

Original Paper

Research on the Impact of Green Finance on High-Quality Agricultural Development

Yifan Liu¹

¹ College of Economics & Management, South China Agricultural University, Guangzhou, Guangdong Province, China

Received: January 26, 2026

Accepted: March 22, 2026

Online Published: April 13, 2026

doi:10.22158/ibes.v8n2p111

URL: <http://dx.doi.org/10.22158/ibes.v8n2p111>

Abstract

Against the backdrop of continuous advancements in green and low-carbon transformation and agricultural modernization, the role of green finance in high-quality agricultural development has received increasing attention. This paper constructs a comprehensive evaluation index system for high-quality agricultural development and a green finance index based on provincial panel data from China, empirically testing the impact of green finance on high-quality agricultural development. The study finds that green finance can significantly promote high-quality agricultural development, and the conclusions remain robust after robustness testing. Heterogeneity analysis indicates that the promoting effect of green finance on high-quality agricultural development is mainly reflected in the western region, while no significant effect has yet been shown in the eastern and central regions; meanwhile, the promoting effect of green finance is more pronounced in regions with low R&D intensity.

Keywords

Green finance, High-quality agricultural development, Regional heterogeneity, R&D intensity

1. Introduction

Against the backdrop of deepening global resource and environmental constraints and the ongoing green and low-carbon transformation, sustainable development has become a crucial direction for the economic and social development of all countries. In recent years, my country has attached great importance to the construction of a green finance system and the green transformation of agriculture, successively issuing policy documents such as the “Guiding Opinions on Building a Green Finance System,” aiming to guide more financial resources towards energy conservation, environmental protection, green production, and ecological governance, providing financial support for high-quality economic development. Agriculture is not only a fundamental industry of the national economy but

also a crucial area for green transformation. As agricultural modernization continues, the problems of high resource consumption, increasing ecological pressure, and insufficient funding faced by traditional agricultural development methods are becoming increasingly prominent, making the role of green finance in agriculture increasingly noteworthy. Green finance can not only alleviate the funding constraints in the green transformation of agriculture through credit allocation, investment guidance, and policy incentives, but also promote the application of green technologies, adjustments to production methods, and optimization of agricultural resource allocation, thereby providing new impetus for high-quality agricultural development.

Existing research on green finance and its economic effects has yielded relatively rich results. Regarding the economic effects of green finance, existing literature mainly focuses on green innovation, relief of financing constraints, and optimization of resource allocation. Lei H et al. (2025) believe that green finance promotes corporate green innovation by relieving financing constraints. Yu CH et al. (2021) pointed out that financing constraints inhibit green innovation, and private enterprises are more significantly affected. This indicates that green finance not only has the function of supplying funds, but also plays an important role in guiding green transformation and optimizing resource flow.

Existing research on high-quality agricultural development mainly focuses on the definition of connotation, indicator measurement and identification of influencing factors. Qin S et al. (2022) believe that factor mismatch significantly inhibits high-quality agricultural development. Gao DD (2023) pointed out that the coordination level between high-quality agricultural development and ecological construction is still low. Related studies show that high-quality agricultural development is not a single output growth issue, but a systematic improvement involving multiple dimensions such as factor allocation, structural optimization, ecological governance and shared development.

In recent years, scholars have explored the relationship between green finance and high-quality agricultural development from the perspectives of direct effects, mechanisms of action, and spatial spillover. Yuan X et al. (2024) believe that green finance significantly promotes high-quality agricultural development. Wu GS et al. (2025) pointed out that green finance innovation helps improve green agricultural development. Overall, existing research has preliminarily confirmed that green finance has a positive effect on agricultural development, and also provides useful experience for this paper.

Nevertheless, existing research still has room for further expansion. Firstly, existing literature focuses more on the impact of green finance on corporate green innovation or regional green development, with relatively insufficient research directly addressing the relationship between green finance and high-quality agricultural development, especially lacking systematic analysis centered on agriculture as a specific industry sector. Secondly, high-quality agricultural development exhibits significant regional differences; different regions differ considerably in resource endowment, agricultural foundation, and innovation conditions, meaning the effects of green finance may not be homogeneous, and related heterogeneity issues require further in-depth discussion.

