of 13 themes, 22 units and nearly 200 indicators.

Upon comparative analysis with other Chinese and international ESG rating methodologies, the CSI ESG Evaluation System exhibits notable features that distinguish it. Firstly, in terms of rating principles, the system aligns with the international sustainable development framework while also incorporating aspects relevant to China's development context, thereby focusing on ESG issues critical to Chinese corporations. Secondly, regarding the rating framework, it utilizes an "exposure + management" approach particularly in the environmental and social dimensions, which enhances both the logical coherence and interpretability of the system. Thirdly, it integrates ESG controversial event risks into its grading criteria, allowing for a comprehensive and detailed reflection of corporate ESG risks. Fourthly, it applies differentiated weights based on the extent of data disclosure, thereby accentuating critical industry-specific issues, delineating industry characteristics, and depicting the actual ESG risks and opportunities that companies face more precisely. Consequently, this empirical analysis adopts the CSI ESG rating as the pivotal research indicator.

Within the framework of the CSI (China Securities Index) overall ESG (Environmental, Social, Governance) scoring system, the impact and significance of the various indicators across different dimensions are not uniform. To appeal to a broader spectrum of ESG investors, corporations are motivated to improve their ESG scores, thereby showcasing enhanced corporate social responsibility and environmental stewardship. Given the intricate array of indicators, it is imperative for companies to discern which ones have a substantial impact on incremental ESG score improvements. This task requires a strategic evaluation of the cost-benefit ratio to effectively boost their ESG scores in a limited timeframe. Consequently, identifying these pivotal indicators has emerged as a critical challenge for businesses aiming to excel in ESG performance.

3. Empirical design

This article selects a total of 3,000 samples of companies that are constituent stocks of the CSI 300 and CSI 500 from 2017 to 2020. Each sample contains the underlying data of 77 CSI ESG ratings corresponding to the company.

This study established three categories of machine learning models -- XGBoost (XGB), LightGBM (LGB), and Random Forest (RF), to assess the importance of indicator features. The principles for determining feature importance in different models are as follows:

- Both XGB and LGB assess feature importance by evaluating the gain in structural scores when features serve as splitting points in decision trees. The importance of a specific feature is quantified by aggregating its occurrences throughout all trees; thus, the more frequently a feature is employed in constructing decision trees, the greater its relative importance is deemed.
- RF ascertains feature importance by averaging the contributions of each feature across all the decision trees within the forest, ranking them accordingly. This contribution is typically evaluated using metrics such as the Gini index or the out-of-bag (OOB) error rate, providing a comprehensive measure of each feature's impact on model accuracy.

Based on the machine learning outcomes, the indicator system was analyzed across four dimensions: Environmental (E), Social (S), Governance (G), and the overall ESG framework. The analysis aimed to identify critical features within the China Securities Index ESG indicator system for each dimension.

4. Importance analysis and coping strategies

4.1. Environmental scores (E)

Table 1 reveals that significant factors influencing the Environmental (E) score include elements associated with green projects and policy image.

Table 1. The top five important indicators that affect environmental scores (E)

XGB		LGB		RF	
Index content	Importance score	Index content	Importance score	Index content	Importance score
Whether it is a key pollutant discharge	0.28	Average R & D / operating revenue over the past 3 years	1291	Whether it is a key pollutant discharge	0.22
Whether green office	0.10	Total water consumption	404	The company has carbon emission reduction plans and measures	0.14
Are there any waste disposal measures	0.09	Total greenhouse gas (CO_2) emissions	391	Whether green office	0.14
Whether there is a green finance business development policy	0.07	Actual total discharge / approved discharge	384	Average R & D / operating revenue over the past 3 years	0.12
The company has carbon emission reduction plans and measures	0.07	Water consumption / operating income	382	Are there any waste disposal measures	0.09

The environmental score is predominantly affected by waste generation and management aspects, such as "designation as a key pollution-discharging entity," "comparison of actual total discharges to authorized emission limits," and "implementation of waste management measures." Moreover, practices like "green office initiatives" and strategies such as "carbon emission reduction plans" play a crucial role in shaping the environmental score. Of these, the indicators "designation as a key pollution-discharging entity" and "average R&D expenditure relative to revenue over the past three years" (indicative of eco-friendly or resource-efficient innovation) exert the most profound influence. However, these indicators typically necessitate long-term strategic investment and are often constrained by industry-specific characteristics, making them less susceptible to rapid enhancement.

Conversely, certain corporate policies and projects, like green office practices and carbon reduction strategies, are more amenable to swift improvements. Green office practices, which include water and energy conservation, transitioning to paperless operations, adopting video conferencing, and initiating green building projects, offer viable avenues for enhancement. With the exception of green building, most of these practices can be augmented at a relatively low cost by refining existing procedures and regulations. Carbon reduction strategies, aimed at fostering

a green corporate image, can be quickly developed to boost the environmental score. Over the long term, the implementation of such strategies, including the reduction of overall greenhouse gas (CO2) emissions and the establishment of waste management protocols, can substantially elevate the environmental score, representing a vital blend of short-term actions and long-term commitments.

