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The Impact of Modern Agricultural Parks on Regional Agricultural Economic Growth: A Case Study of Modern Agricultural Parks in Southwest China

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Abstract

The level of agricultural economic development is a critical indicator for assessing the achievements of rural revitalization and the construction of a modern agricultural power. How to elevate agricultural economic standards remains a significant challenge for China today. This study treats modern agricultural parks as a quasi-natural experiment and employs a multi-period difference-in-differences (DID) model to analyze panel data from 98 modern agricultural parks in southwest China, aiming to explore whether the construction of modern agricultural parks can influence regional agricultural economic growth. The findings demonstrate that the establishment of modern agricultural parks significantly enhances the level of agricultural economic development. This effect remains robust after conducting parallel trend tests, placebo tests, and propensity score matching (PSM)-DID checks. Further mechanism analysis reveals that such parks drive agricultural economic growth through innovations in agricultural technology. Additionally, heterogeneity analysis indicates that the policy effect of modern agricultural parks varies across regions, with stronger impacts observed in areas with moderate development levels compared to less developed regions. These research findings provide valuable insights for accelerating the construction of a socialist modern agricultural power in the new era and offer a theoretical foundation for advancing the modernization of agriculture and rural areas.

Keywords: national agricultural science and technology parks, agricultural economic development, innovation in agricultural technology, southwest region

1. Introduction

The level of agricultural economic development is a crucial metric for evaluating the progress of rural revitalization and the construction of a modern agricultural power. At present, China is in a critical phase of comprehensively advancing the rural revitalization strategy, making the effective enhancement of agricultural economic standards an urgent issue that requires immediate attention. The 2024 Central Document No. 1 explicitly states that advancing Chinese-style modernization necessitates persistent efforts to strengthen the agricultural foundation and promote comprehensive rural revitalization. Against this backdrop, modern agricultural parks, as vital carriers for driving agricultural modernization, have garnered significant attention.

Modern agricultural parks serve not only as key platforms for the dissemination and innovation of agricultural technologies (Jiang and Cui, 2009) but also as primary vehicles for promoting the integration of rural industries (Luo et al., 2020). The issuance of the "Opinions of the Central Committee of the Communist Party of China and the State Council on Implementing the Employment-Priority Strategy and Promoting High-Quality and Full Employment" on September 25, 2024, further emphasizes the strategic deployment of guiding capital, technology, and labor-intensive industries to shift towards central and western regions. This presents new opportunities for the development of modern agriculture in the southwest region. As a pivotal strategic point in the western development initiative, the southwest region, with its core cities of Chengdu and Chongqing, plays a significant role in regional economic development due to its technological innovation capabilities and its role in ensuring food security. By December 2024, the southwest region had established a total of 98 modern agricultural parks, significantly contributing to regional grain production and efficiency. Taking Sichuan Province as an example, grain production in 2023 increased by 16.7 billion pounds compared to the previous year, setting a new historical record. This underscores the strategic value of modern agricultural parks in "hiding grain in the land and in technology."

Existing literature on modern agricultural parks primarily focuses on their development status (Lan Ge et al., 2011; Yan Ru Li et al., 2009), innovative capabilities (Sun and Chen, 2020; Chang and Luo, 2019; Qian and Wang, 2021), and spatial regional disparity measurements (Huo et al., 2022), with most studies remaining at a theoretical level. While Xue and Zhu (2022) analyzed the impact of modern agricultural parks on regional agricultural economic growth based on data from 254 prefecture-level cities in China from 2010 to 2019, research specifically targeting the southwest region, with its unique geographical characteristics, remains insufficient. The southwest region is characterized by complex terrain, a high proportion of mountainous and hilly areas, low standards of high-quality farmland, and issues such as inadequate mechanization and restricted development (Yue, 2018). These factors severely constrain the large-scale and industrialized development of regional agricultural economies (Liu, 2021; Zeng and Liu, 2018).

In light of this, this study takes 438 counties in the southwest region as its research subjects, utilizing data from the China County Statistical Yearbook and regional statistical yearbooks spanning 2007 to 2021. It employs a multi-period difference-in-differences (DID) method to thoroughly investigate the impact of modern agricultural park establishment on regional agricultural economic development and its underlying mechanisms. The innovative aspects of this research are twofold: first, it focuses on the agricultural economic development at the county level in the southwest region, systematically analyzing the effects of modern agricultural park establishment on regional economies, thereby offering a new research perspective for the modernization of agriculture in the southwest. Second, by exploring the heterogeneity of modern agricultural parks in the southwest region, it enriches the micro-level research on how modern agricultural parks influence agricultural economic growth, providing significant practical implications for enhancing agricultural economic levels and increasing grain production in the southwest region.

