

Research on Enterprise Environmental Risk Management of Industrial Bank under Analytic Hierarchy Process

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Abstract: With the frequent occurrence of corporate environmental incidents and the intensification of bank credit risks, the banking industry urgently needs to strengthen the prevention, control and management of corporate environmental risks. Based on the analytic hierarchy process, this paper takes the three enterprises that have been granted credit by IB as samples, selects the enterprise environmental risk model of four sub-indicators: carbon emissions, basic environmental management, environmental risk management measures, and environmental risk emergency management, and selects the appropriate green credit objects according to the calculation results. It also puts forward suggestions on environmental risk management to improve the collection and transmission of enterprise environmental information, strengthen the supervision of enterprise risk management measures, and formulate a unified enterprise environmental risk rating standard, so as to provide reference for the banking industry to carry out enterprise environmental risk management.

Keywords: Environmental risk, Analytic hierarchy process, Green credit.

1. Introduction

In 2012, the China Banking Regulatory Commission (CBRC) issued the Green Credit Guidelines, which incorporated green credit indicators into the macro-prudential assessment system of commercial banks, and the concepts of "environmental risk" and "environmental risk management" were formally proposed for the first time. In recent years, the state has issued a series of policy opinions, such as the Guiding Opinions on Promoting Investment in Response to Climate Change in 2020, the Guiding Opinions on Accelerating the Establishment and Improvement of a Green, Low-Carbon and Circular Development Economy in 2021, and the Opinions on Accelerating the Construction of a National Unified Market in 2022. Green credit brings development opportunities to financial institutions, but also faces huge corporate environmental risk challenges, and banks' ineffective management of corporate environmental risks will cause major obstacles to the sustainable development of the banking industry [1]. If the bank is not effective in the management of the environmental risk of the enterprise, the environmental pollution in the production process of the enterprise, the real estate pollution of the mortgage assets, the pollution of the land of the enterprise and other pollution will affect the profitability of the enterprise, the difficulty of loan repayment, and the adverse impact on the operation of the bank. As the first Equator Bank in China, IB regards environmental risk management as the core content of bank risk management [2]. In 2020, IB revised the Sub-Strategy on Environmental and Social Risk Management, and used it as a long-term mechanism to consolidate sustainable finance and improve the structure, tools and methods of enterprise environmental risk management. In this paper, the analytic hierarchy process is used to evaluate the environmental risk of IB's credit enterprises, and to screen the enterprises that fail to meet the environmental risk indicators, so as to improve the environmental risk management and

control capabilities of banks, reduce the risk of bad debts of banks, and control the industry financing of "two highs and one capital".to support the development of green industries.

2. Literature Review

2.1. Sources and characteristics of environmental risks

Ma Jun (2020) divides environmental risks into transition risks and physical risks according to their sources, based on the research results of environmental risk analysis. Among them, the source of transition risk is mainly the transformation of human factors such as policies, technologies, and concepts to cope with climate change and environmental challenges. Sources of physical risks include extreme weather events, sea level rise, ecological and environmental pollution accidents, and destruction and shortage of natural resources [3]. Yan Lu (2023) argues that environmental risks have the characteristics of strong externality, strong transitivity, and strong dynamics, and have an impact on the overall risk control of commercial banks [4]. Lu et al. (2021) concluded that environmental risks have unique characteristics that are different from traditional financial risks, that is, the uncertainty of environmental risks, the nonlinear and irreversible changes of environmental risks, and the complex and systemic impact on the financial environment [5].

2.2. The impact of environmental risks on the bank's business operations

Zhang Hongli and Zhou Yueqiu (2016) empirically analyzed that the demand and supply of bank loans are jointly determined by environmental risks, deposit interest rates, and loan interest rates, and that environmental risks affect their operating costs and revenues [6]. Xie Fang and Li Junqing (2019) empirically tested the impact of environmental risk on loan interest rates through commercial bank loan data, that is, the higher the environmental risk score, the lower the loan

interest rate obtained by listed companies from commercial banks [7]. Wu Jie and Tian Yingqi (2013) constructed a green credit risk evaluation system and used examples to verify the relationship between the changes in corporate environmental risk indicators and the bank's green credit default risk, and proposed that environmental risk is positively correlated with the bank's green credit default risk and negatively correlated with the bank's overall operating performance [8].

