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Coupling Coordination Between Green Finance Development and Industrial Structure Optimization: A Case Study of Hebei Province

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Abstract: Under the "dual carbon" goals, green finance, as a financial activity aimed at optimizing resource allocation and protecting the environment, holds significant scientific importance for the rational adjustment and upgrading of regional industrial structures. Hebei Province, a key industrial hub in China, faces an urgent need for industrial structure adjustment and optimization. This paper employs time series data from Hebei Province spanning 2001 to 2023 to measure the development levels of green finance and industrial structure, and constructs a coupling coordination model to analyze their interactions. Furthermore, the study uses the GM (1,1) grey model to predict future trends. The results indicate that the coupling coordination degree between green finance and industrial structure upgrading in Hebei Province has steadily improved but remains at a moderate coupling stage. It is projected that the coupling coordination degree will continue to rise, entering a high coordination stage by 2032.

Keywords: Green finance; Industrial structure; Coupling coordination degree; Trend prediction

1 Introduction

Green finance refers to economic activities aimed at supporting environmental improvement, addressing climate change, and promoting resource conservation and efficient utilization. It includes financial services such as investment and financing, project operation, and risk management in areas like environmental protection, energy saving, and clean energy [1]. As an important financial tool for the green allocation of various financial resources, green finance plays a positive role in optimizing and upgrading the industrial structure through specific transmission mechanisms, making it an effective measure to promote the realization of the dual carbon strategy [2, 3].

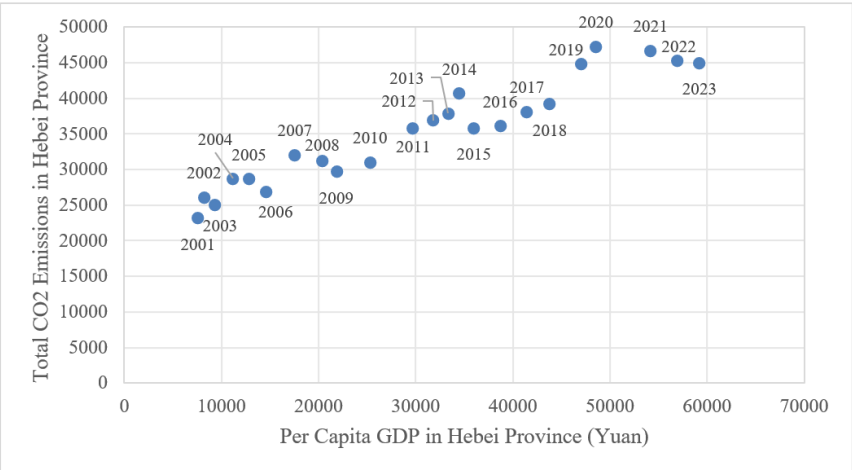

Figure 1. Trend of the EKC in Hebei Province from 2001 to 2023

Hebei Province is located in the Beijing-Tianjin-Hebei economic belt and ranked 12th nationwide in GDP in 2023, with its economic development at the middle level in the country. Although the tertiary industry has developed rapidly in recent years, the secondary industry in Hebei Province still accounted for 37.4% in 2023, remaining a major force in economic development. However, the high-pollution and high-energy-consumption development model of the secondary industry has brought severe ecological and environmental challenges to Hebei Province [4]. According to the Environmental Kuznets Curve (EKC) (Figure 1), the economic development of Hebei Province (represented by annual per capita GDP) and environmental degradation (represented by annual CO_2 emissions) have not yet reached a definitive turning point, remaining in the range of environmental deterioration. Hebei Province urgently needs to improve and implement a green financial system and related policies to promote industrial structure upgrading [5].

From the perspective of industrial structure upgrading, this paper explores the coupling relationship between green finance development and industrial structure optimization in Hebei Province, predicts the coupling development trend, provides practical suggestions for further improving the green financial system in Hebei Province, and offers insights for the formulation of green financial policies.