2. Theoretical Analysis and Research Hypotheses

2.1 The Impact of Modern Agricultural Park Development on Regional Agricultural Economic Growth

In the 1950s, economist François Perrou proposed the non-equilibrium theory of regional economic development, known as the "core-periphery theory." This theory posits that growth poles, or focal points of economic growth, play a driving role within a system. According to Perrou, growth poles can be categorized into spontaneously formed poles and planned and cultivated poles (Wang, 2011). Modern agricultural parks clearly represent planned and cultivated growth poles. By establishing these parks, resources such as funds, technology, and talent are invested to increase the population density in surrounding areas, thereby improving residents' living standards and promoting regional economic growth. During the initial stages of park development, local governments typically provide strong financial support and infrastructure development, laying a solid foundation for the park's growth. As modern agricultural parks mature and progress, the agricultural economic strength of the region gradually increases. Simultaneously, the driving forces of growth poles and the interactive effects of industrial chains become more pronounced, effectively promoting sustained regional prosperity and development. In essence, the gradual refinement of the parks and the improvement in agricultural economic levels create a virtuous cycle, providing strong momentum for the comprehensive revitalization of the regional economy.

Based on this theory, the following hypothesis is proposed:

H1: The establishment of modern agricultural parks promotes regional agricultural economic growth.

2.2 Mechanisms through Which Modern Agricultural Park Development Affects Regional Agricultural Economic Growth

2.2.1 Driving Technological Innovation

The introduction of agricultural new productive forces, which emphasize innovation-driven development and technology empowerment, aims to advance the process of agricultural modernization with Chinese characteristics, achieving a historic transformation from a "large country with weak agriculture" to a "large country with strong agriculture" (Luo and Geng, 2024). Modern agricultural parks play a critical role in fostering technological innovation and the commercialization of research findings. They focus on developing innovative crop varieties and production techniques, while also introducing advanced agricultural technologies and production models, thereby significantly enhancing the intensity of technological innovation. This comprehensive strategy ensures that cutting-edge technologies are integrated into every aspect of agricultural production. The introduction of new crop varieties and technologies not only boosts the market competitiveness of agricultural products and increases their value-added potential but also drives the innovation of agricultural production methods, leading to significant improvements in production efficiency. Additionally, these innovative measures facilitate the optimization of agricultural structures, providing a robust technological foundation for the sustainable development of the agricultural industry.

Based on this theory, the following hypothesis is proposed:

H2: Modern agricultural parks stimulate agricultural economic growth through technological innovation.

2.2.2 Promoting Agricultural Industrial Integration

The concept of rural industrial integration is rooted in the foundational role of agriculture, leveraging new agricultural business entities to drive the extension of agricultural value chains, the enhancement of industrial functions, the aggregation of production, the integration of resources, and the innovation of organizational management systems. This integrated development model seeks to transcend the boundaries of traditional agriculture, fostering the deep integration of rural primary, secondary, and tertiary industries. This promotes a mutually reinforcing and synergistic development cycle, ultimately leading to the comprehensive revitalization of the rural economy and the continuous advancement of agricultural modernization (Sun et al., 2024). As a new type of agricultural business entity, modern agricultural parks facilitate rural industrial integration through various means, such as extending agricultural value chains, developing multifunctional agricultural applications, and new agricultural business models.

From a micro economic perspective, the rural industrial integration strategy enhances agricultural production efficiency by adopting advanced agricultural technologies and optimizing resource allocation. This not only increases farmers' economic benefits but also drives overall agricultural economic growth. From a macroeconomic perspective, rural industrial integration accelerates the pace of agricultural modernization, promotes rural economic diversification, fosters the formation of industrial clusters, and strengthens regional economic competitiveness, ultimately contributing to sustained agricultural economic growth.

Additionally, due to variations in the hierarchical status and strategic positioning of different cities, modern agricultural parks possess distinct resource conditions and development goals. These differences result in varying impacts of modern agricultural parks on the agricultural economic development of their respective counties. To explore how these differences affect the specific effects of modern agricultural parks on regional agricultural economies, we propose the following hypotheses:

H3: Modern agricultural parks drive agricultural economic growth through the promotion of rural industrial integration.

H4: The impact of modern agricultural parks on agricultural economic growth exhibits heterogeneity across regions.

The mechanism through which modern agricultural park development influences agricultural economic growth is illustrated in Figure 1.

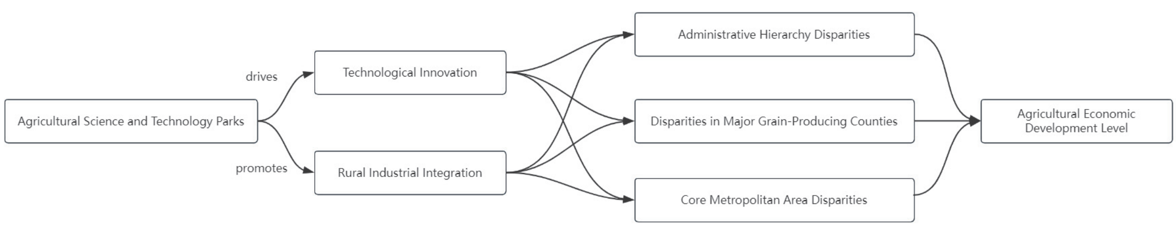

Figure 1. The Logical Framework of How Modern Agricultural Park Construction Influences Agricultural Economic Development

3. Econometric Model, Variables, and Data Sources

3.1 Econometric Model

Different counties were approved to establish modern agricultural parks at different times. Therefore, this study employs a multi-period difference-in-differences (DID) approach, treating the establishment of modern agricultural parks as a quasi-natural experiment. This method allows us to assess the impact of modern agricultural park development on agricultural economic growth by comparing economic data before and after their establishment, while also contrasting with a control group (regions without modern agricultural parks). This approach helps to identify the direct effects of modern agricultural parks on agricultural economic growth, providing more precise and scientific analysis results. The specific model is as follows:

$$\ln Y_{i,t} = \alpha_0 + \beta_0 did_{i,t} + \gamma_0 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{1}$$

i represents the county, and t represents the year.