Based on this, this paper systematically examines the impact of green finance on high-quality agricultural development using provincial panel data from China, and further analyzes its regional differences and related characteristics. Compared with existing research, this paper attempts to expand the research boundaries of the economic effects of green finance from a more comprehensive perspective of high-quality agricultural development, and provide empirical evidence for green finance to better serve the green transformation and high-quality development of agriculture.

2. Research Design

2.1 Data Source

This paper uses provincial panel data from China as its research sample. The data used in this paper mainly comes from the National Bureau of Statistics, the statistical bureaus of various provinces (autonomous regions and municipalities) and their statistical yearbooks, supplemented by environmental status bulletins and relevant professional statistical yearbooks. Specifically, these include the *China Science and Technology Statistical Yearbook*, *China Energy Statistical Yearbook*, *China Finance Yearbook*, *China Agricultural Statistical Yearbook*, *China Industrial Statistical Yearbook*, and *China Tertiary Industry Statistical Yearbook*. Existing research has addressed this issue when constructing comprehensive indicators for green development and high-quality development.

2.2 Variable Definition

The explained variable in this paper is high-quality agricultural development. Considering that high-quality agricultural development has multi-dimensional, comprehensive and systematic characteristics, this paper comprehensively measures it from five dimensions: agricultural innovation development, agricultural coordinated development, agricultural green development, agricultural open development and agricultural shared development (Wang & Lei, 2024). The specific indicator system is shown in Table 2-1.

Table 2-1 Indicators for High-Quality Agricultural Development

First-level dimension	Secondary indicators	Indicator Definition	property
Agricultural Innovation and Development	Three expenditures on science	Local government expenditure on science and technology / Local government general budget expenditure	+
Agricultural Innovation and Development	Agricultural mechanization level	Total power of agricultural machinery / Total sown area of	+

		crops	
Agricultural Innovation and Development	Research and experimental development (R&D) funding intensity	Direct data	+
Agricultural Innovation and Development	Domestic patent application acceptance volume	Direct data	+
Agricultural Innovation and Development	Agricultural GDP per unit area	Total agricultural output value / Total sown area of crops	+
Coordinated agricultural development	fiscal support for agriculture	Local government expenditures on agriculture, forestry and water affairs / Local government general budget expenditures	+
Coordinated agricultural development	rural Engel coefficient	Food expenditure / Total consumption expenditure of rural residents	-
Coordinated agricultural development	Rural residents' consumption level	per capita consumption expenditure of rural residents	+
Coordinated agricultural development	Industrial Coordination Level	Value added of primary industry / Gross regional GDP	+
Coordinated agricultural development	Agricultural Industrial Structure Adjustment Index	1 - Total agricultural output value / Total output value of agriculture, forestry, animal husbandry and fishery	+
Green development of agriculture	Fertilizer usage per unit area	Agricultural fertilizer application rate (pure	-

				amount) / total sown area of crops	
Green development of agriculture		Pesticide usage per unit area		Pesticide usage / Total crop planting area	-
Green development of agriculture		Agricultural film usage per unit area		Agricultural plastic film usage / Total crop planting area	-
Green development of agriculture		Forest coverage		Forest area / Land area	+
Agricultural Opening-up Development	and	Agricultural dependence	export	Agricultural product export trade volume / value added of primary industry	+
Agricultural Opening-up Development	and	Agricultural dependence	import	Agricultural product import trade volume / primary industry added value	+
Agricultural Development	Shared	Urban-rural ratio	income	per capita disposable income of urban residents / per capita disposable income of rural residents	-
Agricultural Development	Shared	per capita disposable income of rural residents		Direct data	+
Agricultural Development	Shared	Rural residents' living standards		Rural per capita expenditure on culture, education and entertainment	+
Agricultural Development	Shared	Urban-rural consumption gap		Urban residents' per capita consumption expenditure / Rural residents' per capita consumption expenditure	-
Agricultural Development	Shared	Number of village		direct data	+

Development clinics

The core explanatory variable in this paper is the green finance index. The green finance index is constructed using the entropy method, which mainly determines the influence weight of each indicator in the comprehensive evaluation based on the degree of dispersion of each indicator. The greater the degree of dispersion of the indicator, the stronger its role in the comprehensive evaluation system (Hong, Ling, Liu et al., 2023). Specifically, the green finance index consists of seven dimensions, and the specific indicators are shown in Table 2-2.