2 Literature Review

Climate change and economic development have triggered in-depth discussions in academia regarding their relationship. As early as 1998, Salazar proposed the concept of environmental finance, laying the theoretical foundation for subsequent green finance [6]. Labatt and others suggested that green financial activities aim to improve environmental quality and transfer climate risks [7]. Chenayah S. analyzed the future direction of green finance development by interpreting the 2010 Global Investment Analysis Report and combining it with relevant green finance policies and environmental resource protection policies [8]. Green finance was first included as a topic at the G20 Summit in 2016, and in recent years, more than 30 countries worldwide have started to formulate green finance policies. In 2021, the G20 Sustainable Finance Working Group was re-established, making the improvement of the green financial service system a key theme in global financial markets. Current academic research on green finance primarily focuses on three aspects: first, the study of green finance policies and their impacts on financial systems; second, the exploration of green finance theories and concepts; and third, the discussion of the mechanisms and effects of green finance on environmental improvement, socioeconomic development, and ecological changes.

Domestic scholars have actively explored the relationship between green finance and industrial structure. Feng and Cheng [9] analyzed the significant role of green finance in promoting industrial upgrading and transformation from a macro perspective. Ding et al. [10] and others demonstrated that green finance has a positive guiding effect on the structure of high-tech industries, continuously contributing to sustainable economic growth. Cai [11] pointed out that green credit and green investment in green finance have a significant positive impact on industrial structure optimization, but their marginal effects decrease over time. Lin [12] used the SBM-DEA model combined with panel data from 30 provinces, municipalities, and autonomous regions in China to conduct empirical research, finding that green credit significantly improves the efficiency of green technological innovation in China's industries. However, some scholars have suggested that green finance inhibits corporate productivity and performance [13, 14]. Regarding regional studies, Zhou [15] demonstrated that the implementation of green credit in Jiangxi Province significantly affected its three major industries, with more pronounced effects on the primary and secondary industries than on the tertiary industry. Yu and He [16] empirically tested the impact of green credit and green technological progress on carbon emissions based on data from 29 provinces, finding that the inhibitory effect of green credit on carbon emissions is more significant in the western regions, followed by the eastern regions, while it is not significant in the central regions.

In summary, existing literature has explored the impact of green finance on industrial structure from different perspectives at both macro and micro levels. However, the proposal and implementation of green finance in China are still in their infancy, with the green financial system under continuous construction and improvement. The lack of relevant measurable data and methodological limitations pose challenges, particularly in regional studies, which are relatively scarce. Research specifically targeting Hebei Province is even more limited. Clarifying the mechanism of green finance's role in industrial structure optimization is an urgent issue, as it is essential for deepening the reform and development of green finance in Hebei Province and providing valuable experience for further promoting China's industrial upgrading and green development.

3 Empirical Analysis of the Coupling Coordination Degree Between Green Finance Development and Industrial Structure Upgrading in Hebei Province

3.1 Construction of the Indicator System

This paper discusses the coupling coordination degree of green finance's role in industrial structure adjustment in Hebei Province from the two aspects of green finance development and industrial structure upgrading. Based on this, an indicator system is preliminarily established for both aspects. According to the different contents of green

financial services, green finance can be divided into five categories: green credit, green bonds, green investment, green insurance, and carbon finance. However, as China's carbon finance trading market is still in its infancy [17], with limited and incomplete data, this paper does not include carbon finance as an indicator.

As shown in Table 1, The indicator system for green finance development is constructed from two dimensions: structure and scale, including six primary indicators (green credit, green bonds, green insurance, green investment, financial development level, and the ratio of financial industry output value) and twelve secondary indicators. For the industrial structure development indicator system, this paper constructs an indicator system from the three dimensions of advancement, rationalization, and greening, including four indicators: industrial structure optimization rate, industrial structure advancement level, industrial structure rationalization level, and the depth of green awareness, as shown in Table 2.