$\ln Y_{i,t}$ is the dependent variable, representing the level of agricultural economic development i in county in year t.

$did_{i,t}$ is the core explanatory variable, a dummy variable indicating whether county i established a modern agricultural park in year t.It is set to 1 if the park was established (treatment group) and 0 otherwise (control group).

β_0 is the key coefficient of interest, capturing the effect of modern agricultural park establishment on agricultural economic growth.

$X_{i,t}$ represents control variables that account for factors such as agricultural labor, agricultural machinery, agricultural land inputs, etc.

γ_0 is the coefficient vector for these control variables.

μ_i and λ_t are county and year fixed effects, respectively.

$\epsilon_{i,t}$ is the random error term.

The study focuses on determining whether β_0 is statistically significant. If positive and significant, it indicates that modern agricultural parks have a positive effect on agricultural economic growth.

To address selection bias and ensure the validity of the multi-period DID model, this study conducts a parallel trend test between the treatment and control groups. This test evaluates whether the trends of the dependent variable (agricultural economic development) in the treatment and control groups were parallel before the treatment (i.e., the establishment of modern agricultural parks). The model for the parallel trend test is as follows:

$$\ln Y_{i,t} = \alpha_1 + \sum_{n=1}^{8} \beta_{-n}\, did_{i,t}^{-n} + \sum_{n=1}^{6} \beta_n\, did_{i,t}^{n} + \gamma_1 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{2}$$

$did_{i,t}^{\pm n}$ and did $_{i,t}^{-n}$ are sets of dummy variables indicating years before 8 and after 6 the establishment of modern agricultural parks.

β_{-n}captures the trend in agricultural economic development before the establishment of modern agricultural parks. If β_{-n} is not significant, it satisfies the parallel trend assumption.

β_n captures the effect of modern agricultural parks on agricultural economic growth after their establishment.

To explore the pathways through which modern agricultural parks affect regional agricultural economic growth, this study constructs a mechanism test model. The specific models are as follows:

$$tech_{i,t} = \alpha_2 + \beta_1 did_{i,t} + \gamma_2 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{3}$$

$$\ln Y_{i,t} = \alpha_3 + \beta_2 did_{i,t} + \beta_3 tech_{i,t} + \gamma_3 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{4}$$

$$merge_{i,t} = \alpha_4 + \beta_4 did_{i,t} + \gamma_4 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{5}$$

$$\ln Y_{i,t} = \alpha_5 + \beta_5 did_{i,t} + \beta_6 merge_{i,t} + \gamma_5 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} \tag{6}$$

$tech_{i,t}$ represents the level of technological innovation.

$merge_{i,t}$represents the level of rural industrial integration.

α_2、α_3、α_4、$\alpha_5$represent constant terms.

β_1、β_2、β_3、β_4、β_5、β_6、γ_2、γ_3、γ_4、$\gamma_5$are coefficients to be estimated.

The remaining symbols carry the same meanings as defined in the preceding equations.

3.2 Variable Selection

3.2.1 Dependent Variable

The dependent variable represents the indicator used to measure regional agricultural economic level. In previous studies, some scholars have utilized the added value of agriculture, forestry, animal husbandry, and fishery or rural residents' per capita net income as (Yuan et al., 2021; Huang et al., 2021; Deng and Wang, 2020). To mitigate the impact of price fluctuations on research results, this study follows the methodologies of Wang et al. (2021), Huang et al. (2021), and Deng et al. (2020) by employing the annual total output value of agriculture, forestry, animal husbandry, and fishery at the county level as a proxy variable. Data are log-transformed to more accurately reflect the actual regional agricultural economic levels.

3.2.2 Core Explanatory Variable

The core explanatory variable is a binary variable indicating whether a modern agricultural park has been established. Based on the earliest year each county was approved to establish a modern agricultural park, the variable is assigned a value of 1 if the county has a modern agricultural park in the given year or any subsequent year, and 0 otherwise. This binary variable captures the treatment effect of modern agricultural park establishment, contrasting the outcomes of counties with such parks to those without.

3.2.3 Control Variables

This study incorporates six control variables to account for factors that may influence regional agricultural economic growth, drawing from the methodologies of Xue et al. (2023) and Yin (2020). These variables are:

Agricultural Labor: The number of persons employed in agriculture, forestry, animal husbandry, and fishery reflects labor input in agricultural development. Notably, the population engaged in these sectors has declined annually as rural residents migrate to urban areas.

Agricultural Machinery: The total power of agricultural machinery used in a region indicates the level of agricultural mechanization, enhancing production efficiency and crop output.

Agricultural Land Inputs: The total cropped area serves as an indicator of a region's agricultural land resources.

Farmers' Income Levels: This encompasses income from farming, animal husbandry, and 务工 activities, assessing the economic well-being of farmers.

Agricultural Output Levels: This measures regional agricultural production capacity and directly impacts agricultural economic growth.