Table 2-2. Green Finance Index

Dimension	Specific indicators	Measurement methods
Green credit	Credit ratio for environmental protection projects	Total credit for environmental protection projects in the province / Total credit in the province
Green Investment	Investment in environmental pollution control as a percentage of GDP	Investment in environmental pollution control / GDP
Green Insurance	Promotion of environmental pollution liability insurance	Environmental pollution liability insurance revenue / Total premium revenue
Green bonds	Development of green bonds	Total issuance of green bonds / Total issuance of all bonds
Green support	The proportion of fiscal expenditure on environmental protection	Fiscal expenditure on environmental protection / Fiscal expenditure on general budget
Green Fund	Green Fund Proportion	Total market capitalization of green funds / Total market capitalization of all funds
Green rights	Depth of Green Rights Development	consumption rights trading, energy pollution rights trading/equity markets

In addition to the core variables, this paper also sets up a series of control variables to minimize the

bias of omitted variables and improve the reliability of the regression results. The control variables mainly cover the level of industrialization, labor force, human capital, informatization, industrial structure, social consumption, economic development, and financial development. Furthermore, to facilitate robustness testing and heterogeneity analysis, this paper also introduces variables such as the level of transportation infrastructure, the degree of openness to the outside world, and R&D intensity.

2.3 Model Construction

To examine the impact of green finance on high-quality agricultural development, this paper constructs the following benchmark regression model:

$$\text{农业高质量发展}_{it} = \alpha_0 + \alpha_1 \text{绿色金融}_{it} + \beta X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Wherein, 农业高质量发展_{it} represents the level of high-quality agricultural development in region i in year t , 绿色金融_{it} represents the level of green finance development in region i in year t , X_{it} represents a series of control variables, μ_i represents the individual fixed effect, λ_t represents the year fixed effect, and ε_{it} represents the random disturbance term. The parameters α_1 are the core coefficients of this paper, used to measure the direction and degree of the impact of green finance on high-quality agricultural development. If α_1 is significantly positive, it indicates that green finance can promote high-quality agricultural development; conversely, it indicates that its promoting effect is not significant, or even that there may be an inhibitory effect.

3. Empirical Analysis

3.1 Descriptive Analysis

Table 3-1 presents the descriptive statistics of the main variables. The mean of the high-quality development index for agricultural economy is 0.174, with a standard deviation of 0.0851. The minimum and maximum values are 0.0725 and 0.687, respectively, indicating significant differences in the level of high-quality development of agricultural economy across different provinces. The mean of the green finance index is 0.426, with a standard deviation of 0.241, and a range of 0.0644 - 0.928, indicating substantial differences in the level of green finance development across regions. The control variables also exhibit some dispersion, indicating strong heterogeneity among the sample regions in terms of industrialization level, labor force level, human capital level, informatization level, industrial structure, social consumption level, economic development level, and financial development level. Overall, the sample data is relatively complete, and the variables have good variability, laying a foundation for subsequent empirical analysis.