4.2. Social scores (S)

Table 2 identifies significant indicators that notably influence the Social Responsibility (S) score, including the transparency of regulatory systems, the sophistication of the enterprise management system, and social contribution metrics. The Social Responsibility score heavily relies on a corporation's implementation of robust regulatory systems across various processes, which serve to mitigate potential risks to stakeholders. Furthermore, a company's tax contributions and per-share social contribution values play crucial roles in shaping the Social Responsibility score.

Table 2. The top five important indicators that affect social scores (S)

XGB		***LGB***		***RF***	
Index content	***Importance score***	***Index content***	***Importance score***	***Index content***	***Importance score***
Whether the perfect procurement management, supervision system, bidding system and other management systems have been formulated	***0.43***	***Per-capita tax revenue for businesses***	***709***	***Social contribution value per share of enterprises***	***0.2***
Whether there is a perfect after-sales service and customer feedback and complaint mechanism	***0.08***	***A net increase in company headcount from the previous year is reported***	***676***	***Whether the perfect procurement management, supervision system, bidding system and other management systems have been formulated***	***0.16***
Total tax revenue of the enterprise	***0.06***	***Social contribution value per share of enterprises***	***648***	***Total tax revenue of the enterprise***	***0.16***
Social contribution value per share of enterprises	***0.06***	***Per capita salary (excluding senior executives)***	***615***	***A net increase in company headcount from the previous year is reported***	***0.12***
A net increase in company headcount from the previous year is reported	***0.04***	***Total tax revenue of the enterprise***	***577***	***Per-capita tax revenue for businesses***	***0.12***

Within the domain of Social Responsibility scoring, key indicators such as the "net increase in company headcount from the previous year," and taxation-related metrics like "per capita tax contribution of employees" and "total tax contributions of the company" are emphasized. These indicators highlight the scoring system's focus on employment and taxation, which are fundamental to the economic well-being of the community.

Moreover, the "per share social contribution value" of a corporation integrates diverse social values and costs, significantly impacting the Social Responsibility score. This metric moderates the unchecked rapid growth of shareholder profits, requiring corporations to not only generate basic earnings per share for shareholders but also to concurrently enhance value for other stakeholders within the same fiscal period. This comprehensive approach to value creation encompasses increasing national tax revenues, boosting wages for employees, making interest payments to creditors such as banks, and contributing to charitable causes, all while reducing societal costs related to environmental degradation.

Compared to environmental and governance scores, social scores encompass a broader range of aspects. Thus, aside from developing a more refined management system, it is challenging for companies to rapidly improve their social responsibility scores in the short term. Instead, achieving higher social scores typically requires more prolonged, in-depth planning and systematic reform.

4.3. Governance scores (G)

Table 3 outlines significant indicators critically influencing the Governance (G) score, including the extent of information disclosure, the occurrence of negative events, and board dynamics. The governance score is primarily determined by the level of corporate information disclosure as evaluated by stock exchanges, along with factors such as the absence of objections in financial reports, any public censures, or recognitions by the exchange within the past year, and whether the company has been under investigation or subjected to administrative penalties by the Securities Regulatory Commission. Companies that maintain operations free from major errors or mishaps receive favorable evaluations from rating agencies, indicating a risk-averse approach and an emphasis on the management of negative events.

Additionally, the governance score scrutinizes the effectiveness of the board's current operations and continues to prioritize fundamental risk assessment metrics. Key factors impacting this score include executive compensation incentives, the proportion of independent directors, the concentration of equity ownership, and the ratio of pledged shares. These structural components, typically strategic in nature for the medium to long term, necessitate targeted adjustments such as modifying executive compensation schemes and resolving share pledges by shareholders possessing sufficient liquidity. However, such adjustments often require intricate coordination processes and the balancing of diverse stakeholder interests, making them complex and multifaceted challenges.

Table 3. The top five important indicators that affect governance scores (G)

XGB		***LGB***		***RF***	
Index content	***Importance score***	***Index content***	***Importance score***	***Index content***	***Importance score***
Objection of independent director	***0.36***	***Executive compensation incentive***	***821***	***Review opinions of regulatory authorities on information disclosure***	***0.5***
Report for no material change	***0.25***	***ACCRUAL (abs (operating profit-cash flow from operating activities in the past three years) and / total assets in the past three years)***	***713***	***Executive compensation incentive***	***0.09***
Review opinions of regulatory authorities on information disclosure	***0.18***	***Asset-to-liability ratio (capital structure)***	***712***	***Proportion of independent directors: number of independent directors / number of directors***	***0.07***
In the past year, whether it was publicly condemned by the exchange, and whether it was investigated and administrative punishment by the CSRC	***0.07***	***The shareholding ratio of the top ten shareholders (%)***	***622***	***ACCRUAL (abs (operating profit-cash flow from operating activities in the past three years) and / total assets in the past three years)***	***0.05***
Whether in the past three years of continuous no dividends	***0.03***	***Global stock major shareholder pledge ratio***	***613***	***Report for no material change***	***0.04***

