Research on the Influence of Green Finance on Industrial Structure Optimization

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Abstract: Under the background of "dual carbon", green finance plays a key role in promoting the optimization, transformation and upgrading of regional industrial structure. The conclusions are as follows: green finance has a significant spatial spillover effect on the optimization of industrial structure, and there is regional heterogeneity. The spillover effect of green finance on the optimization of industrial structure is more significant in the western region, followed by the central and western regions. Therefore, in the process of regional green finance development, each region should actively promote the improvement and development of green finance according to local conditions, to drive the optimization and transformation of regional industrial structure.

Keywords: Green Finance, Optimization of Industrial Structure, Spatial Spillover Effect

1. Introduction and Literature Review

China's economy has gone through a series of development stages such as reform and opening up, and has entered the "14th Five-Year Plan" period. China has gradually shifted from the low-end labor-intensive industries to the innovation-driven development stage, and the resource-intensive and environmentally polluting industries in the past are no longer suitable for the current economic development structure of China. At the same time, drastic changes in the domestic and international environment pose severe challenges to China's economic development. First of all, the past low-end industries tend to be saturated, their marginal contribution to China's economic growth has gradually weakened, and the employment absorption capacity of related industries has become saturated. In addition, foreign restrictions on China's high-tech related fields have made it urgent for China's economy to find new growth points, and relevant industries need to be transformed and optimized to develop high-end technology industries to drive new economic growth points. To absorb surplus labor at the middle and low end; Secondly, in the stage of rapid industrial development, the negative environmental externalities brought by traditional industries seriously restrict China's economic growth, and the related governance costs need to be gradually increased. The impact of various disasters and extreme weather caused by global environmental problems has become increasingly significant, and it needs to be paid more attention to. China's past industrial development mode of "emphasizing economy and ignoring environment" is no longer suitable for the current development situation. It is necessary to gradually adjust the industrial structure, carry out green transformation from the inside and outside of the industry, and transform to the industrial development mode of "economic quality and environment friendly". However, the traditional financial development model cannot achieve both ecological environment protection and economic development. Therefore, green finance has emerged as a new financial development model that takes both ecological environment and economic development into account. Green finance can adjust the factor structure between industries and drive regional industrial transformation through the resource allocation and other functions of various innovative financial tools.[1]

To sum up, the domestic and international environment of China's economic development has changed, and the past industrial structure model is no longer suitable for the current and future economic development of China. China urgently needs to seek new economic growth points, optimize the industrial structure, and promote the optimization and transformation of regional industrial structure through various functional means of green finance. To provide a new direction for the "green, efficient and high-quality" development of China's economy.

2. Literature Review

The research on the mechanism of green finance and industrial structure started relatively late.[2] Schumpeter (1934) found in his systematic study of banking credit products and services that bank-related credit products can rationally allocate funds in various industries, and then have a significant positive effect on industrial structure adjustment. Cowan(1999) proposed that financing is one of the ways that green finance affects industrial development. Subsequently, the research on the mechanism related to green finance and industrial structure gradually entered the empirical stage. Tadesse(2007) conducted an empirical analysis on the data of 38 countries at the national level and found that the development of financial industry had a significant impact on the upgrading of industrial structure and the improvement of labor productivity. Acemoglu(2012) went further on this basis and found that the promotion effect of financial development on industrial structure upgrading was mainly realized by improving total factor productivity (TFP).

For the research on green finance and industrial structure, domestic scholars focus on the theoretical level and the industrial level. From the theoretical perspective, Ma Jun (2015) believed that compared with traditional finance, green finance pays more attention to the environmental effect of industrial economic development, and requires financial institutions to take environmental protection and sustainable development into consideration in the process of business development, so as to effectively link the financial sector with the environmental sector and guide funds to flow into the green and environmental protection industry. In order to promote the upgrading of regional industrial structure and high-quality economic development.

