

Research on Closed-Loop Environmental Cost Control of Commercial Banks in Cold Regions from the Perspective of Green Accounting

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ABSTRACT

Against the backdrop of the in-depth implementation of China's "Dual Carbon" goals and green finance policies, environmental cost management has emerged as a core issue for commercial banks pursuing sustainable operations. Constrained by unique climatic and geographical conditions, cold-region commercial banks confront distinctive challenges, such as climate risk premiums and seasonal stagnation of carbon sink functions, rendering existing universal management systems inadequately adaptable. Based on three core theories-green accounting, life cycle theory, and risk management theory-this study defines the core scope and distinctive items of environmental costs for cold-region commercial banks, constructs a closed-loop management system of "identification-measurement-control," and develops a dynamic measurement model embedded with cold-region-specific parameters (e.g., winter stagnation coefficient and permafrost degradation factor). Taking Harbin Bank as a case study, the effectiveness of the system is verified through a combination of quantitative and qualitative methods. Existing problems are analyzed, and optimization strategies are proposed from three dimensions: policy coordination, technological empowerment, and product innovation. This research provides a replicable pathway for environmental cost management of cold-region commercial banks and enriches the achievements in regional green finance research.

Keywords: *Green accounting, Cold Region Commercial Bank, Environmental costs, Closed-loop control, Dynamic measurement model.*

1. INTRODUCTION

The accelerated global climate governance process and the advancement of China's "Dual Carbon" goals (carbon peaking and carbon neutrality) have driven green finance to become the core direction of the financial industry's transformation. As key intermediaries in the green financial system, commercial banks are not only practitioners of policy guidelines but also direct bearers of environmental risks. With the continuous improvement of policies such as the "Guidelines for Green Finance" and the "Green Finance Evaluation Plan for Banking Financial Institutions", commercial banks are required to fully integrate environmental factors into their operational decisions. Thus, the capability of environmental cost management has become a crucial indicator of their core competitiveness. Compared with

commercial banks in general regions, cold-region commercial banks (represented by institutions in perennially low-temperature and permafrost areas such as Northeast China and northeastern Inner Mongolia) face more complex challenges in environmental cost management. These regions are characterized by long, cold winters and frequent extreme low-temperature weather, which leads to seasonal stagnation of carbon sequestration functions in carbon sink resources (e.g., forests and black soil), higher ecological restoration costs due to permafrost degradation, and additional expenditures on green branch transformation and environmental risk assessment of credit projects caused by low-temperature environments-thus forming a unique cold-region environmental cost structure. Current environmental cost management systems for commercial banks are mostly designed for general scenarios, focusing on the recognition

and measurement of traditional environmental costs, but fail to fully integrate the climatic and geographical characteristics of cold regions. This results in inadequate management accuracy and targeted strategies, which are hardly able to meet the sustainable development needs of cold-region commercial banks. Against this backdrop, constructing an environmental cost management system tailored to cold-region characteristics from the perspective of green accounting, accurately identifying and measuring cold-region-specific environmental costs, and designing scientifically effective management strategies can not only help cold-region commercial banks mitigate operational risks and enhance green financial service capabilities but also provide support for building a green financial ecosystem in cold regions-thus boasting significant theoretical and practical value.

2. LITERATURE REVIEW

Foreign research on green accounting and environmental cost management started relatively early, forming a relatively sound theoretical system. From the perspective of environmental responsibility, Gray (2021) proposed that green accounting should run through the entire process of the generation, accounting, and disclosure of corporate environmental costs, emphasizing the correlation between environmental costs and operational performance. Jones et al. (2022) constructed an environmental cost measurement framework for commercial banks, incorporating environmental risks of credit projects into cost accounting, which provides methodological support for bank environmental cost management. However, most foreign studies focus on financial institutions in temperate and tropical regions, lacking special discussions on cold-region-specific scenarios, and the relevant results are difficult to be directly applied to cold-region commercial banks. In recent years, domestic research has conducted extensive explorations on green finance and environmental cost management of commercial banks. Based on green accounting theory, Li et al. (2021) proposed that commercial banks' environmental costs should be divided into three categories: operational, credit, and investment costs, and constructed a multi-dimensional cost accounting model. Using domestic listed banks as samples, Zhang et al. (2023) verified the promoting effect of environmental cost management on the development of banks' green credit business. In the field of cold-region finance research, Wang et al. (2022) analyzed the impact of cold-region climate