2.3. The environmental risk management policies and roles of commercial banks

Li Weikang (2019) argues that production enterprises have direct environmental risk control obligations, and commercial banks need to form a loan constraint mechanism through green credit to manage corporate environmental risks due to the requirements of national macro policies [9]. Meng Jianuo and Mei Licheng (2019) proposed the establishment of a comprehensive enterprise environmental risk management system, classified management of enterprise environmental risks, reduced the hidden risks of banking business, and established and improved the guarantee mechanism for enterprise environmental risk management [10]. Cao Xuan (2021) From the perspective of risk management, the establishment of an enterprise environmental risk management system by commercial banks is conducive to sustainable development [11]. On the one hand, it can grasp and control the negative impact of financial activities on the environment, and evaluate the adaptability and long-term outlook of enterprises in the process of low-carbon transformation and development. On the other hand, it can effectively predict and manage the asset quality of banks against risk fluctuations. He Dan (2020) Enterprise environmental risk management under the Equator Principles of commercial banks can internalize environmental and social benefits, prompt project sponsors to establish or improve internal environmental and social assessment management systems, and actively reduce or eliminate negative externalities in the process of project financing, which is conducive to environmental protection in the area where the project is located, while improving labor conditions, increasing employment, and promoting local economic development [12].

3. Enterprise Environmental Risk Assessment Model

In this paper, the analytic hierarchy process is used to evaluate and analyze the environmental risks of enterprises from both quantitative and qualitative aspects, and the decision-making problem is decomposed into different hierarchies such as the overall goal, each level of sub-objectives, and evaluation criteria, and the overall goal is weighted, with the largest weight as the optimal solution [13].

3.1. Research samples

In this paper, we select three key industries for current emission reduction: electricity, cement, and steel, which are also the three industries that are most vulnerable to environmental risks, and select the more representative companies in the industries as the research objects. Company X is a large-scale cement company, mainly engaged in the production, sales, export, import of cement and auxiliary materials, cement products, machinery and equipment, instrumentation and spare parts Company Y is a large-scale

power generation company, whose main business is mainly the production, sales and service of power products and heat products. The business scope includes the production and sales of electric power commodities and heat commodities, fuels, materials and electric power high-tech Company Z is a large steel conglomerate enterprise that produces, processes and sells plates, profiles, wire rods, bars, billets, thin strips.

3.2. Selection of indicators

Based on the Guidelines for the Preparation of Enterprise Environmental Reports, the Technical Guidelines for the Evaluation of Enterprise Environmental Behavior and the Measures for the Evaluation of Enterprise Environmental Credit, this paper selects four indicators of enterprise carbon emission reduction, environmental risk prevention and control measures, basic environmental management, and environmental risk emergency management to reflect the environmental risk of the enterprise, and evaluates the corresponding values of the environmental risk index of the enterprise in combination with the Evaluation Index and Score Table of the Environmental Risk and Control Level of the Enterprise Based on this, a judgment matrix is constructed, the index weights are calculated, and the environmental risks of the enterprise are comprehensively evaluated. Finally, the green credit standard of IB was selected as the basis for decision-making, so that IB could carry out enterprise environmental risk management more effectively.

3.2.1. Carbon emission reduction (A1).

According to the energy conservation and emission reduction targets of the "14th Five-Year Plan" Comprehensive Plan for Energy Conservation and Emission Reduction, combined with the requirements of the CBRC's enterprise green credit statistical system, carbon emission reduction is selected as the enterprise risk evaluation index. The greenhouse gas emissions were examined from the total amount standard and concentration standard, and the standard coal savings, carbon dust emission reduction, carbon dioxide emission reduction, sulfur dioxide emission reduction, and carbon oxide emission reduction of the enterprise were mainly investigated.

3.2.2. Environmental risk prevention and control measures (A2).

Taking the environmental risk prevention and control measures of enterprises as the evaluation indicators can better represent the prevention and control capabilities of enterprise environmental risks. The company's environmental risk prevention and control measures mainly inspect the enterprise's hazardous chemicals interception system, accident wastewater collection system, production wastewater total discharge cut-off device, harmful gas leakage early warning and cut-off device, solid waste disposal and stacking.

3.2.3. Basic Environmental Management (A3).

Basic environmental management is mainly to establish an environmental management system from within the enterprise to prevent adverse effects on the environment. The indicators mainly examine whether the enterprise has established a relatively complete environmental protection responsibility system, whether it clarifies the responsibilities of the person in charge of enterprise environmental management, the responsibilities of the enterprise environmental supervisor and the responsibilities of the enterprise environmental management department, whether it

establishes and improves the enterprise environmental management data, and whether it establishes and improves the internal environmental management system.