Some scholars have discussed the impact of green finance on industrial transformation from the aspects of rationalization, optimization and ecological industrial structure. Liu and He (2019) divided industrial transformation into two indicators: the rationalization of industrial structure and the optimization of industrial structure, and argued that the development of green finance has a significant role in promoting the industrial transformation and high-quality economic development in the central region. Gao and Zhang (2021) found that the development of green finance has significantly promoted the ecological transformation of industrial structure, and its promotion effect on the eastern region is greater than that on the western region. Guo Kesha (2021) believed that green finance not only guided financial resources to flow to green and environmental protection industries, but also restricted the capital lending of "high, high and surplus" industries, and promoted the industrial transformation and upgrading of the region by encouraging the development of clean industries and restricting the development of high-pollution industries. At the same time, other scholars put forward the opposite view on the relationship between green finance and industrial transformation and development. Zhang Yu and Qian Shuotu (2021) believed that the impact of green finance on the clean industrial structure will be restricted by the bias of environmental technology progress. When the bias of environmental technology progress is lower than a certain critical value, the development of green finance is not conducive to the clean transformation of environmental protection industry.[3] Based on the quasi-natural experiment of green finance Reform and innovation pilot zone, Si Lijuan found that green finance has significant heterogeneity on the ecological transformation of industrial structure, which is different in the regions with different financial development levels and urban industrial characteristics. Hu Wentao (2023) took the ecological industrial structure as the threshold variable, and found that the role of green finance in promoting green development would be more significant only when the level of ecological industrial structure was high.[4]

3. Research Design and Data Description

3.1 Variable Selection and Data Description

3.1.1 Data Source

The purpose of this paper is to study the impact of green finance on the optimization of industrial structure in China, so the data of 30 provinces (except Tibet, Hong Kong, Macao and Taiwan) from 2005 to 2021 are selected as the research samples. In order to ensure the robustness of the model, the logarithm of some variables is taken, and the missing values are supplemented according to the average growth rate. The relevant data come from China Statistical Yearbook, China Energy Statistical Yearbook, China Financial Statistical Yearbook, China Insurance Statistical Yearbook, Industrial Economic Statistical Yearbook, EPS database, CSMAR database, WIND database, and the official website of the People's Bank of China.[5]

3.1.2 Explained Variable

Industrial structure optimization is a complex and comprehensive index system. The optimization of industrial structure not only includes the transformation and upgrading of industrial structure, which drives the high-level development of regional industrial development. At the same time, regional industries should also adapt to local resource endowment and economic development level. Therefore, the environmental externalities brought by industrial development should also be considered when measuring the level of industrial structure, that is, the ecological measurement of industrial structure. There are few studies on the comprehensive measurement of industrial structure optimization in China, and most of them analyze the level of regional industrial structure from a single index. This paper introduces the ecological level of industrial structure, combines the optimization of industrial structure and the rationalization of industrial structure into one index, and uses the principal component analysis method to evaluate the optimization level of regional industrial structure more scientifically and reasonably.[6]

Among them, the optimization index of industrial structure refers to the measurement method of Liu Wei et al., and labor productivity is incorporated into the optimization index system of industrial structure.

AIS_{it}= x, $\sum_{m=1}^{3}\frac{Y_{itm}}{Y_{it}}\frac{Y_{itm}}{L_{itm}}$ m = 1, 2, 3

i is the region, m is the industry, t is the period, Y represents the output value, and L represents the employees. $\frac{Y_{itm}}{Y_{it}}$Represents the proportion of the output value of industry m in the total output value of region i, and $\frac{Y_{itm}}{L_{itm}}$ represents the labor productivity of industry m in region i. AIS_{it}The higher the value is, the higher the level of industrial structure optimization is.

According to Gan Chunhui's method, the Theil index is used to measure the rationalization of regional industrial structure. The index is a reverse index, the more the value is to 0, the higher the level of rationalization of regional industrial structure is, otherwise, the lower the level of rationalization of regional industrial structure is. The corresponding formula is as follows:

$$RIS_{it}=\sum_{m=1}^{3}\frac{Y_{itm}}{Y_{it}}\ln\left(\frac{\frac{Y_{itm}}{L_{itm}}}{\frac{Y_{it}}{L_{it}}}\right)\ldots\ldots\ldots(1)$$

i is the region, m is the industry, t is the period, Y represents the output value, and L represents the employees. $\frac{Y_{itm}}{Y_{it}}$ Represents the proportion of the output value of industry m in the total output value of region i, $\frac{Y_{itm}}{L_{itm}}$ represents the labor productivity of industry m in region i, and $\frac{Y_{it}}{L_{it}}$ is the total labor productivity of region i.