Table 1. Evaluation indicator system for green finance development in Hebei Province

		Primary Indicators	Secondary Indicators	Calculation Method	Direction
Green Finance Development Level	Structure	Green Credit	Proportion of Green Credit	Green Credit Total / Total Credit	+
			Proportion of Interest Expenditure in Energy-Intensive Industries	Interest Expenditure of Six High Energy Consuming Industries / Total Interest Expenditure in All Industries	+
		Green Bonds	Development Level of Green Bonds	Total Issuance of Green Bonds / Total Issuance of All Bonds	+
			Market Value Ratio of Environmental Protection Enterprises	Market Value of Environmental Protection Enterprises / Total Market Value of A-shares	+
			Market Value Ratio of High Energy-Consuming Industries	Market Value of Six High Energy Consuming Industries / Total Market Value of A-shares	-
		Green Investment	Proportion of Investment in Environmental Pollution Control	Investment in Pollution Control / GDP	+
			Proportion of Public Expenditure on Energy Saving and Environmental Protection	Public Expenditure on Energy Saving and Environmental Protection / Total Fiscal Expenditure	+
		Green Insurance	Proportion of Investment in Pollution Control	Environmental Pollution Prevention Investment Account / GDP	+
			Promotion Level of Environmental Pollution Liability Insurance	Revenue from Environmental Pollution Liability Insurance / Total Premium Income	+
			Ratio of Agricultural Insurance	Agricultural Insurance Expenditure / Total Insurance Expenditure	+
	Scale	Financial Development Level	Proportion of Total Deposit and Loan Balances in Financial Institutions	Sum of Deposit and Loan Balances / Regional GDP	+
		Financial Industry Output Ratio	Proportion of Financial Industry Output	Output of Financial Industry / Regional GDP	+

Table 2. Evaluation indicator system for industrial structure development

	Primary Indicators	Secondary Indicators	Calculation Method	Direction
Industrial Structure Development	Advancement	Industrial Structure Optimization Rate	Contribution of the Tertiary Industry to the Contribution of the Secondary Industry	+
	Rationalization	Advanced Industrial Structure	R&D/GDP	+
		Rationalization Level of Industrial Structure	Theil Index (IST)	-
	Greening	Depth of Green Concept Awareness	Energy Consumption of Industrial Enterprises Above Designated Size	-

The formula for the Theil Index is:

$$\mathrm{TL} = \sum_{i=1}^{n} \left(\frac{Y_i}{Y}\right) \ln\left(\frac{Y_i/L_i}{Y/L}\right) \tag{1}$$

where, L: Number of employees; Y: Output value; i: Industry; n: Number of industries. TL≥0, and the smaller the TL value, the more rational the industrial structure.

Industrial Upgrading Index:

$$\mathrm{IS} = \sum_{i=1}^{n} q_i * i \tag{2}$$

where, i: Industry; n: Number of industries; q_i: Total value of the i-th industry as a proportion of total output value. The weighted value of the industry ratio is used as an indicator for measuring industrial structure upgrading. The larger the IS value, the higher the degree of industrial structure upgrading.

3.2 Data Standardization

Due to the selection of both positive and negative indicators, it is necessary to normalize and standardize the data to eliminate the impact of differing units.

The normalization formula for positive indicators is:

$$X_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \tag{3}$$

The normalization formula for negative indicators is:

$$X_i = \frac{X_{\min} - X_i}{X_{\max} - X_{\min}} \tag{4}$$

3.3 Determining Indicator Weights

To ensure the correctness of the weights, this paper adopts a combination of subjective and objective methods, using the Analytic Hierarchy Process (AHP) and the TOPSIS method to determine subjective and objective weights, respectively. It assumes equal importance between subjective and objective weights, and the final combined weight is calculated as follows:

$$W_j = \frac{(V_j + C_j)}{2} \tag{5}$$

where, V_j represents the subjective weight, C_j represents the objective weight, and W_j represents the final combined weight.

The final combined weights are shown in Table 3 and Table 4.

3.4 Coupling Degree Model

The coupling coefficient model is used to evaluate the coupling degree between green finance development and industrial structure optimization in Hebei Province. The calculation formula is as follows:

$$\mathrm{C} = 2 * \sqrt{\frac{U_1 U_2}{(U_1 + U_2)^2}} \tag{6}$$

where, U_1 is the comprehensive index of green finance development, U_2 is the comprehensive index of industrial structure upgrading, and C is the coupling degree, $C \in$[0,1]. A higher C value indicates better coupling between green finance and industrial structure upgrading.