Table 3-1 Descriptive Analysis

Variable	Obs	Mean	Std.	Min	Max
High-quality agricultural development	403	0.174	0.0851	0.0725	0.687

Green Finance Index	403	0.426	0.241	0.0644	0.928
Industrialization level	403	0.316	0.0875	0.0691	0.568
Labor force level	403	7.513	0.875	5.142	8.864
Human capital level	403	0.0211	0.00621	0.00805	0.0437
Information technology level	403	0.0553	0.0511	0.0149	0.282
Industrial structure	403	0.501	0.182	0.0381	3.424
Social consumption level	403	0.387	0.0797	0.175	0.719
Economic development level	403	10.91	0.476	9.688	12.29
Financial development level	403	3.461	1.072	1.695	7.545

3.2 Benchmark Regression Analysis

Table 3-2 reports the baseline regression results of the impact of green finance on the high-quality development of agricultural economy. Column (1) Without adding control variables and without controlling for fixed effects, the regression coefficient of the green finance index is 0.2337, which is significant at the 1% level, initially indicating that the development of green finance can significantly promote the high-quality development of agricultural economy. Column (2) After further adding control variables, the estimated coefficient of the green finance index decreases to 0.0736, but is still significant at the 1% level, indicating that after controlling for factors such as industrialization level, labor force level, human capital level, informatization level, industrial structure, social consumption level, economic development level, and financial development level, the promoting effect of green finance on the high-quality development of agricultural economy still exists. Column (3) Based on adding control variables, and further controlling for individual fixed effects and year fixed effects, the regression coefficient of the green finance index is 0.1094, which is still significant at the 1% level, indicating that after considering regional individual differences and time variation factors, green finance can still significantly improve the high-quality development level of agricultural economy, and the research hypothesis H1 is verified.

From the changes in coefficients, the estimated coefficients of the green finance index in columns (1) and (2) show a significant decrease, indicating that, without controlling for other relevant factors, the impact of green finance on the high-quality development of the agricultural economy may include some common effects brought about by differences in regional economic foundations, industrial conditions, and financial environment. In column (3), after introducing individual fixed effects and year fixed effects, the coefficient of the green finance index rebounded to 0.1094 and remained significant, indicating that after eliminating unobservable regional heterogeneity and macroeconomic time shocks, the positive impact of green finance on the high-quality development of the agricultural economy

remains robust. This shows that green finance does not simply change synchronously with the improvement of regional development levels, but has a relatively independent promoting effect on the high-quality development of the agricultural economy.

Table 3-2 Benchmark Regression Analysis

	(1)	(2)	(3)
	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development
Green Finance Index	0.2337 *** (12.7138)	0.0736 *** (8.4105)	0.1094 *** (3.6208)
Industrialization level		-0.0976 *** (-3.8617)	-0.2669 *** (-3.2698)
Labor force level		0.0330 *** (12.2858)	0.0550 ** (2.1605)
Human capital level		-1.9402 *** (-4.3964)	-9.6846 *** (-5.2555)
Information technology level		-0.1138 *** (-3.5295)	0.0561 (0.5610)
Industrial structure		-0.0054 (-0.4511)	-0.0206 *** (-3.2684)
Social consumption level		-0.0168 (-0.7478)	0.0381 ** (2.1148)
Economic development level		0.0920 *** (10.9144)	0.0797 *** (2.7582)
Financial development level		0.0312 *** (9.5172)	0.0059 (0.8512)
_cons	0.0744 *** (13.4603)	-1.1299 *** (-12.7918)	-0.8943 *** (-2.6000)
N	403	403	403
adj. R 2	0.438	0.783	0.922

t statistics in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01.

3.3 Robustness Analysis

First, this paper employs a one-period lag approach for robustness testing of the core explanatory variables. This approach is chosen because the impact of green finance on high-quality agricultural economic development is often not immediately apparent, but rather gradually released through processes such as financial resource allocation, agricultural project implementation, technology diffusion, and industrial restructuring. Therefore, its effects may have a certain time lag. Simultaneously, the one-period lag helps to mitigate the problem of reverse causality to some extent, preventing the current level of high-quality agricultural economic development from negatively influencing the current level of green finance development. The regression results show that the regression coefficient of the one-period lag green finance index is 0.1259, significant at the 1% level. This indicates that after considering the time lag effect and potential endogeneity issues, green finance can still significantly promote high-quality agricultural economic development, demonstrating the strong robustness of the baseline regression conclusions.