Referring to the practice of Hu Wentao et al., the environmental efficiency index is used to measure the ecological level of industrial structure, and the specific formula is as follows:

$EIS_{it}=\frac{1}{PI}$, where $PI=\frac{1}{PI}\frac{\sum_{m=1}^{n}pi_m}{n}$

So $EIS_{it}=\frac{n}{\sum_{m=1}^{n}pi_m}$, where pi_m is the proportion of total emissions of type m pollutants in GDP, that is, the emissions of pollutants per unit GDP; Here, the amount of industrial wastewater discharge, industrial sulfur dioxide discharge and industrial solid waste are respectively taken. EIS_{it}The higher the median value is, the higher the level of ecological industrial structure is, and otherwise the lower the level of ecological industrial structure is.

Table 1. Industrial Structure Optimization (OIS) Index System

First-level indicators	Secondary indicators	Indicator description
Optimization of industrial structure	Industry structure upgrade	Positive
	Rationalization of the industrial structure	Negative
	Ecological industrial structure	Positive

3.1.3 Explanatory Variables

The construction of green finance index system began in recent years. The index system uses entropy weight method to measure, mainly from five dimensions: green credit, green securities, green insurance, green investment and carbon finance.[7] Among them, green credit mainly includes the following four types of measurement indicators: the proportion of green credit, the proportion of loans for energy conservation and environmental protection projects, the "bank loan" in industrial pollution control investment, and the proportion of interest expenses of six energy-intensive industries, which are reverse indicators. Since the statistics of green credit started in recent years, the data year is relatively short, and most of them are internal data of each bank. Green securities, green insurance, green investment, carbon finance and other relevant measurement indicators refer to the practice of Shu Taiyi. The indicators of each variable are shown in the following table:

Table 2. Indicators of Green Finance (Ge)

Name of variable	Specific instructions	Directions
Green credit	Interest ratio of six industries with high energy consumption	Negative direction
Green securities	Market value of energy-intensive industries/total market value of A shares	Negative direction
Green insurance	Ratio of agricultural insurance income to total agricultural output value	Positive direction
Green investments	Investment in fighting pollution as a percentage of GDP	Positive direction
Carbon finance	Carbon dioxide emissions as a percentage of GDP	Negative direction

3.1.2 Explained Variable

This paper selects urbanization level (urb), human capital level (hc), foreign investment level (fdi), opening-up level (ope), government intervention level (gov), research and development intensity (r&d) and transportation infrastructure (jtjc) as control variables in the analysis of the impact of green finance on industrial structure optimization. Among them, urbanization level (urb) is expressed by dividing the urban population of each region by the total population of the region; The level of human capital (hc) was expressed by dividing the total number of colleges and universities in each region by the total number of colleges and universities in each region at the end of the year; The level of foreign investment (fdi) is used; Level of openness (ope); Level of government intervention (gov); Research and development intensity (r&d); And transportation base (jtjc).[8]

3.2 Measurement Model Selection and Establishment

3.2.1 Spatial Correlation Test

Moran's I is a statistical index used in spatial data analysis to measure spatial autocorrelation. It was proposed by Patrick Alfred Pierre Moran in 1950. The global Moran index is calculated as follows:

$$\text{Moran's I}=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}\ldots\ldots(2)$$

Table 3. Global Moran Index of Green Finance

Year	Moran's I index	Z-score	P-value
2005	0.197	2.756	0.006
2006	0.192	2.784	0.005
2007	0.186	2.762	0.006
2008	0.199	2.930	0.003
2009	0.208	3.021	0.003
2010	0.220	3.151	0.002
2011	0.228	3.223	0.001
2012	0.224	3.194	0.001
2013	0.218	3.148	0.002
2014	0.223	3.289	0.001
2015	0.204	3.068	0.002
2016	0.176	2.808	0.005
2017	0.146	2.480	0.013
2018	0.214	3.237	0.001
2019	0.221	3.323	0.001
2020	0.227	3.399	0.001
2021	0.225	3.366	0.001

Before constructing spatial econometric model to analyze each variable, it is necessary to analyze the spatial correlation between explanatory variables and explained variables. Based on the green finance index constructed above, the following global Moran index is obtained by using the spatial inverse distance matrix (W1). The following table shows the global Moran index of green finance from 2005 to 2021.

It can be seen from the above table that the global Moran's index of green finance has passed the 1% significance test, and the global Moran's index of green finance shows a general growth trend from 0.197 in 2005 to 0.225 in 2021, and is significantly positive, indicating that there is a positive spatial autocorrelation of green finance in each province.