The coupling degree model reflects the interaction between green finance and industrial structure upgrading but does not indicate whether the indicators are mutually promoting at a high level or mutually constraining at a low level. Therefore, this paper introduces a coupling coordination degree index to construct a coupling coordination model between the two indicators, reflecting the coordinated development status of green finance and industrial structure upgrading. The formula is as follows:

$$\mathrm{D} = \sqrt{CT} \tag{7}$$

$$\mathrm{T} = \alpha \cdot U_1 + \beta \cdot U2 \tag{8}$$

where, D is the coupling coordination degree, T is the coordination index, α and β are coefficients to be determined, generally $\alpha + \beta = 1$. In this study, it is assumed that green finance development and industrial structure optimization are equally important, thus α=β=0.5. Drawing on existing research results, the classification of coupling coordination degree and coupling degree is shown in Table 5 and Table 6.

Table 3. Explanation of weights for green finance development indicators

		Primary Indicators	Secondary Indicators	Weight
Green Finance Development	Structure	Green Credit	Proportion of Green Credit	0.3018
			Proportion of Interest Expenses in High-Energy-Consuming Industries	0.0695
			Degree of Green Bond Development	0.0608
		Green Bonds	Market Value Ratio of Environmental Protection Enterprises	0.1350
			Market Value Ratio of High-Energy-Consuming Industries	0.0327
		Green Investment	Proportion of Environmental Pollution Control Investment	0.0501
			Proportion of Public Expenditure on Energy Conservation and Environmental Protection	0.0324
			Proportion of Environmental Pollution Control Investment	0.0534
		Green Insurance	Degree of Environmental Pollution Liability Insurance Promotion	0.0607
			Proportion of Agricultural Insurance	0.2036
	Scale	Financial Development Level	Proportion of Total Deposits and Loans of Financial Institutions	0.4375
		Financial Industry Output Ratio	Proportion of Financial Industry Output	0.5625

Table 4. Explanation of weights for industrial structure development indicators

	Primary Indicators	Secondary Indicators	Weight
Industrial Structure Development	Advancement	Industrial Structure Optimization Rate	0.3824
		Industrial Structure Advancement	0.2019
	Rationalization	Rationalization Level of Industrial Structure	0.1863
	Greening	Depth of Green Awareness	0.2294

Table 5. Coupling degree evaluation criteria

Coupling Degree Type	Coupling Degree Interval	Characteristics
Low-level Coupling Stage	$(0, 0.3]$	Green finance and industrial structure begin to interact and are at a low-level coupling stage. When $\mathrm{C} = 0\mathrm{C} = 0\mathrm{C} = 0$, the two indicators are unrelated and tend to develop in a disordered manner.
Competitive Stage	$(0.3, 0.5]$	The interaction between green finance and industrial structure is strengthened.
Adjustment Stage	$(0.5, 0.8]$	Green finance and industrial structure exhibit mutual adjustment and coordination, showing positive coupling characteristics.
High-level Coupling Stage	(0.8, 1]	Green finance and industrial structure show stronger positive coupling, gradually moving towards an orderly development phase. When $\mathrm{C} = 1\mathrm{C} = 1\mathrm{C} = 1$, the two indicators achieve resonance coupling and tend to form a new orderly structure.

Table 6. Coupling coordination degree evaluation criteria

Coupling Coordination Degree Type	Coupling Coordination Degree Interval	Characteristics
Disequilibrium Stage	(0, 0.2]	Extensive development of the industrial structure leads to worsening pollution and environmental degradation, with minimal impact of green finance on the industrial structure.
Near Disequilibrium Stage	(0.2, 0.4]	The industrial structure is still extensively developed, but the optimization effect of green finance on the industrial structure is improved.
Barely Coordinated Stage	(0.4, 0.6]	The industrial structure gradually shifts towards cleanliness and greenness, with the role of green finance in optimizing the industrial structure further strengthened, and ecological problems beginning to be resolved.
Moderately Coordinated Stage	(0.6, 0.8]	Industrial structure optimization achieves certain results, with green finance playing a significant guiding role, and noticeable improvement in the ecological environment.
Highly Coordinated Stage	$(0.8, 1]$	Green finance and industrial structure optimization mutually promote each other, meeting the needs of various stakeholders and achieving an orderly development of the ecological environment.

