

Coupling Study of Green Finance and High-Quality Economic Development

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Abstract: Based on panel data from 16 prefecture-level cities in Shandong Province from 2012 to 2021, a comprehensive evaluation system for the development of green finance and high-quality economic development in Shandong Province was constructed. The entropy weight method was used to calculate the comprehensive index of both. The research shows that, temporally, from 2012 to 2021, the coupling degree between green finance development and high-quality economic development in the prefecture-level cities of Shandong Province was mostly at a high or relatively high level, with the coordination degree increasing year by year. However, the overall level remained low, with most cities in a state of mild or near imbalance. Spatially, only coastal cities such as Qingdao, Dongying, Weihai, and Rizhao achieved basic coordination, with the coordination degree of coastal cities being higher than that of inland cities. Among them, coastal cities mainly exhibited high-high or high-low types, while inland areas mostly showed low-low types, failing to form a good linkage effect.

Keywords: Shandong Province, green finance, high-quality economic development, coupling coordination, Moran index

1. Introduction

Since the reform and opening up, China has experienced tremendous economic development. However, with this rapid economic growth, various environmental pollution problems have also emerged one after another. In the new era, while coordinating economic development, the central government has also paid attention to the protection of the natural environment. The central government has consistently emphasized developing China's economy without compromising the natural environment [1]. In 2017, during the 19th National Congress of the Communist Party of China, the central government first proposed the important concept of high-quality development. The congress emphasized that China's economy is transitioning from high-speed growth to a stage of high-quality development, with a focus on environmental protection. Environmental protection has gradually become a focal point of concern, necessitating measures to achieve sustainable economic and social development. This new statement marks a shift in China's development philosophy, highlighting the importance of the quality of economic growth and environmental protection, and providing strategic guidance for building a modern economic system and ecological civilization [2]. Green finance, as an environmentally-friendly financial approach, can guide high-energy-consumption, high-pollution enterprises to transition towards low-carbon and green operations. The

2023 Government Work Report pointed out that during the 14th Five-Year Plan period, energy consumption per unit of GDP is expected to decrease by 8.1%, and carbon dioxide emission intensity by 14.1%, demonstrating China's determination to promote green, low-carbon, and high-quality economic development. As a major province in eastern coastal China, with significant population, resources, and industry, Shandong Province's development trajectory mirrors that of China [3]. Since the new era, China's rapid economic growth has exerted tremendous pressure on Shandong's resources and environment. Shandong Province's pollutant emissions once ranked among the highest in the country, prompting the provincial government to explore pathways for green transformation. In 2016, Shandong's 13th Five-Year Plan proposed the development of green finance. At the beginning of 2018, the inaugural year of Shandong's conversion from old to new growth drivers, the government adhered to the path of green development and resolutely eliminated outdated capacities. The 14th Five-Year Plan and the 2035 long-term goals put forward by Shandong Province in 2021 emphasized accelerating green and low-carbon development, promoting the formation of green production methods, and continuing to develop green finance.

2. Theoretical Analysis

Since the 13th Five-Year Plan, China has vigorously advocated for the establishment of a green finance system, leveraging the advantages of green finance to foster economic development. Achieving high-quality economic development is inseparable from the support of green finance, which plays roles in adjusting capital flows, assuming social responsibilities, and promoting green consumption. By developing green finance and establishing an environmentally friendly, low-carbon market, economic high-quality development can be promoted [4].

2.1. Adjusting Capital Flows

The market should fully exert its role in helping green finance achieve a virtuous cycle of green financing and green investment. At the same time, the government should play a guiding role by formulating policies and setting incentives to promote the low-carbon, environmentally friendly functions of green finance [5]. Providing funds and liquidity is one of the key functions of the financial market, and green finance has become a bridge promoting financial development and economic growth. Currently, China has both traditional high-energy-consuming, high-pollution industries and emerging low-carbon, environmentally friendly industries. If the original industrial structure is maintained and high-energy-consuming, high-pollution industries are encouraged to continue developing, it will inevitably lead to resource waste and environmental pollution [6]. As a part of the entire financial industry, green finance can not only guide capital towards environmentally friendly industries but also integrate other production factors, pushing resources to flow towards these industries [7].