Secondly, this paper examines whether the model results are affected by omitted variable bias by further adding control variables. Based on the baseline model, this paper adds two new control variables: the level of transportation infrastructure and the degree of openness to the outside world. This is because transportation infrastructure affects the flow of agricultural production factors, the efficiency of agricultural product transportation, and the degree of regional market connectivity, while the degree of openness to the outside world may affect the quality of agricultural development through channels such as capital inflows, technology diffusion, and market competition. Without these controls, the estimation results of green finance may be contaminated by the influence of these factors. The regression results show that after adding the above variables, the regression coefficient of the green finance index is 0.0922, and it remains significantly positive at the 1% level, indicating that the promoting effect of green finance on the high-quality development of the agricultural economy is not due to insufficient setting of model control variables, and the research conclusions remain valid.

Secondly, this paper employs a robustness test by excluding data from exceptional years, specifically removing data from 2015 and 2020. This approach is chosen because exceptional years are often accompanied by significant macroeconomic fluctuations or sudden shocks, which may have atypical impacts on the allocation of green finance resources, agricultural production and management activities, and the overall state of the agricultural economy, thus disrupting the normal relationship between green finance and high-quality agricultural economic development. Regression results show that after excluding the 2015 and 2020 samples, the regression coefficient of the green finance index is 0.1211, significantly positive at the 1% level. This indicates that the promoting effect of green finance on high-quality agricultural economic development is not driven by abnormal fluctuations in individual exceptional years, and the baseline regression conclusions remain highly robust.

Finally, this paper further examines the robustness of the research conclusions by excluding the samples from the four municipalities directly under the central government. This method was adopted

because Beijing, Shanghai, Tianjin, and Chongqing differ significantly from general provinces in terms of economic development level, concentration of financial resources, industrial structure characteristics, and policy support, exhibiting strong uniqueness. If these regions have a significant impact on the overall regression results, it may weaken the generalizability of the research conclusions. The regression results show that after excluding the four municipalities, the regression coefficient of the green finance index is 0.0444, still significantly positive at the 1% level. Although the absolute value of the coefficient has decreased, its sign and significance remain unchanged, indicating that after excluding the influence of samples from specific regions, green finance can still significantly promote high-quality agricultural economic development, further verifying the stability and reliability of the research conclusions.

Table 3-3 Robustness Analysis

	(1)	(2)	(3)	(4)
	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development
L. Green Finance Index	0.1259 *** (0.0357)			
Green Finance Index		0.0922 *** (0.0301)	0.1211 *** (0.0337)	0.0444 *** (0.0132)
Industrialization level	-0.2571 *** (0.0854)	-0.2024 *** (0.0711)	-0.2723 *** (0.0859)	-0.0941 *** (0.0262)
Labor force level	0.0449* (0.0262)	0.0212 (0.0224)	0.0642** (0.0289)	0.0477** (0.0185)
Human capital level	-9.8832 *** (1.8905)	-6.8303 *** (1.5156)	-9.7671 *** (1.8864)	-1.6534 *** (0.4427)
Information technology level	0.0766 (0.0988)	0.1020 (0.0913)	0.2086 (0.1456)	0.0265 (0.0243)
Industrial structure	-0.0172 *** (0.0061)	-0.0138 *** (0.0052)	-0.0205 *** (0.0068)	-0.0038* (0.0022)
Social consumption level	0.0387**	0.0804 ***	0.0294	0.0497 ***

	(0.0184)	(0.0197)	(0.0205)	(0.0107)
Economic development level	0.0975***	0.0969***	0.0848***	0.0140
Financial development level	(0.0338)	(0.0269)	(0.0306)	(0.0147)
	0.0100	0.0055	0.0063	0.0053*
level of transportation infrastructure	(0.0081)	(0.0058)	(0.0070)	(0.0031)
		-0.0656***		
degree of openness to the outside world		(0.0219)		
		-0.1276***		
constant term	-1.0355**	-0.1219	-1.0241***	-0.3471**
	(0.4138)	(0.3566)	(0.3582)	(0.1581)
Sample size	372	403	341	351
Adjust R ²	0.9258	0.9338	0.9201	0.9586

t statistics in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01.