3.5 Empirical Analysis

Using the above coupling degree model and coupling coordination degree model, this study measures the levels of green finance development, industrial structure development, the coupling degree of green finance development and industrial structure optimization, and the coupling coordination degree across four dimensions. It empirically analyzes the development status of the green finance and industrial structure systems in Hebei Province and their mutual influences. From temporal and spatial perspectives, it explores whether the coupling coordination degree between green finance and the ecological environment system in Hebei Province exhibits consistency and balanced development synergy. The ultimate goal is to enhance the role of the green finance system in promoting industrial structure optimization. The results are shown in Table 7, and a more intuitive line chart is shown in Figure 2.

Table 7. Results of the coupling model for green finance development and industrial structure adjustment in Hebei Province

Year	Coupling Degree C	Coupling Coordination Degree D	Classification
2001	0.546	0.336	Near Disequilibrium Stage
2002	0.599	0.360	Near Disequilibrium Stage
2003	0.678	0.367	Near Disequilibrium Stage
2004	0.851	0.359	Near Disequilibrium Stage
2005	0.824	0.373	Near Disequilibrium Stage
2006	0.855	0.373	Near Disequilibrium Stage
2007	0.863	0.379	Near Disequilibrium Stage
2008	0.881	0.385	Near Disequilibrium Stage
2009	0.896	0.389	Near Disequilibrium Stage
2010	0.893	0.408	Barely Coordinated Stage
2011	0.900	0.416	Barely Coordinated Stage
2012	0.900	0.408	Barely Coordinated Stage
2013	0.880	0.397	Near Disequilibrium Stage
2014	0.880	0.420	Barely Coordinated Stage
2015	0.900	0.491	Barely Coordinated Stage
2016	0.873	0.549	Barely Coordinated Stage
2017	0.897	0.585	Barely Coordinated Stage
2018	0.900	0.636	Moderately Coordinated Stage
2019	0.897	0.677	Moderately Coordinated Stage
2020	0.896	0.643	Moderately Coordinated Stage
2021	0.899	0.597	Barely Coordinated Stage
2022	0.898	0.594	Barely Coordinated Stage
2023	0.900	0.659	Moderately Coordinated Stage