2.2. Assuming Social Responsibility

Green finance serves as a financial tool and financial institution role in China's ecological construction and alleviation of environmental pressure. By promoting sustainable development and driving the construction of an ecological civilization, it provides important support and guarantees for achieving sustainable economic and social development [8]. As an industrial powerhouse in China, most enterprises in Shandong Province are characterized by high pollution and high energy consumption. Green finance, an effective tool that integrates traditional finance with green economic development, significantly emphasizes the mission of promoting social development. As an emerging financial activity, green finance is inherently sensitive to and accurately reflects national policies. Firstly, by establishing supervision and indicators, it can moderately increase financing amounts and

carbon emission quotas for enterprises that comply with energy conservation and emission reduction regulations, while correspondingly reducing financial support for those that violate regulations [9]. Secondly, green finance can guide enterprises to adopt green concepts, proactively assume social responsibilities, and promote a green, healthy social development.

2.3. Promoting Green Consumption

As environmental awareness awakens among people, green consumption has become an increasingly sought-after demand by consumers [10]. The improvement of green finance policies helps cultivate the concept of green consumption among the public. With its low-carbon, environmentally friendly principles, green finance promotes the public's awareness of green consumption, enhancing both consumer demand for green products and enterprises' green supply, thereby driving the development of green industries [11]. The rise of green industries will propel other traditional industries towards green transformation and sustainable development, promoting the optimization and upgrading of the industrial structure. In this process, green finance plays a crucial role.

3. Empirical Analysis

This paper uses the entropy method to construct the indices of green finance and high-quality economic development as a composite entity. Studying these aspects with only a single indicator cannot adequately reflect their development. Given data availability, the study examines green finance from dimensions such as green credit, green insurance, green investment, and carbon finance. Since carbon emission data is not easily obtainable, the carbon emission coefficient is used for calculations. High-quality economic development is examined from dimensions such as innovative development, coordinated development, green development, open development, and shared development.

The coupling degree between green finance and high-quality economic development is categorized into low coupling, medium coupling, relatively high coupling, and high coupling. Their coordination degree is divided into severe imbalance, moderate imbalance, mild imbalance, on the verge of imbalance, basic coordination, good coordination, and high coordination.

3.1. Temporal Coupling Evolution

The coupling degree and coupling coordination degree between green finance and high-quality economic development were calculated for the 16 prefecture-level cities in Shandong Province from 2012 to 2021, as shown in Table 1.

Table 1: Scores and Coupling Analysis of Green Finance and High-Quality Economic Development in Prefecture-Level Cities of Shandong Province (2012-2021)

Year	Comprehensive Score of High-Quality Economic Development	Comprehensive Score of Green Finance	Coupling Degree	Coupling Coordination Degree	Comprehensive Coordination Index
2012	0.207	0.081	0.896	0.354	0.144
2013	0.220	0.089	0.905	0.369	0.154
2014	0.235	0.094	0.899	0.379	0.164
2015	0.263	0.093	0.878	0.391	0.178
2016	0.280	0.091	0.854	0.393	0.185
2017	0.293	0.091	0.854	0.400	0.192
2018	0.381	0.149	0.802	0.451	0.265

Table 1: (continued).

2019	0.402	0.147	0.822	0.466	0.275
2020	0.466	0.103	0.783	0.457	0.275
2021	0.490	0.111	0.781	0.478	0.300

Based on the data shown in Table 1, the comprehensive indices for green finance and high-quality economic development have shown a year-on-year growth trend, but the overall development level remains relatively low. Specifically, the comprehensive score for green finance peaked in 2018 at 0.149, then gradually declined; meanwhile, the comprehensive score for high-quality economic development has steadily increased over the past decade, reaching its highest value of 0.490 in 2021.

In terms of the temporal evolution of the coupling degree, the coupling degree between green finance development and high-quality economic development in Shandong Province was as high as 0.905 in 2013, the highest value in the past decade. In other years, the coupling degree fluctuated between 0.781 and 0.905. Although it has slightly decreased, it has remained relatively stable overall. Overall, the coupling level between green finance development and high-quality economic development in Shandong Province is relatively high, falling into the high and above intensity levels, indicating that the two systems can achieve a positive cycle. However, it is worth noting that the comprehensive score for green finance development is significantly low. Although the comprehensive score for high-quality economic development is increasing year by year, it is still below 0.5. The coupling degree between the two, however, is above 0.78, showing a distinct characteristic of “low development, high coupling.”