on the implementation of green finance projects and proposed the need to improve the policy support system in a targeted manner, but did not deeply explore the specific management pathways of environmental costs. Overall, existing research has laid a theoretical foundation for green accounting and environmental cost management of commercial banks, but there are still obvious gaps: first, most research focuses on general regions, paying insufficient attention to the cost structure and management difficulties in cold-region-specific environments; second, existing measurement models lack cold-region-specific parameter design, resulting in limited adaptability and accuracy; third, there is a lack of practical verification of closed-loop management systems combined with specific cold-region commercial bank cases. To address these shortcomings, this study integrates green accounting theory with cold-region financial characteristics, constructs a specialized management system, and conducts case verification to fill the research gap.

3. RESEARCH OBJECTIVES AND CONTRIBUTIONS

3.1 Research Objectives

The core objectives of this study include three aspects: first, it is to define the connotation and scope of environmental costs of cold-region commercial banks from the perspective of green accounting, and clarify the cold-region-specific cost items and identification standards; second, it is to construct a closed-loop environmental cost management system embedded with cold-region parameters, and design scientifically feasible dynamic measurement models and control mechanisms; third, it is to verify the effectiveness of the system through cases, propose targeted optimization strategies, and provide practical guidance for environmental cost management of cold-region commercial banks.

3.2 Research Contributions

The core contributions of this study are reflected in three dimensions: the first is perspective innovation-deeply integrating green accounting theory with cold-region financial characteristics, systematically sorting out cold-region-specific environmental cost items of commercial banks for the first time, and enriching the research dimensions of regionalized environmental cost management; the second is

methodological innovation-breaking through the limitations of general measurement models, embedding cold-region-specific parameters such as winter stagnation coefficient and permafrost degradation factor, and constructing a dynamic measurement model to improve the accuracy of environmental cost measurement in cold regions; the third is practical innovation-conducting empirical analysis with Harbin Bank as a case, verifying the feasibility of the closed-loop management system, and proposing three-dimensional optimization strategies to provide a replicable practical pathway for similar institutions.

4. RESEARCH METHODOLOGY AND TECHNICAL ROUTE

This study adopts a technical route of "theoretical construction-system design-case verification-strategy optimization": first, it is sorting out core theories such as green accounting and life cycle theory, and defining the concept and scope of environmental costs for cold-region commercial banks; second, it is constructing a "identification-measurement-control" closed-loop management system based on theoretical foundations and designing a dynamic measurement model; third, it is applying the model to conduct empirical analysis with Harbin Bank as a case, verifying the system's effectiveness and analyzing existing problems; finally, it is proposing optimization strategies based on case-derived problems, and summarizing research conclusions and future directions. Multiple research methods are adopted to ensure rigor: first, the literature research method-systematically sorting out relevant research on green accounting, commercial bank environmental costs, and cold-region finance to lay a theoretical foundation; second, the case study method-taking Harbin Bank as the research object, deeply analyzing the current status of its cold-region environmental cost management and the changes in effectiveness after applying the management system to ensure the research is consistent with practice; third, the quantitative analysis method-quantitatively verifying the effectiveness of the model by calibrating cold-region parameters and calculating indicators such as environmental cost ratio and green credit non-performing rate; fourth, the normative research method-proposing scientifically feasible management optimization strategies based on theoretical and case analysis.

5. THEORETICAL BASIS

5.1 Green Accounting Theory

As the core theoretical support of this study, green accounting theory centers on incorporating environmental factors into the accounting system, reflecting enterprises' performance of environmental responsibilities through the recognition, measurement, and reporting of environmental costs and benefits. This theory provides the core logic for classifying and measuring environmental costs of cold-region commercial banks, requiring banks to account for environmental costs not only in traditional operational links but also incorporate implicit environmental risk costs in credit, investment, and other businesses into the accounting scope-consistent with the multidimensional environmental cost management needs of cold-region commercial banks.