Government Intervention: Measured by local government's general budget revenue, reflecting financial capacity and support for agricultural development.

3.2.4 Mechanism Variables

To analyze how modern agricultural parks influence agricultural economic growth, this study examines two mechanisms: technological innovation and rural industrial integration.

Technological Innovation: The number of patent applications in a county is used to assess technological innovation, as it reflects the intensity of scientific and technological activities (Guo et al., 2023; Dong et al., 2023).

Rural Industrial Integration: The proportion of the primary sector in a region's GDP is used to gauge the extent of rural industrial integration. A smaller proportion indicates a more diversified economic structure with enhanced synergies across agricultural, industrial, and service sectors, facilitating extended agricultural value chains and efficiency improvements.

For comparability and to neutralize scale effects, all variables except the core binary explanatory variable and the rural industrial integration index have been log-transformed.

3.3 Data Sources

The data for this study are derived from non-panel data spanning 2007 to 2021 for 438 counties across four provinces in southwest China: Sichuan, Guizhou, Yunnan, and Chongqing. The dataset includes:

Modern Agricultural Parks: A list of modern agricultural parks, sourced from the website of the Chinese Ministry of Science and Technology.

Patent Applications: Data on patent applications, sourced from the China National Intellectual Property Administration (CNIPA) patent search and analysis platform.

Control Variables: Data on agricultural labor, machinery, land inputs, farmers' income, agricultural output, and government revenue, sourced from the China County Statistical Yearbook. For missing values, the data were supplemented using local city and county statistical yearbooks, and linear interpolation was applied to impute any remaining missing values.

Notably, due to severe data missingness and difficulties in collection, data from the Tibet Autonomous Region were excluded from the analysis of the southwest region.

Table 1 presents the definitions and descriptive statistics of the variables used in the study.

Table 1. Variable Definitions and Descriptive Statistics

Variable Category	Variable Name	Variable Description	Mean	Standard Deviation
Dependent Variable	Agricultural Economic Level	Logarithm of the total output value of agriculture, forestry, animal husbandry, and fishery (in 10,000 CNY)	12.02	1.152
Core Variable	Interaction Term	Whether a modern agricultural park is established: Yes = 1, No = 0	0.128	0.334
Control Variables	Agricultural Labor Level	Logarithm of the number of employees in agriculture, forestry, animal husbandry, and fishery (in persons)	11.53	0.684
	Agricultural Mechanization Level	Logarithm of the total power of agricultural machinery (in kilowatts)	2.983	0.807
	Agricultural Land Input	Logarithm of the total sown area of crops (in hectares)	3.729	0.933
	Farmers' Income Level	Logarithm of the per capita disposable income of rural residents (in CNY)	8.876	0.623
	Grain Output Level	Logarithm of the total output value of grain (in tons)	11.52	1.394
	Degree of Local Government Intervention	Logarithm of local government general budget revenue (in 10,000 CNY)	10.66	1.301
Mediating Variables	Regional Sci-Tech Innovation Level	Logarithm of the number of patent applications in each region	3.456	1.922
	Rural Industrial Integration	Proportion of the added value of the primary industry to regional GDP	0.289	0.204

4. Empirical Results Analysis

4.1 Analysis of Baseline Regression Results

Table 2 reports the estimation results of the baseline regression examining the impact of modern agricultural park construction on agricultural economic development. Column (1) does not include control variables, while columns (2) to (7) progressively add control variables. All equations employ a multi-period difference-in-differences (DID) model for parameter estimation, with two-way fixed effects controlled. Based on the sign of the correlation coefficients and the statistical significance of the variables, the estimated results of the core explanatory variable across all columns are significant at the 1% level.

In column (1) of Table 2, only the agricultural economic level is regressed. The results show a positive effect at the 1% significance level, indicating that in counties where modern agricultural parks are established, the agricultural economic level has increased by an average of 6.23%. When control variables are gradually introduced in columns (2) to (7), we find that the regression results of the interaction term remain highly significant, and the impact coefficient increases from 0.0623 to 0.0862. This increase reflects that the positive impact of modern agricultural parks on agricultural economic development is not only significant but also robust after controlling for other relevant factors. Therefore, we can confirm that Hypothesis 1 holds, i.e., the establishment of modern agricultural parks has a significant positive impact on agricultural economic growth. By establishing modern agricultural parks, we can effectively integrate sci-tech innovation resources, promote the development and transformation of agricultural technologies, and thereby improve agricultural production efficiency and product quality.

Regarding the control variables, it is observed that only the degree of local government intervention has a negative impact. This could be because local governments, in their pursuit of increased fiscal budget revenue, have adopted more aggressive tax collection measures, such as raising agricultural tax rates or strengthening tax enforcement. These measures may increase production costs and economic burdens for farmers.