3.2.4. Emergency management of environmental risks (A4).

The environmental risk emergency management index mainly evaluates the ability of the enterprise to deal with environmental emergencies, so as to minimize the loss of the emergency to the enterprise, and mainly examines the enterprise's environmental accident emergency plan and drill, environmental is intentional hidden danger investigation,

environmental accident emergency materials, etc.

3.3. Indicator evaluation

According to the 2022 annual report released by X, Y and Z companies and the relevant information of the official database, the corresponding values of the environmental risk indicators of X, Y and Z companies at this stage are summarized as follows by combining the status of each indicator of environmental risk of X, Y and Z companies in combination with the "Evaluation Indicators and Score Table of Enterprise Environmental Risk and Control Level" (Appendix I.):

Table 1. Scores of enterprise environmental risk indicators

The name of the metric Indicator score	X Enterprise	Y enterprise	Z Enterprise
Carbon Reductions	7.21	14.41	2.38
Environmental risk prevention and control measures	29.41	5.88	14.71
Basic environmental management	1.70	3.40	11.90
Emergency management of environmental risks	0.75	2.25	6.00

Source: 2022 Annual Report of Companies X, Y, and Z

According to the enterprise evaluation indicators and score table (Appendix 1), the impact of carbon emissions, environmental risk prevention and control measures, basic environmental management, and environmental risk

emergency management on the environmental risk of the enterprise was scored, and the higher the score, the deeper the impact, and the quantitative matrix of the target layer and the index layer was constructed, as shown in Table 2.

Table 2. Judgment matrix at the target layer and indicator layer

A	A1	A2	A3	A4
A1	1	1/2	2	3
A2	2	1	3	5
A3	1/2	1/3	1	2
A4	1/3	1/5	1/2	1
total	3.83	2.03	6.50	11.00

Note: The judgment matrix is a positive and mutual inverse matrix, and the diagonal line of the matrix is the comparison of each element itself, so the value is 1, that is, $A_{II}=1$.

The n-order judgment matrix needs to give a judgment on $n(n-1)/2$ upper (lower) triangular elements, and the lower (upper) triangular element on the other side corresponds to the reciprocal. According to the judgment matrix, the maximum eigenvalue and the corresponding vector are obtained, and the

weight value of each index is obtained by normalization[15], with the weight of A1 being θ_1 and the weight of Ai being θ_i . The data in Table 3 were calculated by the arithmetic mean method (sum product method) to find the normalized weight values of each index, as shown in Table 3.

Table 3. Normalized weights of each indicator by column

A	A1	A2	A3	A4	Normalized weight value (θ).	A* θ
A1	0.26	0.25	0.31	0.27	0.2725	1.09
A2	0.52	0.49	0.46	0.45	0.4800	1.94
A3	0.13	0.16	0.15	0.18	0.1550	0.63
A4	0.09	0.10	0.08	0.09	0.0900	0.35

With the formula where is the consistency index, is the consistency ratio, is the $CR = CI/RI$ random consistency index, the consistency test of the judgment CI matrix, the consistency is acceptable, otherwise the matrix needs to be modified CR , where RI , is the $CR < 0.1$ eigenvalue, $CI = (\lambda - n)/(n - 1)$ check the analytic hierarchy process λ

$$\lambda = \sum_{i=1}^n \frac{(A\theta)_i}{n\theta_i} \quad RI \text{ The value table (Appendix 2) is}$$

obtained $RI = 0.91645$, and the $CR = 0.0052 < 0.1$ substitution is judged to meet the requirements.

3.4. Green credit standards

The environmental behavior of enterprises is divided into five levels according to the grading standard, namely excellent, excellent, good, poor, and very poor, which are expressed as green, blue, yellow, red, and black by color grades, corresponding to different scores. This is shown in Table 4.