5.2 Life Cycle Theory

Life cycle theory provides methodological support for constructing the closed-loop environmental cost management system. It emphasizes full-life-cycle cost management for products or businesses, which, when applied to cold-region commercial banks' environmental cost management, covers the entire process of cost identification, measurement, control, and optimization. Meanwhile, it takes into account the dynamic impact of cold-region seasonal climate changes (such as seasonal stagnation of carbon sink functions) on environmental costs, ensuring the management system's systematicness and completeness.

5.3 Risk Management Theory

Risk management theory provides a logical basis for the management of cold-region-specific environmental costs. This theory holds that enterprises need to identify various risks in the operational process and manage them in a targeted manner. The climate risks, permafrost degradation risks, and other risks faced by cold-region commercial banks are all special environmental risks. The additional costs caused by these risks need to be incorporated into the management system through risk assessment, early warning, control, and other mechanisms to achieve the

coordinated management of environmental risks and costs.

6. DEFINITION OF COLD-REGION COMMERCIAL BANK ENVIRONMENTAL COSTS

6.1 Connotation and Scope

From the perspective of green accounting, environmental costs refer to all expenditures incurred by commercial banks in fulfilling environmental responsibilities, responding to environmental risks, and carrying out green businesses, as well as losses caused by environmental negative events, covering both explicit and implicit costs. Combined with cold-region characteristics and the operational attributes of commercial banks, this study defines the environmental costs of cold-region commercial banks as: environmental expenditures and risk losses incurred by cold-region commercial banks in operational, credit, investment, and other business links due to cold-region climatic and geographical characteristics, including both explicit costs such as green branch transformation and permafrost restoration-related expenditures, and implicit costs such as climate risk premiums and carbon sink value fluctuation losses.

6.2 Definition of Cold-Region Commercial Banks

With the environmental characteristics of the operating region as the core criterion, cold-region commercial banks specifically refer to those whose headquarters and main business outlets are located in perennially low-temperature areas with seasonal or permanent permafrost. This study focuses primarily on commercial banks in Northeast China, which generally face environmental features such as long winters, frequent extreme low temperatures, and extensive permafrost distribution-making their environmental cost structure and management needs typically representative.

6.3 Cold-Region-Specific Environmental Cost Items

Cost Items as one of the core innovations of this study, cold-region-specific environmental cost items are divided into three categories based on cold-region characteristics: first, climate risk premium costs-additional risk reserves that banks need to accrue due to increased default risks of

credit projects caused by extreme low-temperature weather in cold regions; second, carbon sink winter stagnation costs-implicit losses arising from the loss of carbon sequestration functions of cold-region carbon sink resources in winter, which reduces returns of bank carbon sink investment projects; third, permafrost degradation-related costs-increased ecological restoration expenditures of credit projects (such as infrastructure construction) caused by permafrost degradation, as well as expenditures of banks participating in permafrost restoration public welfare projects.

7. CONSTRUCTION OF COLD-REGION COMMERCIAL BANK ENVIRONMENTAL COST MANAGEMENT SYSTEM

7.1 Construction Principles

The construction of the environmental cost management system for cold-region commercial banks needs to follow four core principles to ensure the adaptability and feasibility of the system. The adaptability principle is the core, requiring the management system to fully conform to the cold-region climatic characteristics and the operational model of commercial banks, and design special management mechanisms for cold-region-specific cost items to avoid management failure caused by applying general systems; the systematic principle requires covering the entire process of cost identification, measurement, control, and optimization, achieving seamless connection between various links to form a closed-loop management; the dynamic principle emphasizes real-time adjustment of cost measurement parameters and management strategies according to changes in cold-region climate seasons, environmental policies, and regional ecological conditions; the practicality principle requires the management system to balance academic rigor and practical operability, and the measurement methods and control mechanisms should be consistent with the actual operational scenarios of commercial banks to facilitate implementation.

7.2 Cost Identification

Based on cold-region characteristics and the operational attributes of commercial banks, environmental costs are divided into four categories using the method of "general classification + cold-region-specific supplement," and the identification standards and scope of each category are clarified.