Table 2. Regression Results of the Effect of Establishing Modern Agricultural Parks on Agricultural Economic Level

Variable	**Dependent Variable: Agricultural Economic Level**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction Term	0.0623***	0.0724***	0.0739***	0.0757***	0.0932***	0.0870***	0.0862***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural Labor Level		0.588***	0.544***	0.540***	0.250***	0.127***	0.125***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.005)
Agricultural Mechanization Level			0.321***	0.293***	0.244***	0.181***	0.183***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural Land Input				0.488***	0.510***	0.231***	0.252***
				(0.000)	(0.000)	(0.006)	(0.004)
Farmers' Income Level					0.611***	0.551***	0.556***
					(0.000)	(0.000)	(0.000)
Grain Output Level						0.306***	0.306***
						(0.000)	(0.000)
Degree of Local Government Intervention							-0.0969***
							(0.000)
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES
County Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Constant	12.01***	5.234***	4.784***	3.085***	1.073	0.714	1.658***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.103)	(0.232)	(0.005)
Observations	6570	6570	6570	6570	6570	6570	6568
R^2	0.938	0.939	0.942	0.943	0.949	0.950	0.954

Notes. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Standard errors in parentheses are robust standard errors.

4.2 Parallel Trend Test

To confirm the validity and accuracy of the multi-period difference-in-differences (DID) model, this study follows the method proposed by Beck et al. (2010) to test the parallel trends before and after the establishment of modern agricultural parks. A dynamic trend test graph is plotted to visually present the results. In this test, data from eight years before the policy implementation to six years after the policy implementation are selected, with the year before the policy implementation set as the baseline year.

As shown in Figure 1, the estimated coefficients for most years before the policy implementation are not statistically significant and fluctuate widely around zero. However, after the policy implementation, the estimated coefficients for each year become significant and exhibit an upward trend, with all coefficients located above zero. This indicates that there is no significant difference between the treatment group and the control group before the policy implementation. The results demonstrate that the treatment group and the control group satisfy the parallel trend assumption, validating the applicability of the multi-period DID model in this study.

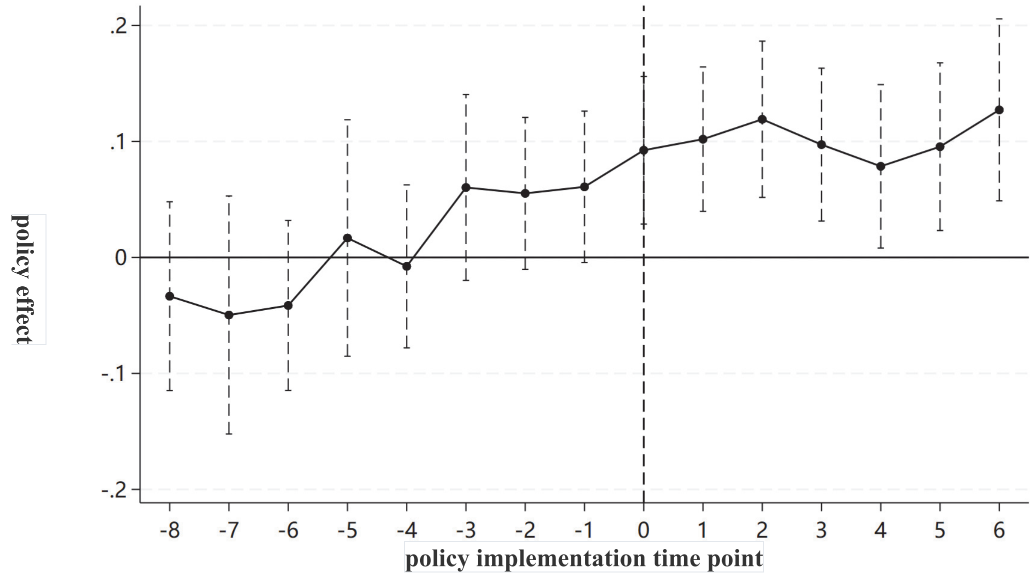

Figure 2. Parallel Trend Test

4.3 Placebo Test

To address the potential influence of unobservable factors at the county-year level on the estimation results, despite the inclusion of two-way fixed effects in the baseline regression to control for heterogeneity across counties and years, this study adopts the approach of Tang Haodan et al. (2022) to conduct a placebo test. Specifically, counties and policy implementation years are randomly assigned to generate a pseudo-core explanatory variable, which is then used for regression analysis.

Figure 3 illustrates the results of 500 random sampling iterations. As shown, the majority of the 500 estimated coefficients are distributed around zero rather than clustering around the true estimated result of 0.0861. Additionally, the p-values for most of these coefficients are statistically insignificant. This indicates that the true estimated result in this study is a clear outlier within the sampling distribution and is unlikely to have occurred by chance. Thus, the placebo test confirms that the agricultural economic growth effect attributed to the modern agricultural park policy is genuine and not influenced by unobservable factors at the county-year level.