4.4. ESG comprehensive scores

Incorporating metrics related to environmental stewardship (E), social responsibility (S), and corporate governance (G), the most critical determinant of the composite ESG score is corporate governance (G). This aspect especially pertains to the evaluation of corporate information disclosure, highlighted by "review opinions of regulatory authorities on information disclosure," and includes considerations such as "executive remuneration incentives," along with essential corporate metrics like "EBIT/Total Assets" and "Debt-to-Asset Ratio" (refer to

Table 4). Enhancing corporate disclosure emerges as a cost-effective strategy for improvement, though it requires evaluating the existing capacity for further disclosure in alignment with ESG standards.

Social responsibility (S) is identified as the second most significant component within the sub-index system. The ESG scoring framework prioritizes factors that affect various societal stakeholders, including the existence of robust procurement management and monitoring systems, and transparent tendering processes, to ensure fairness and integrity. Additionally, employment metrics such as "a net increase in company headcount" from the previous year are considered. Companies can incrementally enhance their transparency and governance by refining these systems, thereby maintaining robust operational health while continually attracting skilled workers and expanding the labor force.

Regarding environmental friendliness (E), its contribution to the overall ESG score is comparatively modest, and its directional impact is less pronounced than the other two sub-indexes. Critical environmental indicators include "designation as a major polluter," "adoption of green office practices," and "implementation of waste management measures, including emission reduction initiatives." The latter two indicators offer more straightforward opportunities for improvement and can be effectively enhanced from their existing foundations.

Table 4. The top five important indicators that affect ESG scores

XGB		*LGB*		*RF*	
Index content	*Importance score*	*Index content*	*Importance score*	*Index content*	*Importance score*
Review opinions of regulatory authorities on information disclosure	*0.23*	*Executive compensation incentive*	*357*	*Review opinions of regulatory authorities on information disclosure*	*0.24*
Whether the perfect procurement management, supervision system, bidding system and other management systems have been formulated	*0.18*	*The interest-to-debt ratio of monetary funds (is the monetary funds / interest-bearing debt ratio in the past year）*	*311*	*Whether the perfect procurement management, supervision system, bidding system and other management systems have been formulated*	*0.1*
Whether it is a key pollutant discharge	*0.05*	*A net increase in company headcount from the previous year is reported*	*299*	*ACCRUAL (abs (operating profit-cash flow from operating activities in the past three years) and / total assets in the past three years)*	*0.07*
Whether green office	*0.04*	*ACCRUAL (abs (operating profit-cash flow from operating activities in the past three years) and / total assets in the past three years)*	*297*	*Whether it is a key pollutant discharge*	*0.05*
Are there any waste disposal measures	*0.04*	*Asset-to-liability ratio*	*292*	*Per-capita tax revenue for businesses*	*0.05*

5. Conclusions and suggestions

Through computational analysis of indicator importance based on data from CSI 300 and CSI 500 constituent stocks from 2017 to 2020, the following conclusions and recommendations have been derived using the E, S, G, and ESG framework:

- Chinese companies are advised to enhance their corporate governance and improve both the quality and quantity of information disclosure. In the ESG scoring framework, corporate governance is paramount, followed by social responsibility, with environmental scores playing a less significant role. Firms should bolster their management practices and continuously refine their governance structures to align the quality and quantity of disclosed information with international standards.

- In terms of corporate governance scores, Chinese companies should focus on preventing significant negative incidents. It is essential during external reporting and daily operations to adhere to personnel and procedural standards and maintain proactive communication with regulatory bodies to address and mitigate potential adverse incidents swiftly.
- For social responsibility scores, Chinese companies should implement robust internal regulatory systems tailored to meet specific indicator requirements, comply with legal obligations regarding tax and wage payments, and engage in meaningful charitable and community contributions. These actions will contribute to achieving a sustainable high ESG score over the long term.
- Regarding environmental scores, Chinese companies can initially adopt greener office practices as a cost-effective strategy to enhance their environmental ratings. Over the medium to long term, firms should develop and implement comprehensive carbon reduction plans.
- Compared to social and governance aspects, the environmental score is generally easier for companies to improve in the short term. However, it carries the lowest weight within the ESG evaluation framework. This weighting suggests that the ESG system overall aims to foster long-term and sustainable capacity enhancement among Chinese companies. Focusing exclusively on short-term "quick fixes" in one aspect does not lead to significant or enduring improvements in ESG scores.

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