3.2. Spatial Coupling Evolution

Table 2: Analysis of the Coupling Coordination Degree of Green Finance and High-Quality Economic Development in Shandong Province in 2012 and 2021

Coupling Coordination Degree	Moderate Imbalance	Mild Imbalance	On the Verge of Imbalance	Basic Coordination
2012	Zaozhuang	Dezhou, Tai'an, Jining, Heze, Rizhao, Dongying, Yantai, Binzhou, Weifang, Zibo, Liaocheng, Linyi	Jinan, Qingdao, Weihai	
2021			Dezhou, Tai'an, Jining, Heze, Rizhao, Dongying, Binzhou, Zaozhuang, Weifang, Jinan, Liaocheng, Linyi	Qingdao, Dongying, Yantai, Weihai

Based on the coupling degree criteria mentioned above, Table 2 shows that in 2012, there was only one city in Shandong Province in a state of moderate imbalance, which was Zaozhuang. In 2021, no cities were in a state of moderate imbalance. In 2012, 12 cities were in a state of mild imbalance, and three cities were on the verge of imbalance, namely Jinan, Qingdao, and Weihai. In 2021, 12 cities were on the verge of imbalance, and four cities were in a state of basic coordination, namely Qingdao, Dongying, Yantai, and Weihai, with no cities in a state of mild imbalance. Overall, there were no cities in the province with good coordination or high coordination, but the coordination level of each prefecture-level city has been increasing year by year. This indicates that there are certain obstacles

in the coordination role between the development of green finance and high-quality economic development in Shandong Province, but there is great potential for development and considerable room for improvement.

3.3. Spatial Effects Test of Coupling Coordination Degree between Green Finance and High-Quality Economic Development

3.3.1. Global Moran's Index

The Global Moran's Index was constructed to detect the spatial correlation degree of the coupling coordination between green finance and high-quality economic development in Shandong Province. The specific results are shown in Table 3. Over the ten years from 2012 to 2021, most years showed significant results in the coupling coordination degree of green finance and high-quality economic development in Shandong Province. This indicates that the coupling coordination degree between green finance and high-quality economic development in Shandong Province does not exhibit a random spatial distribution but rather shows significant spatial dependence.

Table 3: Global Moran's Index of Shandong Province (2012-2021)

Year	I	E(I)	sd(I)	z	p-value*
2012	0.231	-0.067	0.177	1.683	0.046
2013	0.148	-0.067	0.168	1.276	0.101
2014	0.429	-0.067	0.177	2.806	0.003
2015	0.320	-0.067	0.180	2.143	0.016
2016	0.300	-0.067	0.181	2.028	0.021
2017	0.120	-0.067	0.183	1.021	0.154
2018	-0.196	-0.067	0.114	-1.132	0.129
2019	0.159	-0.067	0.120	1.879	0.030
2020	0.248	-0.067	0.180	1.946	0.026
2021	0.139	-0.067	0.179	1.145	0.126

3.3.2. Local Moran's Index

Table 4: Comparison of Local Moran's Index in Shandong Province in 2012 and 2021

Quadrant	1st Quadrant	2nd Quadrant	3rd Quadrant	4th Quadrant
2012	Qingdao, Rizhao, Weifang, Dongying, Weihai	Yantai, Binzhou, Dezhou, Zibo, Liaocheng	Tai'an, Linyi, Zaozhuang, Jining, Heze	Jinan
2021	Weihai, Yantai	Weifang, Rizhao, Binzhou, Zaozhuang, Tai'an	Dezhou, Liaocheng, Heze, Jining	Jinan, Qingdao, Zibo, Dongying, Linyi

In 2012, the cities in the first quadrant were Rizhao, Qingdao, Weifang, Yantai, Weihai, and Dongying, which are coastal cities. This indicates that they had a high level of coordinated development. However, by 2021, only Yantai and Weihai remained in the first quadrant, representing the only cities capable of achieving a good interaction effect. Rizhao, Weifang, and Binzhou, as coastal cities, moved to the second quadrant in 2021 and did not form effective interaction with surrounding cities. Jinan has consistently been in the fourth quadrant. Despite having a high self-coordination degree, as an inland provincial capital, it did not play a leading role and failed to establish linkage with surrounding inland cities. Among the cities around Jinan, only Zibo moved to

the fourth quadrant in 2021, falling into the high-low category, while the others such as Dezhou, Liaocheng, Tai'an, and Binzhou remained in the low-low and low-high categories. Dongying and Qingdao shifted from the first quadrant in 2012 to the fourth quadrant in 2021. Although their coordination degree is inherently high, they did not leverage their advantageous positions as coastal cities to drive the coordinated development of other cities.