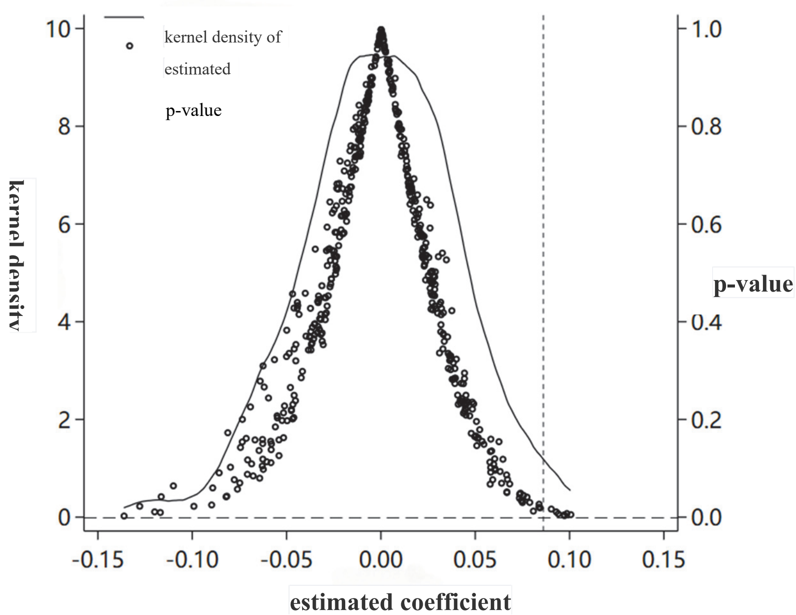

Figure 3. placebo test

4.4 Robustness Test

Given that the establishment of modern agricultural parks is not a random process but rather a decision based on comprehensive evaluations by the Ministry of Science and Technology or provincial science and technology departments, considering factors such as regional agricultural development levels, the status of specialized agriculture, the scale of technological investment, and scientific research and innovation capabilities, there is an inherent difference between the treatment and control groups. This inevitably leads to sample selection bias. To address the potential self-selection bias in the policy effect evaluation using the difference-in-differences (DID) method, this study employs the propensity score matching-difference-in-differences (PSM-DID) approach (Table 3). By matching each treatment group sample with a control group sample that has a similar propensity score, the robustness test ensures that the evaluation results are more reliable and accurate.

In Table 3, column (1) presents the baseline regression results, primarily for comparison with the subsequent columns. Column (2) shows the regression results using samples with non-empty weights. By including these samples in the matching process, they are incorporated into the DID regression model for parameter estimation, thereby mitigating the selection bias present in the baseline regression to some extent. Column (3) displays the regression results using samples that satisfy the common support assumption, while column (4) presents the frequency-weighted regression analysis results, considering the importance of sample weights. Notably, all four estimated coefficients are statistically significant at the 1% level, reaffirming that the establishment of modern agricultural parks has a significant positive impact on improving local agricultural economic levels.

Table 3. PSM-DID Robustness Test

Variable	(1) Fixed Effects Regression	(2) Weight!=.	(3) On_Support	(4) Weight_Reg
Interaction Term	0.0862***	0.181***	0.0875***	0.184***
	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural Labor Level	0.125***	0.0737	0.0959**	0.180
	(0.005)	(0.555)	(0.031)	(0.113)
Agricultural Mechanization Level	0.183***	0.205***	0.184***	0.175***
	(0.000)	(0.002)	(0.000)	(0.002)
Agricultural Land Input	0.252***	-0.171	0.254***	-0.106
	(0.004)	(0.329)	(0.003)	(0.493)
Farmers' Income Level	0.556***	0.655***	0.564***	0.631***
	(0.000)	(0.000)	(0.000)	(0.000)
Grain Output Level	0.306***	0.153***	0.303***	0.145***
	(0.000)	(0.003)	(0.000)	(0.003)
Degree of Local Government Intervention	-0.0969***	-0.0892***	-0.0973***	-0.103***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.658***	4.559***	1.949***	3.658**
	(0.005)	(0.004)	(0.001)	(0.013)
Year Fixed Effects	YES	YES	YES	YES
County Fixed Effects	YES	YES	YES	YES
Observations	6568	2103	6545	2475
R^2	0.954	0.961	0.954	0.963

Notes. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Standard errors in parentheses are robust standard errors.

4.5 Mechanism Analysis

4.5.1 The Impact of Modern Agricultural Parks on Agricultural Economy Through Technological Innovation

Column (2) of Table 4 presents the estimated results of the impact of establishing modern agricultural parks on regional technological innovation levels. The data show that the establishment of modern agricultural parks significantly promotes regional technological innovation capabilities by effectively aggregating innovation resources such as high-tech talent, specialized technologies, and financial support, thereby enhancing agricultural technological levels. In column (3), although the estimated coefficient of the interaction term is significant at the 1% level, the impact of regional technological innovation capabilities on local agricultural economic development is not statistically significant. To further verify the existence of the mediating effect, the Sobel test or bootstrap test was employed. Given the statistical power of the bootstrap test and the sample size of this study, the bootstrap method was chosen. By resampling the original sample with replacement and repeating the process 1,000 times, the results in Table 5 indicate that the total effect of modern agricultural parks on regional agricultural economic levels is 0.326, of which the direct effect is 0.16 and the indirect effect is 0.165, accounting for 50.61% of the total effect. Furthermore, both the confidence interval (P) and the bias-corrected confidence interval (BC) do not include zero, indicating that the mediating effect is significant. Therefore, we can conclude that Hypothesis 2 holds.

Table 4. The Impact of Modern Agricultural Parks on Agricultural Economy Through Technological Innovation

Variable	(1) Baseline Regression	(2) Regional Technological Innovation Level	(3) Agricultural Economic Level
Interaction Term	0.0862***	0.253***	0.0849***
	(0.000)	(0.000)	(0.000)
Regional Technological Innovation Level			0.00505
			(0.195)
Control Variables	Included	Included	Included
Year Fixed Effects	YES	YES	YES
County Fixed Effects	YES	YES	YES
Constant	1.658***	0.573	1.656***
	(0.005)	(0.856)	(0.005)
Observations	6568	6568	6568
R^2	0.954	0.738	0.954

Notes. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Standard errors in parentheses are robust standard errors.