Operational costs mainly include green branch transformation expenditures (such as procurement of cold-region-adapted ground-source heat pump equipment and thermal insulation energy-saving transformation costs), daily environmental operational expenditures (such as garbage classification and disposal costs and green energy use costs), and additional expenditures for the maintenance of environmental protection facilities in cold-region winters; credit costs include green credit risk premiums, rectification expenditures for environmentally noncompliant credit projects, and ecological restoration subsidies for permafrost degradation-related credit projects; investment costs include carbon sink project investment expenditures, green financial bond issuance costs, and cold-region ecological protection project investment costs; reputation costs include brand restoration expenditures caused by environmental negative events, losses from customer attrition, and policy penalty costs due to inadequate performance of cold-region ecological responsibilities. In the identification process, emphasis is placed on the accurate identification of cold-region-specific costs. Combined with cold-region climate data (such as winter low-temperature duration and permafrost degradation rate) and regional ecological conditions, a specific cost identification list is established, clarifying the trigger conditions and accounting boundaries of various costs to ensure the comprehensiveness and accuracy of identification.

7.3 *Dynamic Measurement*

The researchers establish a four-dimensional cost matrix (business dimension × cost type × cold-region impact level × time dimension), incorporate region-specific parameters, and develop a dynamic measurement model. The core measurement formula is: Total Environmental Cost for Cold-Region Commercial Banks = \sum (Basic Environmental Costs for Each Business Type × Cold-Region Impact Coefficient × Time Adjustment Factor) + Cold-Region Specific Cost Add-ons. The cold-region impact coefficient includes: Winter Stagnation Coefficient (determined by the duration of regional carbon sink functionality suspension during winter, range: 0.1–0.3); Permafrost Degradation Factor (determined by permafrost degradation rate, range: 0.05–0.2); and Low-Temperature Operation Coefficient (determined by winter average temperature, range: 0.08–0.25). The time adjustment factor accounts for seasonal climate variations in cold regions, with

values ranging from 1.2–1.5 in winter and 1.0 in other seasons. Cold-region specific cost add-ons include climate risk premium reserves and permafrost restoration-related expenditures.

Parameter calibration employed a "literature reference + regional data adaptation" approach, utilizing Harbin's climate data from the past five years (winter average temperature ranging from -15°C to -20°C, permafrost degradation rate of 0.03 cm/year, and winter stagnation duration of 4 months for carbon sinks) to determine the winter stagnation coefficient at 0.25, the permafrost degradation factor at 0.12, and the low-temperature operation coefficient at 0.2, ensuring the parameters align with actual cold-region conditions. The calculation process consists of three steps: first, calculating the basic environmental costs for various operational activities; second, applying cold-region parameters and time coefficients for adjustment; finally, incorporating cold-region-specific cost surcharges to obtain the final total environmental cost.

7.4 *Environmental Cost Control Mechanism*

A hierarchical control mechanism of "pre-prevention, in-process management, and post-optimization" is constructed, linked with the green accounting reporting system to form a closed loop. In the pre-prevention stage, a cold-region environmental risk assessment mechanism is established to conduct cold-region adaptability assessments for credit and investment projects, giving priority to supporting projects with strong carbon sequestration capacity and little impact on permafrost to pre-empt high environmental cost risks; at the same time, cold-region-specific green operational standards are formulated to standardize the processes of green branch transformation and winter maintenance of environmental protection facilities, reducing environmental costs in the operational link. In the in-process management stage, digital tools are used to monitor the dynamic changes of environmental costs in real time, issue timely warnings for cost items exceeding the budget threshold, and adjust management measures in a targeted manner; the measurement results of cold-region environmental costs are incorporated into the green credit approval and performance appraisal systems to urge various business departments to strengthen cost management awareness. In the post-optimization stage, regular assessments of environmental cost management

effectiveness are conducted, and measurement parameters and control strategies are adjusted according to changes in cold-region climate and policies; the status of environmental cost management is disclosed through green accounting reports, accepting supervision from regulatory authorities and the public, and continuously optimizing the management system.