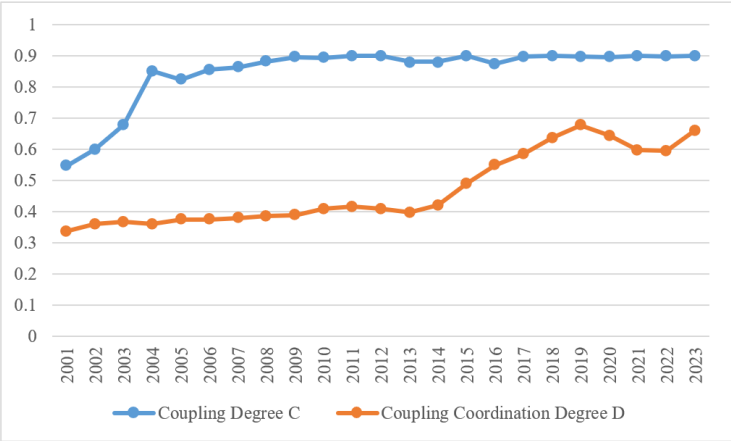

Figure 2. Line chart of coupling degree and coupling coordination degree

According to the coupling coordination degree model, the coupling degree in Hebei Province in 2001 was calculated as 0.546, and the coupling coordination degree was 0.336, classified as the near disequilibrium stage. After ten years of efforts, a qualitative change occurred in 2010 due to the accumulation of quantitative changes, achieving a barely coordinated coupling degree between green finance and industrial structure upgrading. In the following years, the coupling coordination degree generally showed an upward trend. In 2015, the Central Committee of the Communist Party of China and the State Council issued the Overall Plan for the Reform of the Ecological Civilization System, proposing for the first time the overall goal of "establishing a green financial system." Hebei Province's green finance development entered a fast track. In 2016, seven ministries and commissions, including the People's Bank of China and the Ministry of Finance, jointly issued the Guidelines for Establishing a Green Financial System, which clarified key tasks and specific measures for constructing the green financial system, providing policy support for the standardized development of green finance. To further implement central policies, financial regulatory departments such as the Shijiazhuang Central Sub-branch of the People's Bank of China, the Hebei Banking and Insurance Regulatory Bureau, and the Hebei Provincial Financial Office successively issued a series of policy guidance documents, including the Implementation Opinions on Financial Support for Economic Structural Adjustment and Industrial Transformation and Upgrading in Hebei Province by the Shijiazhuang Central Sub-branch of the People's Bank of China, the Guiding Opinions on the Banking Industry of Hebei Province Supporting Industrial Structure Adjustment, Air Pollution Prevention, and Bank Risk Control, and the Implementation Opinions on Building a Green Financial System by twelve departments including the Hebei Provincial Financial Office. These policies actively guided financial resources toward low-carbon and environmental protection sectors, promoting the transformation and green development of Hebei's economy [18]. With the continuous implementation of national and local green finance policies, the coupling degree of green finance development and industrial structure upgrading in Hebei Province rose to the moderately coordinated stage starting in 2018. However, due to the special economic environment and the impact of the pandemic in recent years, the coupling degree fell back to the barely coordinated stage in 2021 and 2022. After the pandemic ended in 2023, it slightly rebounded to the moderately coordinated stage.

Overall, the coupling degree between green finance development and industrial structure optimization in Hebei Province shows an upward trend, with increasing interaction. However, it is still in the moderately coordinated stage, indicating that there is still a long way to go in terms of how the green financial system can drive industrial structure upgrading.

3.6 Coupling Coordination Degree Development Forecast for Hebei Province

To better explore the coupling relationship between green finance development and industrial structure optimization in Hebei Province, this paper uses the Grey GM(1,1) model. The coupling coordination degree data of Hebei Province from 2001 to 2023 are taken as the initial values, and the forecast for the coupling relationship between green finance and industrial structure is made using R software, followed by a posteriori residual check. The final posterior residual ratio is C=0.23. Based on the posterior residual accuracy classification in Table 8 and Table 9, the model's accuracy is considered excellent.

Based on the forecast results of the Grey GM(1,1) model, it can be concluded that under the condition that the macroeconomic environment does not experience drastic changes, the overall coupling coordination degree of Hebei Province will show an upward trend. Between 2024 and 2031, it will remain at a moderately coordinated stage, and by 2032, it will officially enter a highly coordinated stage. At that time, green finance and industrial

structure optimization will mutually promote each other, meeting the demands of different stakeholders, and achieving coordinated and orderly development of the ecological environment and economic growth. In 2023, Hebei Province's GDP was 4.39441 trillion yuan, an increase of 157.37 billion yuan from the previous year, with a growth rate of 5.5%, slightly higher than the national GDP growth rate of 5.2%. This growth rate is commendable, especially under the considerable environmental pressures and continuous supply-side reforms, allowing Hebei to maintain growth that is on par with the national average. Regarding the industrial structure, in 2023, the added value of the primary, secondary, and tertiary industries accounted for 10.2%, 37.4%, and 52.4% of the GDP in Hebei Province, respectively. Compared to the industrial structure of 2022 (10.4:40.2:49.4), the proportion of the secondary industry has decreased, while the proportion of the tertiary industry has increased. However, the industrial sector remains an important pillar. Therefore, Hebei Province should focus on the green transformation of pillar industries such as the steel industry, equipment manufacturing, petrochemicals, and food sectors, and develop specialized green finance policies. At the same time, it should vigorously cultivate strategic emerging industries with low energy consumption and high added value, such as new-generation information technology, biomedicine, new energy, and new materials, while appropriately orienting the green finance system to support these sectors.