4. Conclusion and Recommendations

4.1. Conclusion

First, from the perspective of temporal coupling, the comprehensive score for high-quality economic development in Shandong Province gradually increased from 2012 to 2021, while the score for green finance initially rose, peaked in 2018, and then declined. The coupling degree between the two remained at a relatively high level. However, the overall coupling coordination degree was relatively low, with the highest level only reaching “near imbalance,” indicating a shallow degree of misalignment. Despite this, the coupling coordination degree gradually increased from 2012 to 2021, suggesting significant development potential. Observing the comprehensive scores and coupling degrees of the two subsystems—green finance and high-quality economic development—reveals a substantial gap between them, which may have prevented the coupling coordination degree from reaching an ideal state.

Secondly, from the perspective of spatial coupling, there are differences in the coupling coordination of green finance and high-quality economic development among the 16 prefecture-level cities in Shandong Province. In 2021, only coastal cities such as Qingdao, Dongying, Yantai, and Weihai achieved basic coordination. Only Zaozhuang experienced moderate imbalance, mild imbalance, and impending imbalance, representing three coordination levels. The coupling coordination of coastal cities is generally higher than that of inland cities. The majority of Shandong Province's global Moran's indexes were significant from 2012 to 2021, indicating a positive spatial correlation. According to the local Moran scatter plot, only Yantai and Weihai formed interactive effects among coastal cities. Jinan did not leverage its provincial capital advantage to drive surrounding inland cities' linkage. Coastal cities such as Qingdao have inherently high coupling coordination but have not leveraged their coastal advantages to drive surrounding cities' coordinated development.

4.2. Recommendations

Firstly, the coupling coordination between green finance and high-quality economic development in Shandong Province is gradually increasing, indicating that they are becoming more closely interconnected, representing a situation where they are gradually promoting each other and achieving mutual benefit. The Shandong Provincial Government should fully supervise green finance's depth and breadth of support for high-quality economic development, while also utilizing high-quality economic development to promote the development of green finance.

Secondly, green finance performs poorly in terms of comprehensive scores, indicating the need for the government to pay more attention to green development and curb the environmental damage caused by highly polluting and energy-consuming enterprises. To achieve this, the government needs to accelerate the improvement of the green finance policy system, promote green concepts among enterprises and the public, and guide more social capital into the green sector. Accelerating the promotion of economic transformation and upgrading will inject vitality into Shandong Province's transition of old and new economic drivers.

Finally, the Shandong Provincial Government should focus on the linkage between green finance and high-quality economic development in each prefecture-level city. Jinan, as an important city in

the central part of Shandong, has unique resources and geographical advantages in green finance and high-quality economic development. Therefore, the government should increase its support for Jinan and promote it to become an economic growth engine in the inland areas.

References

- [1] Zhang, J., Hou, Y., Liu, P., He, J., & Zhuo, X. (2019). *The goal requirements and strategic path of high-quality development. Management World*, (7), 1-7.
- [2] Gong, P. (2023). *The theoretical logic, measurement evaluation, and policy suggestions for China's high-quality economic development. Macroeconomic Research*, (11), 4-13+95.
- [3] Fang, D., & Ma, W. (2019). *Measurement and spatiotemporal characteristics of interprovincial high-quality development in China. Regional Economic Review*, (2), 61-70.
- [4] Li, Q. (2021). *Construction and measurement of evaluation index system for high-quality economic development. Statistics and Decision*, (15), 109-113.
- [5] Li, J., Shi, L., & Xu, A. (2019). *Discussion on evaluation index system for high-quality development. Statistical Research*, (1), 4-14.
- [6] Yin, Z., Sun, X., Xing, M., et al. (2021). *Study on the impact of green finance development on green total factor productivity. Statistics and Decision*, (3), 139-144.
- [7] Wang, J. (2023). *Green finance assists sustainable development. People's Forum*, (22), 18-21.
- [8] Zhang, Y., & Hui, B. (2023). *Research on the impact effect of green financial policies on enterprise total factor productivity. Fujian Forum (Humanities and Social Sciences Edition)*, (6), 112-127.
- [9] Wang, Z., & Wang, Y. (2020). *Green finance promotes high-quality economic development: Main paths and countermeasure suggestions. Journal of Agro-Forestry Economics and Management*, (3), 389-396.
- [10] Wang, R., & Zhan, S. (2023). *Research on the synergistic impact of digital inclusive finance and green finance on high-quality economic development. Modern Economic Research*, (7), 59-70.
- [11] Liu, H., & He, C. (2021). *Empirical study on the support of green finance for high-quality economic development based on the mediating effect model. New Finance*, (10), 21-27.