Table 4. Green credit standards of IB

Grading of environmental behavior	Color grade	score	Environmental implications	Credit Intent
excellent	green	4.5~5.0	Excellent environmental behavior	Loanable
excellent	blue	3.5~4.5	Environmental compliance	Loanable
good	Yellow	3.0~3.5	It basically meets the requirements of environmental management	consider
difference	red	2.5~3.0	Environmental violations	not
Very poor	black	0~2.5	Serious violations	not

Grade description: (1) Green: Exemplary compliance with environmental protection laws and regulations, no environmental risk inducing factors, and no potential environmental risk threat. (2) Blue: The enterprise meets the national or local pollutant discharge standards, has no environmental violations, and there are no factors that induce environmental risks, and the potential environmental risk threat is small. (3) Yellow: The enterprise meets the national or local pollutant discharge standards, but exceeds the total amount control standard, there are certain environmental risk inducing factors, and there is a potential environmental risk threat. (4) Red: The enterprise has not met the national or local pollutant discharge standards, or has had a general or major environmental incident, and there are many environmental risk inducing factors, and the environmental risk threat is greater. (5) Black: The pollutants discharged by

the enterprise seriously exceed the standard or exceed the standard many times, there are important environmental violations or major or particularly major environmental incidents, environmental factors have induced the occurrence of environmental risks, and environmental risks have caused a greater impact on the production and operation of the enterprise.

4. Empirical Analysis

According to the above analysis, the normalized weight values of enterprises X, Y and Z are obtained, and then weighted and averaged with the normalized weight values of each index, and the corresponding scores of each enterprise are calculated as shown in Table 5.

Table 5. Weights of the comprehensive index

Metric weights		Normalized weights of target firms		
A	Normalize the weight value θ	Enterprise X	Enterprise Y	Enterprise Z
A1	0.2725	0.3001	0.6002	0.0998
A2	0.4800	0.5949	0.1285	0.2766
A3	0.1550	0.0944	0.1676	0.7380
A4	0.0900	0.0819	0.2364	0.6816
Score	—	0.389332	0.272489	0.335698

The consistency test of the weight values of the comprehensive $CR = CI / RI$ indicators was carried out by formula CI , in which the weighted average of the values of Table 5-Table 8 and the normalized weight values θ of each index, and the weighted average of the values of Table 1-Table 4 CI and the normalized weight values $\theta RI / RI$ of each index. $CR = 0.0125 < 0.1$

5. Conclusions and Policy Recommendations

5.1. Conclusion

Based on the above calculation results, it can be seen that the score of enterprise Y is 0.272489, and the grade is classified as red, and its environmental risk inducing factors and potential environmental risks are relatively large, which does not meet the green credit loan standards of IB, and is rejected in the loan plan. The score of enterprise Z is 0.335698, which is classified as yellow, which basically meets the requirements of environmental management, but there are certain environmental risk inducing factors, and IB Green Credit can further investigate other environmental factors of the enterprise and consider whether to extend credit to it. The comprehensive score of enterprise X is 0.389332, and the grade is classified as blue, and the impact of corporate

environmental risk on it is small, so IB gives priority to enterprise X when carrying out green credit, which can effectively reduce the unstable factors of corporate environmental risk on IB's green credit, reduce the impact of corporate environmental risk on IB's green credit funds, reduce the bad debt rate of IB's green credit business, and provide guarantee for the sustainable development of IB's green credit business.

5.2. Policy recommendations

5.2.1. Improve the collection and transmission of corporate environmental information

Therefore, it is necessary to improve the collection and transmission of enterprise environmental information to ensure that IB obtains corporate environmental information in a timely and accurate manner and can more effectively assess the environmental risk of enterprises.

5.2.2. Strengthen the supervision of enterprise environmental risk prevention and control measures

Enterprise risk prevention and control measures are the most weighted of all assessment indicators of enterprise risk, and their importance is self-evident. First of all, IB should broaden the scope of its indicators in order to more accurately and comprehensively assess the risk prevention and control

measures of enterprises. Secondly, in terms of execution, to supervise whether enterprises implement environmental risk prevention and control measures in accordance with standards, bank personnel should conduct regular on-site inspections of credit enterprises to ensure that enterprise risk prevention and control measures are implemented.

5.2.3. Formulate a unified enterprise environmental risk rating standard

There are great differences in the classification of corporate environmental risk rating among branches of IB, which leads to a certain deviation in the classification results of each branch's classification of corporate environmental risk. Therefore, IB should issue a unified rating standard for corporate environmental risk, guide all branches in assessing corporate environmental risks in terms of process methods, index selection, rating basis, etc., and formulate a key indicator system as a reference, so that all branches can better prevent environmental risks in credit assessment and protect the safety of bank credit funds more comprehensively.

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