Furthermore, the global Moran index of industrial structure optimization index is calculated. From 2005 to 2021, Moran index showed a certain time series fluctuation. Of particular note is the marked upswing from 2007 to 2011 and from 2013 to 2016. This phenomenon indicates that during these time periods, the adjustment of industrial structure showed a certain agglomeration trend in geographical space. Such trend changes may indicate the promotion of green finance policies or the impact of other relevant factors on industrial structure adjustment during these periods. Although there are large fluctuations in the Moran index in some years, in general, the Moran index remains at a relatively high level during the study period from 2005 to 2021, indicating that the spatial autocorrelation of industrial structure is generally significant.

Table 4. Global Moran's Index for Industrial Structure Optimization

Year	Moran's I index	Z-score	P-value
2005	0.121	2.528	0.011
2006	0.098	2.328	0.020
2007	0.094	2.222	0.026
2008	0.081	2.053	0.040
2009	0.111	2.523	0.012
2010	0.119	2.676	0.007
2011	0.137	3.067	0.002
2012	0.145	3.378	0.001
2013	0.146	3.330	0.001
2014	0.153	3.406	0.001
2015	0.149	3.439	0.001
2016	0.153	3.453	0.001
2017	0.134	3.220	0.001
2018	0.129	3.125	0.002
2019	0.163	3.641	0.000
2020	0.155	3.410	0.001
2021	0.138	3.114	0.002

Since the global Moran index analyzes the spatial aggregation and correlation of green finance and industrial structure optimization at the national level, but cannot observe the correlation among provinces, this paper further calculates the local Moran index in 2012, 2018 and 2021 to analyze the spatial correlation of green finance and industrial structure optimization in each province. First of all, from the Moran scatter plot of green finance in China, it can be found that there is a significant spatial aggregation phenomenon of green finance in China, and the spatial aggregation of green finance is mainly distributed in the first and third quadrants, showing a "high-high" and "low-low" type distribution, and the aggregation situation has not changed significantly from 2015 to 2021. Among them, two data points are far away from the overall distribution, mainly because the level of green finance in Beijing and Shanghai is significantly higher than the national level, and the spatial aggregation is significantly higher than the national level. Secondly, from the scatter diagram of the industrial structure optimization of each province in China, there are also "high-high" and "low-low" spatial aggregation characteristics, and there is no significant change in the spatial aggregation characteristics of each province from 2015 to 2021. From the Moran scatter plot of green finance and industrial structure optimization above, there is a positive spatial correlation between them, and both of them show a "high-high" and "low-low" distribution. The following figures show the local Moran scatter plots of green finance and industrial structure optimization in 2015, 2018 and 2021 respectively:

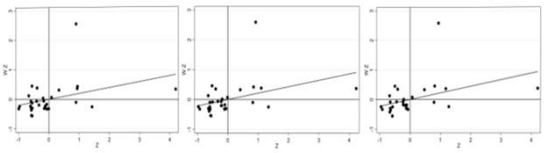

Figure 1. Moran's i Scatter Plot of Green Finance in 2015, 2018 and 2021

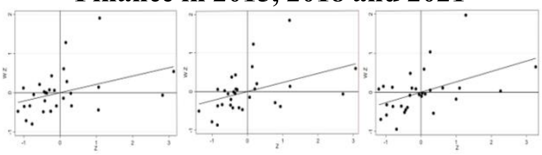

Figure 2. Moran's i Scatter Plot of Industrial Structure Optimization in 2015, 2018 and 2021

3.2.2 Measurement Model Setting

Common spatial econometric models include spatial lag model (SAR), spatial error model (SEM) and spatial Durbin model (SDM). In order to select an appropriate model to measure the impact of regional green finance on industrial structure optimization, relevant tests should be conducted before model selection to determine which measurement model to use. It can be seen from the table that LM-Lag, R-LM-Lag, LM-Error and R-LM-Error all pass the significance test, indicating that the spatial econometric model is more reasonable in this study. Secondly, the Wald-Spatial-Lag and LR-Spatial-Lag passed the 1% significance test, which rejected the null hypothesis, and the spatial Durbin model (SDM) would not degenerate into the spatial lag model (SAR). Both Wald-Spatial-Error and LR-Spatial-Error pass the 1% significance test, rejecting the null hypothesis, and the spatial Durbin model (SDM) does not degenerate into spatial error model (SEM).