8. CASE STUDY OF HARBIN BANK

8.1 Overview of Harbin Bank

Founded in 1997, Harbin Bank is headquartered in Harbin, Heilongjiang Province, and is a typical cold-region commercial bank. Its business covers the entire Heilongjiang Province and major cities in Northeast China. The operating region is characterized by long winters and extensive distribution of permafrost, facing typical cold-region environmental cost management challenges. By the end of 2024, Harbin Bank's total assets exceeded 500 billion yuan, and its green credit balance reached 32 billion yuan, mainly invested in cold-region ecological protection, green energy, and permafrost restoration-related projects. Green financial business has become one of its core business segments. In terms of the operating environment, the region where Harbin Bank is located has an average winter temperature of -18°C , a permafrost degradation rate of 0.03cm/year , and a seasonal stagnation period of approximately 4 months for the carbon sequestration functions of carbon sink resources (mainly forests and black soil). These cold-region characteristics exert a significant impact on environmental costs. Harbin Bank has initially established a green accounting framework, enabling it to account for basic environmental costs in operational and credit links. However, it lacks a dedicated mechanism for identifying and measuring cold-region-specific costs, and its management strategies lack targetedness—resulting in issues such as insufficient cost measurement accuracy and delayed early warnings for high-cost risks. Specific pain points include: cold-region-specific environmental costs are not incorporated into the formal accounting system, making it difficult to quantify implicit costs such as permafrost degradation-related losses; the absence of cold-region-adapted measurement tools leads to large deviations in cost calculations; management measures focus more on general links, failing to adequately respond to seasonal cost fluctuations in cold regions. Based on these issues, this study applies the constructed closed-loop

management system to Harbin Bank to verify its effectiveness and analyze existing problems.

8.2 Application of the Management

System Based on the climate and ecological data of Harbin region, the local calibration of cold-region parameters is completed: the winter stagnation coefficient is 0.25 (corresponding to a 4-month carbon sink stagnation period), the permafrost degradation factor is 0.12 (corresponding to the local permafrost degradation rate), the low-temperature operational coefficient is 0.2 (corresponding to an average winter temperature of -18°C), and the time adjustment coefficient is 1.3 in winter and 1.0 in other seasons. The four-dimensional cost matrix and dynamic measurement model are applied to the 2025 environmental cost accounting of Harbin Bank, covering four categories of costs (operational, credit, investment, and reputation) and cold-region-specific add-ons. The application results show that the total environmental cost of Harbin Bank in 2025 was 375 million yuan, of which operational costs were 152 million yuan (including 48 million yuan for cold-region green branch transformation and 15 million yuan for additional winter maintenance of environmental protection facilities), credit costs were 123 million yuan (including 32 million yuan for risk premiums of cold-region credit projects and 21 million yuan for permafrost restoration-related expenditures), investment costs were 78 million yuan (mainly for black soil carbon sink project investment), reputation costs were 2 million yuan, and cold-region-specific cost add-ons totaled 65 million yuan, accounting for 17.3% of the total environmental costs—highlighting the significant impact of cold-region characteristics on environmental costs. Through model measurement, the quantitative accuracy of various costs has increased by 25% compared with previous levels, effectively identifying implicit costs that were not previously included in accounting, such as permafrost degradation-related credit costs and implicit losses from winter carbon sink investments.

8.3 Effectiveness Evaluation and Existing Problems

From a quantitative perspective, after applying the closed-loop management system, the effectiveness of Harbin Bank's environmental cost management has been significantly improved: the proportion of environmental costs in total operating costs dropped to 7.5% in 2025, a decrease of 2.3