Table 5. Bootstrap Test Results

Test Method	Regression Coefficient	Bias	Standard Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	
Indirect Effect	0.16568611	-0.0009081	0.01533964	0.1361087	0.1956324	(P)
				0.137309	0.197297	(BC)
Direct Effect	0.16031955	0.0011065	0.035686	0.0907738	0.2314546	(P)
				0.0918679	0.2317094	(BC)

4.5.2 The Impact of Modern Agricultural Parks on Agricultural Economy Through Rural Industrial Integration

Column (2) of Table 6 presents the estimated results of the effect of establishing modern agricultural parks on rural industrial integration. The estimated coefficient is positive and significant at the 5% level, indicating that although the establishment of modern agricultural parks does not significantly enhance the level of rural industrial integration, it does help increase the proportion of the primary industry in the local economy, relatively reducing the output value of the secondary and tertiary industries, thereby promoting agricultural development. In column (3), the estimated coefficient results show that establishing modern agricultural parks cannot drive regional agricultural economic growth by promoting industrial integration but can only promote agricultural economic development by increasing the proportion of the primary industry in the regional economy. Therefore, Hypothesis 3 is not validated. This may be because modern agricultural parks overly focus on the research and innovation of agricultural product technologies while failing to effectively integrate subsequent stages such as agricultural product processing and sales services, resulting in an incomplete industrial chain and thus hindering the integrated development of rural industries.

Table 6. The Impact of Modern Agricultural Parks on Agricultural Economy Through Rural Industrial Integration

Variable	(1)	(2)	(3)
	Baseline Regression	**Rural Industrial Integration**	**Agricultural Economic Level**
Interaction Term	0.0862***	0.0100**	0.0832***
	(0.000)	(0.022)	(0.000)
Rural Industrial Integration			0.299***
			(0.000)
Control Variables	Included	Included	Included
Year Fixed Effects	YES	YES	YES
County Fixed Effects	YES	YES	YES
Constant	1.658***	2.029***	1.052*
	(0.005)	(0.000)	(0.073)
Observations	6568	6568	6568
R^2	0.954	0.893	0.954

Notes. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Standard errors in parentheses are robust standard errors.

4.6 Heterogeneity Analysis

4.6.1 Analysis by Administrative Level

The regression results in columns (1) and (2) of Table 7 show that the coefficients for both provincial capital and non-provincial capital groups are significant at the 1% level. To better understand the differences between provincial capitals and non-provincial capitals, a Chow test was conducted to examine the coefficient differences between the groups. The results, presented in Table 8, show that the p-value for the interaction term between the provincial capital variable and the core explanatory variable (whether a modern agricultural park is established) is 0.000, which is significant at the 1% level. This confirms that the coefficient differences between the groups are significant, supporting Hypothesis 4. The impact of modern agricultural parks on promoting agricultural economic development differs significantly between provincial capitals and non-provincial capitals. Based on the estimated coefficients, establishing modern agricultural parks in provincial capitals yields a 28% benefit for agricultural economic growth. This is because provincial capitals are typically regional political, economic, and cultural centers, making it easier to secure government policy support and resource allocation, including funding, technology, and talent.

Table 7. Heterogeneity Analysis Based on Administrative Level, Core Metropolitan Areas in the Southwest, and Major Grain-Producing Counties

Variable	(1) Provincial Capitals	(2) Non-Provincial Capitals	(3) Core Metropolitan Areas	(4) Non-Core Metropolitan Areas	(5) Major Grain-Producing Counties	(6) Non-Major Grain-Producing Counties
Interaction Term	0.286***	0.0546***	0.213***	0.00784	-0.0387**	0.0788***
	(0.000)	(0.000)	(0.000)	(0.657)	(0.028)	(0.000)
Control Variables	Included	Included	Included	Included	Included	Included
Constant	3.545*	4.619***	-1.882*	6.497***	11.42***	1.593**
	(0.077)	(0.000)	(0.081)	(0.000)	(0.000)	(0.026)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
County Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	808	5760	1648	4920	1710	4858
R^2	0.955	0.955	0.959	0.954	0.979	0.962

Notes. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Standard errors in parentheses are robust standard errors.

Table 8. Coefficient Difference Test Between Groups (Chow Test)

Variable	(1) Agricultural Economic Level
1.provincial_capital#c.did	0.432***
	(0.000)
Control Variables	Included
Constant	12.07***
	(0.000)
Year Fixed Effects	YES
County Fixed Effects	YES
Observations	6570
R^2	0.943

4.6.2 Analysis by Core Metropolitan Areas in the Southwest

Based on the Chengdu Metropolitan Area Development Plan, Chongqing Metropolitan Area Development Plan, Guiyang-Gui'an-Anshun Metropolitan Area Development Plan, and Yunnan Provincial Territorial Spatial Plan (2021-2035), 22 cities, including Chengdu, Deyang, Meishan, Ziyang, Yuzhong District, Dadukou District, Jiangbei District, Guiyang, Gui'an, Anshun, and Kunming, are identified as core metropolitan areas. Columns (3) and (4) of Table 7 show that establishing modern agricultural parks in core metropolitan areas significantly improves agricultural economic levels. This is likely because core metropolitan areas are home to numerous high-quality higher education institutions, top talent, and research institutes, which provide robust technical support and talent reserves for the parks. These resources facilitate the transformation and practical application of agricultural scientific and technological achievements. Additionally, establishing modern agricultural parks in core metropolitan areas can attract related agricultural enterprises, research institutions, and service providers, forming a complete industrial chain. This agglomeration effect promotes resource sharing, information exchange, and technical collaboration, further enhancing the overall competitiveness of agriculture.