Table 5 Spatial Durbin Model Test

Test	Statistics	P	Testing	Quantity of statistics	P
LM-Lag	16.140	0.000	Wald-Spatial-Lag	125.37	0.000
R-LM-Lag	4.760	0.029	LR-Spatial-Lag	108.80	0.000
LM-Error	24.670	0.000	Wald-Spatial-Error	113.76	0.000
R-LM-Error	13.290	0.002	LR-Spatial-Error	100.30	0.000

Hansen's test and double fixed effects test were performed next. As can be seen from the following table, the fixed effect model is better than the random effect model, and the individual fixed effect and time fixed effect are better than the double fixed effect, and the null hypothesis is rejected. Combined with the above test, this paper adopts the spatial Durbin model based on the double fixed effect.

Table 6. Fixed effect Model Test

Test	Statistics	P
The random effects model is the correct model	21.67	0.010
Individual fixation is better than double fixation	22.31	0.0136
Time fixation is better than double fixation	645.09	0.000

To sum up, the dual fixed effect spatial Durbin model is constructed as follows:

$$OIS_{it} = \alpha_0 + \beta_1 WOIS_{it} + \alpha_1 Gf_{it} + \alpha_n Ctr_{it} + \beta_2 WGf_{it} + \beta_n Ctr_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad ......(3)$$

OIS_{ij} Is the industrial structure optimization index of province i in period t; W is the spatial weight matrix; Gf_{it} Is the level of green finance in province i in period t; Ctr_{it} Represents the relevant control variables of province i in period t; α_0 Is the constant term; α_1 Is the influence coefficient of green finance level on industrial structure optimization; μ_i Is the individual fixed effect term of province i that does not change with time; δ_t Is the time fixed effect term; ε_{it} Is the random disturbance term.

4. Analysis of Empirical Results

4.1 Spatial Durbin Model Analysis

Table 6 shows the regression results of two-way fixed effect spatial Durbin model of green finance on industrial structure optimization. It can be seen from the table that the value is R^2 0.872 and the Log-likelihood is 326.873, indicating that the model has a good degree of fit. The coefficient of green finance (Gf) has passed the significance test of 1%, the t value is 25.64, and the coefficient is 6.926, indicating that the improvement of green finance level can significantly promote the optimization and upgrading of regional industrial structure. This is because green finance provides differentiated loan interest rates to regional enterprises through innovative financial instruments, such as green credit, and provides loan interest rates lower than the market average interest rate for green high-tech enterprises to encourage the transformation and development of enterprises. For traditional energy-intensive industries, green finance provides interest rates higher than the market benchmark, which significantly promotes the development and expansion of related enterprises. In order to continuously promote the optimization and upgrading of regional industrial structure. Secondly, the coefficient of $W \times Gf$ is significantly positive, and its coefficient is 3.986, which passes the significance test of 1%. It can be seen that there is a significant spatial spillover effect of green finance in promoting the optimization of regional industrial structure, that is, the development of green finance in this region can also promote the optimization and upgrading of industrial structure in surrounding areas. This is because there are differences in the level of green finance development among regions, and there are often synergies and correlations between economic policies and industrial development among regions. Therefore, the development of regional green finance not only promotes the local industrial structure to be upgraded, rationalized and green, but also generates a positive spatial spillover effect, driving the transformation and upgrading of the industrial chain in the neighboring regions.