Table 8. Posteriori residual accuracy classification table

Accuracy Level	Posterior Residual Ratio
Excellent	< 0.35
Qualified	< 0.5
Barely	< 0.65
Unqualified	≤ 0.7

Table 9. Forecasted coupling coordination degree values

Year	Forecasted Coupling Coordination Degree	Year	Forecasted Coupling Coordination Degree	Year	Forecasted Coupling Coordination Degree
2024	0.671	2029	0.764	2034	0.878
2025	0.692	2030	0.779	2035	0.907
2026	0.714	2031	0.795	2036	0.938
2027	0.737	2032	0.822		
2028	0.750	2033	0.849		

4 Conclusions and Recommendations

Focusing on the role mechanism of green finance in industrial structure upgrading, this paper empirically analyzes the coupling coordination degree between green finance development and industrial structure optimization in Hebei Province, using the time series data from 2001 to 2023. The study reveals that the coupling degree between the two continues to improve, with increasing interactivity, but currently remains at a moderately coordinated stage. Further analysis using the Grey Forecasting Model shows that Hebei Province will continue to experience an upward trend in coupling coordination, officially entering the highly coordinated stage starting from 2032. At that time, green finance development and industrial structure optimization will mutually promote each other, satisfying the needs of different stakeholders, and achieving coordinated and orderly development of the ecological environment and economic growth.

Based on these conclusions, the following insights can be drawn:

(1) Further improve relevant laws, regulations, and policy systems, and build a unified green finance service platform

The development of green finance in Hebei Province is still in its early stages, and its healthy growth relies on the support and regulation of policies and laws. Hebei should further improve local regulations based on regional industrial characteristics and enforce regular supervision, encouraging cooperation among multiple departments to drive high-pollution enterprises toward green transformation. Green finance can play a guiding role in this process.

Additionally, a green finance service platform should be established in Hebei Province to optimize the business environment. By leveraging big data, this platform can precisely match the financing needs of enterprises with the funding supply from financial institutions, providing one-stop financial services to enterprises, thus improving the efficiency of financial institutions and the success rate of financing for SMEs. Advanced technologies such as artificial intelligence and cloud computing can be used to enhance the green finance capabilities of financial institutions, rapidly develop green finance businesses, expand the scale of green finance, and effectively reduce actual financing costs, ultimately guiding green finance services toward high-quality development of the real economy and supporting Hebei's green transformation.

(2) Expand green finance business types and cultivate green finance professionals

At present, green finance primarily consists of green loans, with few other business types and a lack of a comprehensive green finance system [19]. This is insufficient to meet current needs. Government departments, the China Banking and Insurance Regulatory Commission, and other institutions can select and cultivate professional talents through research projects in universities and research institutes or by establishing research institutes. This will further enrich the theoretical and practical system of green finance.

(3) Encourage enterprises to strengthen research on green finance policies and actively transform and upgrade

Government departments and financial institutions should promote the study and research of green finance policies among enterprises through lectures, seminars, and other means. Enterprises should be encouraged to align their efforts with their own difficulties and needs, seeking targeted policy support to enhance their financing capabilities. The government can also offer green consumption subsidies, special funds for green transformation, and other incentives to encourage enterprises to actively transform and upgrade, strengthening the research and development of technologies for energy conservation, emission reduction, and pollution control, thus achieving sustainable development. The development of green finance also requires enterprises to improve environmental information disclosure, allowing society to understand their green investments, green culture, and environmental protection activities, which helps to build and improve the enterprises' green image.

(4) Accelerate the integration of environmental factors into the cost evaluation system

Establishing a sound environmental cost database is essential for reversing the traditional energy-intensive production mode and promoting the creation of green business models. It also facilitates investors in making green investment decisions for listed companies [20]. Therefore, the government should urge enterprises to establish and improve environmental cost information systems, replacing the traditional assessment system with one that includes environmental protection parameters. Financial institutions have the responsibility to set preferential interest rates based on environmental impact when setting loan rates, applying higher rates to projects that oppose sustainable development, and offering low-interest loans to support green and environmentally-friendly projects. Using credit limits, financial institutions can encourage green industries to create environmentally sustainable circular production models.

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Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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