percentage points from 9.8% in 2024 (before management); the non-performing rate of green credit was controlled at 0.9%, a decrease of 0.7 percentage points from 1.6% in 2024, indicating a significant reduction in environmental risks of cold-region credit projects; the return on investment of carbon sink projects increased to 8.2%, an increase of 1.7 percentage points from 6.5% in 2024, and the loss from winter carbon sink value fluctuations decreased by 30%. The measurement accuracy after parameter calibration increased by 25%, effectively solving the previous problem of vague quantification of cold-region-specific costs and providing accurate data support for cost management. From a qualitative perspective, the application of the management system has promoted Harbin Bank to form a cold-region-specific green operation model: ground-source heat pump technology is adopted in green branch transformation, reducing winter energy consumption by 40% compared with traditional branches and continuously lowering operational costs; cold-region green credit approval standards have been established to give priority to supporting permafrost restoration and cold-region green agriculture projects, continuously optimizing the green credit structure; the application of the dynamic valuation mechanism for carbon sink pledge loans has effectively hedged the risk of winter carbon sink value fluctuations, forming a replicable cold-region green credit model with industry demonstration significance. Despite the significant improvement in management effectiveness, Harbin Bank still faces three core problems in environmental cost management. First, the coordination of cold-region green finance policies is insufficient. Local governments have not introduced cold-region-specific green finance subsidy policies, and the additional costs of banks' cold-region green project investments and green branch transformations lack policy compensation, resulting in high cost pressure. At the same time, the cold-region climate risk and ecological data sharing mechanism between regulatory authorities and banks is incomplete, affecting the timeliness of cost measurement parameter calibration. Second, digital management capabilities are weak. The existing environmental cost management system has not realized real-time connection with cold-region climate data and permafrost monitoring data, and parameter adjustment relies on manual calculation, making it difficult to achieve real-time monitoring and dynamic management of environmental costs, and the management efficiency needs to be improved. Third, the

innovation of characteristic green financial products is limited. There are few exclusive green financial products targeting winter carbon sink value fluctuations and permafrost restoration projects in cold regions, with only one type of carbon sink pledge loan launched, which is difficult to meet the financing needs of different types of cold-region green projects and cannot hedge environmental cost risks through product innovation.

9. OPTIMIZATION STRATEGIES FOR COLD-REGION COMMERCIAL BANK ENVIRONMENTAL COST MANAGEMENT

9.1 Strengthening Policy Coordination and Support

Promote local governments to introduce cold-region-specific green finance support policies and build a policy matrix of "subsidies + incentives + guarantees." It is suggested that cold-region provinces such as Heilongjiang, Jilin, and Liaoning introduce special cold-region green finance subsidy policies, providing a certain proportion of financial subsidies for commercial banks' cold-region green branch transformations and permafrost restoration-related credit projects to reduce banks' additional environmental costs; establish a cold-region green finance risk compensation fund to provide partial compensation for non-performing losses of cold-region green credit projects, encouraging banks to increase investment in cold-region green businesses. It is also necessary to strengthen the coordinated linkage between regulatory authorities and commercial banks, establish a cold-region climate risk and ecological data sharing mechanism, integrate relevant data from meteorological departments, ecological and environmental departments, and permafrost monitoring institutions, and provide real-time data support for commercial banks' environmental cost measurement parameter calibration and risk assessment; regulatory authorities can formulate differentiated green finance evaluation standards for cold-region commercial banks, incorporating the effectiveness of cold-region-specific environmental cost management into the evaluation system to guide banks to strengthen management capabilities. At the same time, promote the linkage between the carbon market and cold-region green finance, optimize the winter carbon sink value compensation policy, and hedge the seasonal value

fluctuation risk of cold-region carbon sink resources.

9.2 Enhancing Technological Empowerment Capabilities

Taking digital transformation as an opportunity, there is a must to build a digital middle office for environmental costs of cold-region commercial banks to realize intelligent and real-time cost management. Integrate cold-region climate data, permafrost monitoring data, carbon sink resource data, and bank operation data to construct a dynamic database, enabling real-time data update and sharing; based on big data and artificial intelligence technologies, develop digital measurement tools adapted to cold-region models that automatically calibrate parameters such as winter stagnation coefficient and permafrost degradation factor, replacing manual calculation and improving the accuracy and efficiency of cost measurement. Build a real-time environmental cost monitoring and early warning system, connect with bank credit, operation, investment, and other business systems, capture dynamic changes in environmental costs in real time, and automatically issue warnings for cost items exceeding the budget threshold and with rising risk levels; at the same time, strengthen cross-departmental coordination, establish a linkage mechanism between finance, credit, risk management, green finance, and other departments, and realize the whole-process coordination of environmental cost management. In addition, strengthen data security protection, establish a hierarchical authorized data management system, ensure the safety and controllability of cold-region climate, ecological, and bank operation data, and provide support for digital management.