As far as the control variables are concerned, the development of green finance in the region is concerned. Urbanization level (urb) has a significant inhibitory effect on the optimization of regional industrial structure. The reason for the above phenomenon is that the improvement of regional urbanization level brings economic development, but also leads to the increase of environmental pollution. Secondly, the improvement of urbanization level leads to labor surplus in some regions, which leads to the reduction of the rationalization level of regional industrial structure. However, W×urb does not pass the significance test, indicating that the change of urbanization level in this region cannot significantly affect the level of industrial structure optimization in the surrounding areas. The coefficient of foreign investment level (fdi) is positive, but it does not pass the significance test, indicating that the level of foreign investment in this region can not significantly improve the level of regional industrial structure. The reason for the above phenomenon is that when foreign investors invest in local industries, they do not distinguish whether they are green or high-tech, but focus on whether the industry can bring them higher profits. However, W×fdi is significantly negative, indicating that the growth of foreign investment in this region inhibits the optimization and transformation of industrial structure in the surrounding areas. This is because the higher the level of foreign investment in a region is, the higher the level of development of a certain industry in the region is, which is more able to attract foreign investment, and then attract the labor force and capital from the surrounding areas to transfer to the region, resulting in a siphon effect, which ultimately hinders the transformation and upgrading of the industrial structure in the surrounding areas. Secondly, the level of opening-up (ope), the level of government intervention (gov) and the intensity of research and development (r&d) all passed the significance test, indicating that the improvement of the level of opening-up, the level of government intervention and the intensity of research and development are conducive to the optimization and upgrading of regional industrial structure. The improvement of openness, government intervention and R&D intensity all contribute to the optimization and upgrading of industrial structure in the surrounding areas. Finally, the level of transportation infrastructure (jtjc) passed the significance test of 1%, indicating that the improvement of regional transportation level is conducive to the optimization and upgrading of regional industrial structure. The reason is that in the process of regional industrial development, the transfer of means of production and products is needed, and the improvement of transportation level greatly saves the transfer cost of means of production and products in the circulation process. The improvement of transportation level greatly saves the transfer cost in the process of regional industrial transformation and reduces the geographical barrier in the process. However, W × jtjc is significantly negative, indicating that the improvement of transportation infrastructure in this region hinders the transformation and upgrading of industrial structure in surrounding areas. The reason is that there are differences in economic development, education and medical level among regions, and the regions with higher transportation infrastructure level are mostly economically developed regions.

Table 7. Regression Results of Spatial Durbin Model

Variables of interest	Model
Gre2	6.926^{***}
	(25.64)
czh	-1.442^{***}
	(-3.37)
wstz	1.049
	(1.45)
dwkf	0.235^{***}
	(2.87)
zfgy	0.581^{*}
	(1.84)
yfqd	27.235^{***}
	(7.37)
jtjc	0.258^{***}
	(7.39)
W*gre2	3.986^{***}
	(5.13)
W*czh	1.418
	(1.53)
W* wstz	-6.743^{***}
	(-3.52)
W* dwkf	0.441^{**}
	(2.26)
W* zfgy	1.412^{**}
	(2.17)
W* yfqd	13.817^{*}
	(1.68)
W* jtjc	-0.142^{*}
	(-1.71)
rho	-0.270^{***}
Sigma2_e	0.016^{***}

Fixed time	YES
Space fixing	YES
N	510
R^2	0.872
Log-likelihood	326.873

Note: ***, ** and * represent rejection of the null hypothesis at 1%, 5% and 10% significance levels, respectively.

4.2 Regional Heterogeneity Test

Due to the differences in the level of economic development among different regions, the empirical data are further divided into eastern region, central region and western region according to the level of economic development. The effect decomposition is carried out for each region. It can be seen from the effect decomposition in the following table that the direct effect influence coefficient of green finance on industrial structure optimization in the eastern, central and western regions is significantly positive, indicating that the improvement of regional green finance level can significantly promote the optimization and upgrading of regional industrial structure. However, the promotion effect of green finance on industrial structure optimization is different in regions with different levels of economic development. The economically developed coastal regions have a higher level of green finance development and a more perfect green financial system. Therefore, green finance in the eastern coastal region plays a more significant role in promoting the optimization and upgrading of regional industrial structure, while the central and western regions lag behind the eastern region. Secondly, the indirect effect of green finance on industrial structure optimization passed the significance test, but there are differences among different regions. The spatial spillover effect of green finance on industrial structure optimization in the western region is more significant, and the spatial spillover effect in the western region is higher than the direct effect. The reason is that the economic development level in the western region is low, and the development of green finance is still in the early stage of development. Due to the low level of industrial structure, the development and input cost of green finance in this region are high, which has a low impact on the optimization of regional industrial structure. Compared with the spillover effect brought by green finance development in surrounding areas, the spillover effect of green finance development in this region has a lower promotion effect on the optimization of regional industrial structure. It can be seen that the spillover effect of green finance on the optimization of regional industrial structure is significant for the less developed regions in western China.

4.3 Robustness Test

In order to ensure the robustness of the empirical results, the spatial weight matrix is replaced, and the spatial geographical distance matrix (W2), spatial economic geography matrix (W3) and spatial adjacency matrix (W4) are added to further analyze the effect of green finance on industrial structure optimization. It can be seen from the following table that the goodness of fit of each model is good, and the direct effect, indirect effect and total effect of green finance on the optimization of industrial structure are significantly positive, and all pass the significance test of 1%, which is consistent with the previous analysis results. It further verifies that green finance can not only promote the optimization and upgrading of industrial structure in the local region, but also promote the optimization and upgrading of industrial structure in the surrounding areas.