4.6.3 Analysis by Major Grain-Producing Counties

Sichuan Province, the only core grain-producing region in the southwest, has launched the "Tianfu Granary: Hundred Counties, Thousand Zones" Construction Action Plan (2024–2026), aiming to create 1,000 high-standard, high-yield grain and oil demonstration zones in over 100 counties and districts. This study categorizes counties in the southwest based on whether they are major grain-producing counties and employs heterogeneity analysis. From the regression coefficients in columns (5) and (6) of Table 7, it is evident that modern agricultural parks in major grain-producing counties have a significant negative impact on agricultural economic growth, while in non-major grain-producing counties, the impact is positive and significant at the 1% level. This suggests that establishing modern agricultural parks in non-major grain-producing counties can promote regional agricultural economic growth. The primary reason may be that major grain-producing counties already have well-established agricultural production systems and high resource utilization levels. Establishing modern agricultural parks in these areas could lead to competition for core resources such as land, water, and labor, potentially causing imbalanced resource allocation and negatively affecting traditional grain production efficiency and scale. In contrast, non-major grain-producing counties have lower resource utilization efficiency and lagging agricultural production. Introducing modern agricultural parks in these areas can bring new management practices and technologies, significantly improving resource use efficiency and driving agricultural economic growth.

5. Conclusions and Implications

5.1 Research Conclusions

This study provides a detailed analysis of the role of modern agricultural parks in promoting regional agricultural economic growth and concludes the following:

Significant Positive Impact: Regardless of whether control variables are included, the regression coefficient between modern agricultural parks and agricultural economic growth is significant at the 1% level. This confirms that modern agricultural parks substantially contribute to regional agricultural economic growth.

Robustness of Results: The accuracy and reliability of the regression results are ensured through parallel trend tests, placebo tests, and PSM-DID robustness tests, further validating the causal relationship.

Mechanism Analysis: Modern agricultural parks significantly promote agricultural economic development by enhancing regional technological innovation capabilities. However, this effect is not achieved through rural industrial integration.

Heterogeneity Analysis: The impact of modern agricultural parks on agricultural economic growth varies across administrative levels, core metropolitan areas, and major grain-producing counties. Specifically:

Provincial Capitals: The most significant positive impact is observed in provincial capitals.

Non-Provincial Capitals: Positive effects are also found in non-provincial capital regions.

Core Metropolitan Areas: Modern agricultural parks in core metropolitan areas contribute positively to agricultural economic growth.

Non-Grain-Producing Counties: These regions also benefit from the establishment of modern agricultural parks.

In summary, the establishment of modern agricultural parks has a positive impact on agricultural economic growth, with the most pronounced effects in provincial capitals.

5.2 Policy Implications

Based on the research findings, this study proposes the following policy recommendations:

1. Leverage the Growth Wisdom of Modern Agricultural Parks to Consolidate and Enhance Their Quality, Maximizing Their Role in Promoting Agricultural Economic Prosperity

Specifically, the southwestern region should build on the successful examples and models of existing modern agricultural parks to further strengthen their construction. This includes improving support policies and evaluation mechanisms, establishing a performance-based dynamic assessment system, and implementing promotion and exit mechanisms. Additionally, it is essential to encourage collaboration between municipal-level modern agricultural parks and higher-level parks in the industrial chain, positioning modern agricultural parks as pioneers in regional agricultural industrial upgrading and driving the revitalization of rural economies.

2. Further Enhance the Technological Innovation Capacity of Modern Agricultural Parks to Promote Efficient and High-Quality Agricultural Development

By leveraging the development and application of new technologies, modern agricultural parks can lead the transformation and upgrading of local agricultural economies. The southwestern region should address technical bottlenecks in agricultural production by enhancing agricultural technical support. Advanced agricultural technologies and management models should be widely applied in rural areas to improve agricultural productivity and product quality, thereby increasing farmers' income and accelerating the modernization of agriculture.

3. Develop Leading Agricultural Industries and Build a Robust Modern Agricultural Industrial System

The fundamental goal of the rural revitalization strategy is industrial prosperity. Therefore, innovation should be the driving force to accelerate agricultural modernization and fully implement the rural revitalization strategy, which should be the core purpose of building modern agricultural parks. By constructing high-level modern agricultural parks, pooling superior resources, and advancing the research and development of key technologies, the transformation and dissemination of scientific and technological achievements can be accelerated. This will cultivate a series of leading agricultural industries with demonstration and driving functions, injecting new vitality into agricultural modernization and creating broader opportunities for rural revitalization.

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