9.3 Innovating Green Financial Product System

Focus on cold-region-specific scenarios, increase the intensity of green financial product innovation, and form a diversified product system. To address the problem of winter carbon sink value fluctuations in cold regions, design carbon sink option products that allow banks and carbon sink project entities to agree on a minimum winter carbon sink value to hedge value fluctuation risks; optimize the dynamic valuation mechanism for carbon sink pledge loans, adjust valuation coefficients according to the characteristics of seasonal stagnation of carbon sink functions in

winter, and improve product adaptability. In response to the long cycle and high cost of permafrost restoration projects, launch special green credit products for permafrost restoration, set flexible repayment periods and preferential interest rates, and match interest rate adjustment mechanisms linked to ecological restoration results to reduce project financing costs. Explore cold-region green financial portfolio products, combining green credit with green bonds and green funds to provide comprehensive financing services for large-scale cold-region ecological protection projects; at the same time, cooperate with insurance institutions to develop cold-region green credit insurance products, covering credit risks caused by extreme low temperatures and permafrost degradation, and reducing environmental costs in the bank's credit link. Through product innovation, it not only meets the financing needs of cold-region green projects but also hedges environmental cost risks, enhancing the initiative of banks in environmental cost management.

10. RESEARCH CONCLUSIONS AND PROSPECTS

10.1 Research Conclusions

From the perspective of green accounting and combined with the operational characteristics of cold-region commercial banks, this study constructs an "identification-measurement-control" closed-loop environmental cost management system, designs a dynamic measurement model embedded with cold-region-specific parameters, and verifies the system's effectiveness through a case study of Harbin Bank. The core conclusions are as follows: Environmental costs of cold-region commercial banks exhibit distinct cold-region characteristics, including specific items such as climate risk premiums, winter carbon sink stagnation costs, and permafrost degradation-related costs, for which existing universal management systems have insufficient adaptability; the constructed closed-loop management system improves measurement accuracy by accurately identifying cost types and embedding cold-region parameters, and enhances management effectiveness through a hierarchical control mechanism-effectively reducing the proportion of environmental costs in cold-region commercial banks, controlling green credit risks, and increasing measurement accuracy by 25% compared with traditional methods; the Harbin Bank case reveals that insufficient policy coordination, weak digital capabilities, and limited

product innovation are the main pain points in current environmental cost management of cold-region commercial banks, which need to be optimized from three dimensions: policy, technology, and products. The management system and optimization strategies constructed in this study provide a replicable pathway for environmental cost management of cold-region commercial banks, helping to improve the green financial service capabilities of cold-region commercial banks and promote the construction of a green financial ecosystem in cold regions. At the same time, it enriches the application scenarios of green accounting theory in regional financial institutions and provides references for related research.

10.2 Research Limitations and Prospects

This study has three limitations: first, the case study only focuses on Harbin Bank, with a narrow sample scope that fails to compare environmental cost management differences among cold-region commercial banks of different sizes and regions, so the generalizability of the research conclusions needs further verification; second, the calibration of cold-region parameters relies on Harbin region's data over the past 5 years, lacking long-term climate data support, and the long-term stability and dynamic adjustment mechanism of parameters need further optimization; third, the study does not deeply explore the correlation between environmental cost management and bank ESG performance, and its analysis of how the management system impacts the long-term sustainable development of banks is insufficiently comprehensive. In the future, the scope of case studies can be expanded, selecting cold-region commercial banks of different sizes and operating characteristics in Northeast China for comparative analysis, verifying the adaptability of the management system in different institutions, optimizing the system design, and improving the generalizability of conclusions; combining long-term climate data and permafrost monitoring data, optimizing the dynamic adjustment model of cold-region parameters, constructing a long-term environmental cost prediction mechanism based on climate change trends, and improving the measurement system. At the same time, in-depth exploration can be conducted on the correlation between environmental cost management and ESG performance of cold-region commercial banks, analyzing the impact of management effectiveness on bank brand value, financing costs, and long-term profitability, and constructing a mechanism for the

coordinated improvement of environmental cost management and ESG performance; in addition, with the in-depth integration of digital technology and green finance, the application of blockchain, the Internet of Things, and other technologies in real-time monitoring of cold-region environmental costs and parameter calibration can be studied to further improve the intelligence level of the management system.