5. Conclusions and Policy Implications

This paper selects the provincial panel data from 2005 to 2021 as the research object, and systematically studies the spatial mechanism of green finance and industrial structure optimization. The results show that: 1) Green finance can significantly promote the optimization and upgrading of regional industrial structure. Green finance promotes the green transformation and upgrading of regional industries by innovating green financial instruments, such as green credit, green insurance and other related financial products. 2) Green finance has a spatial spillover effect on the optimization and upgrading of regional industrial structure. The spatial spillover effect of green finance is the most significant in the western region, followed by the central region and the western region. It shows that the development of green finance can not only promote the optimization and upgrading of industrial structure in this region, but also promote the transformation and upgrading of industrial structure in the surrounding areas.

Based on the research of this paper, the following implications can be obtained: (1) The government should constantly improve the green finance policy and regulation system, and improve the green finance evaluation system, so as to ensure the orderly development of regional green finance. For example, the government should introduce preferential tax policies for green finance and a series of measures to support the development of green industries.

Table 8. Effect Decomposition

	Direct effect	Indirect effect	Total effect
The Eastern region	7.022***	1.982***	9.003***
	(15.17)	(2.93)	9.01)
Central Region	4.560***	3.977***	8.537***
	(4.42)	(2.64)	(3.37)
West Region	4.081***	9.611***	13.69***
	(5.59)	(4.33)	(5.28)

Note: ***, ** and * represent rejection of the null hypothesis at 1%, 5% and 10% significance levels, respectively

Table 9. Results of Robustness Test

Variables of interest	W2	W3	W4
Direct effect	6.342***	6.371***	6.335***
	(23.49)	(22.79)	(6.12)
Indirect effect	7.543***	6.557***	3.782***
	(6.28)	(5.60)	(6.12)
Total effect	13.885***	12.93***	10.117***
	(11.57)	(10.79)	(14.78)
Variable of control	Control	Control	Control
rho	−0.737***	−0.541***	−0.482***
Sigma2_e	0.014***	0.014***	0.015***
Time fixed	YES	YES	YES
Space fixing	YES	YES	YES
N	510	510	510
R^2	0.802	0.793	0.914

Note: ***, ** and * represent rejection of the null hypothesis at 1%, 5% and 10% significance levels, respectively

Meanwhile, the government should actively guide regional green finance to invest in the development of regional high-tech and green industries. (2) Banks and other financial institutions should continue to innovate and improve green financial products to meet the financing needs of green industry development. We should continuously improve the domestic green finance support system, build a comprehensive, clear and stable green finance policy framework system, create a good policy environment for the introduction of social capital, and promote the green economic transformation in stages and industries. We should guide the investment and financing of the financial industry to continue to tilt towards green and high-tech industries, enrich the relevant financial products in the green financial system, and innovate targeted and biased green financial products for different industries and regions.

References

[1] Cowan E. Topical Issues In Environmental Finance[Z]. Research Paper Was Commissioned by the Asia Branch of the Canadian International Development Agency(CIDA), 1999,(1):1-20.

[2] Ma Jun. On the construction of China's green finance system [J]. Financial Forum,2015, vol. 20 (5): 18-27.

[3] Liu Xia & He Peng. The impact of green finance on economic development in central China [J]. Journal of Industrial Technology Economics,2019, 38 (3): 76-84.

[4] Gao Jinjie, Zhang Weiwei. Study on the impact of green finance on the ecological development of industrial structure in China: An empirical test based on systematic GMM model [J]. Economic Review,2021,(2): 105-115.

[5] Gao Jinjie, Zhang Weiwei. Study on the impact of green finance on the ecological development of industrial structure in China: An empirical test based on systematic GMM model [J]. Economic Review,2021,(2): 105-115.

[6]. Zhang, Y. & Qian, S. Green finance, bias of environmental technology progress and clean industrial structure [J]. Science Research Management,2022, 43 (4): 129-138.

[7] Si Lijuan, Yao Xiaoqiang. Green finance reform and innovation and ecological regional industrial structure: a quasi-natural experiment from the green finance reform and innovation pilot zone [J]. Learning and Exploration,2022,(4): 129-138,2.

[8] Hu Wentao, Sun Junna, Chen Liang. Green finance, ecological industrial structure and regional green development [J]. Contemporary Economic Management,2023, 45 (5): 88-96.