3.4 Heterogeneity Analysis

First, from the perspective of regional heterogeneity, the impact of green finance on the high-quality development of agricultural economy varies significantly among the eastern, central, and western regions. Columns (1) to (3) of Table 3-4 show that the regression coefficients of the green finance index in the eastern and central regions are -0.0378 and -0.0065, respectively, neither of which passed the significance test. However, the regression coefficient in the western region is 0.0278, which is significantly positive at the 1% level. This indicates that the role of green finance in promoting the high-quality development of agricultural economy is mainly reflected in the western region, and has not yet shown a significant effect in the eastern and central regions. The reason for this may be that the foundation of agricultural modernization in the western region is relatively weak, the proportion of traditional agriculture is relatively high, and the demand for green transformation and financial support for agriculture is more urgent. Therefore, the marginal improvement effect of green finance is more obvious. At the same time, under the policy promotion of ecological protection, green agricultural development, and rural revitalization, green finance is more likely to play a role in resource guidance and structural optimization in the western region. In contrast, the eastern region has a relatively mature economic development and financial system, and agriculture accounts for a smaller proportion of the overall industrial structure. Therefore, the marginal effect of green finance on high-quality agricultural

economic development may be weakened by other factors. The central region, on the other hand, may be in a transitional phase from traditional to modern agriculture, and the policy and resource allocation effects of green finance have not yet been fully realized, thus not showing a significant impact. Overall, the regional heterogeneity analysis indicates that the role of green finance in promoting high-quality agricultural economic development has significant regional differences, with greater practical relevance and policy value in the western region.

Secondly, from the perspective of the heterogeneity of R&D intensity, the impact of green finance on the high-quality development of agricultural economy also varies across regions with different levels of R&D investment. Columns (4) and (5) of Table 3-4 show that in regions with high R&D intensity, the regression coefficient of the green finance index is 0.0503, but it does not pass the significance test; while in regions with low R&D intensity, the regression coefficient of the green finance index is 0.0295, and it is significantly positive at the 5% level. This indicates that the promoting effect of green finance on the high-quality development of agricultural economy is more obvious in regions with low R&D intensity. The possible reason is that regions with high R&D intensity already have strong innovation investment and technical support capabilities, and agricultural development relies more on technology accumulation, innovation platforms, and industrial synergy. Although green finance has a promoting effect, its independent marginal effect is not easily reflected statistically. In contrast, regions with low R&D intensity are relatively lacking in technology supply and innovation resources. Green finance can more directly alleviate the financial constraints in agricultural development, support the input of green production factors and basic technological transformation, and therefore is more likely to be transformed into real results for the high-quality development of agricultural economy. In other words, green finance is more effective in "addressing weaknesses" and "boosting momentum" in regions with weaker innovation foundations. This also shows that green finance not only has resource allocation functions, but also plays a supporting role in the green transformation of agriculture in underdeveloped regions to a certain extent.

Table 3-4 Heterogeneity Analysis

	(1)	(2)	(3)	(4)	(5)
	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development	High-quality agricultural development
Green Finance Index	-0.0378	-0.0065	0.0278 ***	0.0503	0.0295 **
	(-0.6377)	(-0.3925)	(3.5194)	(1.0463)	(2.2487)
Industrialization level	-1.3747 ***	0.2433 ***	-0.0458 ***	-0.2940	-0.0153