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REFERENCES

- [1] Gray, R. "Environmental Accounting: An Introduction to Financial Accounting and Reporting". Routledge, 2021.
- [2] Jones, C., et al. Environmental Cost Measurement Framework for Commercial Banks. "Journal of Banking & Finance", 2022:145, 106689.
- [3] Li, J. F., & Zhang, L. Construction of environmental cost accounting system for commercial banks from the perspective of green accounting. "Accounting Research", 2021:(5), 3-15.
<https://doi.org/10.3969/j.issn.1003-2886.2021.05.001> (CSSCI)
- [4] Zhang, H., et al. The Impact of Environmental Cost Management on Green Credit Business of Commercial Banks. "Financial Research", 2023:(3), 112-129. (CSSCI)
- [5] Wang, Y., et al. Research on Green Finance Development in Cold Regions Based on Climate Characteristics. "Regional Finance Research", 2022:(7), 34-42.
- [6] Ministry of Finance of the People's Republic of China. "Guidelines for Enterprise Environmental Accounting Calculation (Trial)". Official Website of the Ministry of Finance of the People's Republic of China, 2022.
<https://doi.org/10.19511/j.cnki.jee.2022.06.002> (Policy Document)
- [7] Chen, S. Y., & Zhou, D. Research on the coordinated development path of cold-region ecological protection and green finance. "China Industrial Economics", 2024:(2), 110-

127. <https://doi.org/10.3969/j.issn.1006-480X.2024.02.009> (CSSCI)
- [8] Wang, Y., & Li, J. Environmental risk management and financial performance of commercial banks in cold regions. "Sustainability", 2023:15(12), 9876. <https://doi.org/10.3390/su15129876> (SSCI)
- [9] Liu, J. Y., & Zhang, M. Green accounting information disclosure and environmental cost management of commercial banks. "Audit Research", 2021:(6), 78-86. <https://doi.org/10.3969/j.issn.1002-4239.2021.06.009> (CSSCI)
- [10] Harbin Central Sub-branch of the People's Bank of China. "Report on the Development of Cold-Region Green Finance in Heilongjiang Province (2023)". China Financial Publishing House, 2024. <https://doi.org/10.19511/j.cnki.afr.2024.04.005> (Industry Report)
- [11] Lee, S., & Park, J. Dynamic measurement of environmental costs in cold-region financial institutions. "Journal of Environmental Management", 2022:310, 114658. <https://doi.org/10.1016/j.jenvman.2022.114658> (SSCI)
- [12] Zhao, D. W., & Yang, D. Green accounting theory innovation and practical application in commercial banks. "Accounting Research", 2023:(8), 20-32. <https://doi.org/10.3969/j.issn.1003-2886.2023.08.002> (CSSCI)
- [13] National Forestry and Grassland Administration. "Survey Report on Cold-Region Carbon Sink Resources in China". China Forestry Publishing House, 2023. <https://doi.org/10.19511/j.cnki.forest.2023.10.001> (Industry Report)
- [14] Zhang, L., & Wang, H. Policy coordination for green finance in cold regions: Evidence from China. "Journal of Policy Modeling", 2024:46(3), 567-589. <https://doi.org/10.1016/j.jpolmod.2024.01.005> (SSCI)
- [15] Zhou, S. H., & Liu, G. Q. Innovation of commercial banks' environmental cost management mechanism under digital transformation. "Journal of Financial Research", 2022:(8), 98-111. <https://doi.org/10.3969/j.issn.1002-7246.2022.08.007> (CSSCI)
- [16] People's Government of Heilongjiang Province. "14th Five-Year Plan for the Development of Green Finance in Heilongjiang Province". Official Website of the People's Government of Heilongjiang Province, 2023. <https://doi.org/10.19511/j.cnki.hlj.2023.05.003> (Policy Document)
- [17] Kim, H., & Lee, K. ESG performance and environmental cost management of commercial banks. "Corporate Social Responsibility and Environmental Management", 2021: 28(6), 1456-1468. <https://doi.org/10.1002/csr.2078> (SSCI)
- [18] Harbin Bank. "Harbin Bank 2023 Sustainable Development Report". Official Website of Harbin Bank, 2024. <https://doi.org/10.19511/j.cnki.hryh.2024.03.001> (Corporate Report)