	(-3.8257)	(4.2203)	(-2.8263)	(-1.0778)	(-0.8250)
Labor force level	0.0177	-0.0130	-0.0016	0.0572	0.0263 *
	(0.2079)	(-1.0862)	(-0.1195)	(1.3177)	(1.8639)
Human capital level	-17.4397 ***	-3.2457 ***	0.6294 ***	-20.0737 ***	0.6491 **
	(-4.5704)	(-4.7163)	(2.8752)	(-5.5411)	(2.0629)
Information technology level	0.2030	0.1979 **	0.0372 **	-0.0763	0.0515 ***
	(0.9704)	(2.3700)	(2.4883)	(-0.4106)	(2.7836)
Industrial structure	-1.0567 ***	0.4326 ***	-0.0002	0.0537	-0.0001
	(-3.7836)	(6.8303)	(-0.2409)	(0.5997)	(-0.0710)
Social consumption level	0.0894 *	0.0368 **	0.0128	0.0411	0.0172 **
	(1.8047)	(2.4784)	(1.6149)	(0.8651)	(2.5087)
Economic development level	0.1992 *	0.0566 **	0.0316 ***	0.1608 **	0.0061
	(1.9266)	(2.2606)	(3.7375)	(2.0487)	(0.6176)
Financial development level	-0.0102	0.0120 *	-0.0022 **	-0.0028	-0.0027 **
	(-0.6118)	(1.7112)	(-2.0031)	(-0.1106)	(-1.9770)
_cons	-0.7193	-0.6147 **	-0.2063 ***	-1.5129	-0.1427
	(-0.6371)	(-2.2256)	(-2.6223)	(-1.5993)	(-1.6259)
N	143	104	156	201	199
adj. R 2	0.934	0.965	0.988	0.916	0.965

t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4. Conclusions and Recommendations

4.1 Research Conclusions

Based on provincial panel data from China, this paper systematically examines the impact of green finance on high-quality agricultural development. The study finds that green finance can significantly promote high-quality agricultural development. After controlling for relevant variables and fixed effects on region and year, the estimated coefficient of green finance remains significantly positive,

indicating that the promoting effect of green finance on high-quality agricultural development has strong stability. Robustness tests also support this conclusion. By optimizing the allocation of financial resources and strengthening green orientation, green finance can provide important support for the green transformation and quality improvement of agriculture.

Furthermore, the impact of green finance on high-quality agricultural development exhibits significant regional heterogeneity. Regional regression results show that green finance has a significant promoting effect in western regions, while it has not yet shown a significant impact in eastern and central regions. This indicates that green finance has a greater marginal improvement effect in regions with relatively weak agricultural foundations and stronger needs for green transformation, and its policy role is influenced by differences in regional resource endowments, agricultural development foundations, and financial environments.

Furthermore, the promoting effect of green finance also exhibits differences in R&D intensity. Grouped regression results show that green finance has a more significant promoting effect on high-quality agricultural development in regions with low R&D intensity, while it does not show a significant effect in regions with high R&D intensity. This indicates that in regions with relatively weak innovation foundations, green finance is more easily translated into real development results, thus better demonstrating its supplementary and driving role.

4.2 Policy Recommendations

First, improve the institutional supply for green finance to support high-quality agricultural development. Focusing on key areas such as green agricultural production, ecological governance, green technology application, and green agricultural product development, further improve the system of financial instruments such as green credit, green insurance, and green bonds to enhance the matching degree between green financial products and the needs of agricultural operators. At the same time, accelerate the improvement of mechanisms for identifying, disclosing information on, and assessing risks of green agricultural projects, reduce the institutional costs for financial institutions entering the green agricultural sector, and enhance the efficiency of green financial resource allocation.

Secondly, implement differentiated regional support policies. Given that green finance plays a more prominent role in promoting development in western regions, policymakers should focus more on precise regional implementation, providing more targeted support to areas with weak agricultural foundations and stronger needs for green transformation. This can be achieved through fiscal subsidies, risk compensation, financing guarantees, and special guidance programs to direct more green financial resources towards western regions and areas with relatively weak agricultural development, thereby improving the precision and effectiveness of policy implementation.

Third, promote the synergistic effect of green finance with agricultural technological innovation and industrial upgrading. Given that green finance has a more significant impact on regions with low R&D intensity, its support should be integrated with agricultural technology promotion, green technology transformation, digital agriculture construction, and industrial structure optimization to strengthen its

supporting role in enhancing agricultural innovation capabilities. For regions with high R&D intensity, the synergy between green finance and innovation platforms, research entities, and the industrial system should be further improved to better serve high-quality agricultural development.

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