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A study on the impact of rural financial service innovation on regional economic development in the context of digital economy

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SUMMARY: *Rural financial services serve as a vital link between farmers, businesses, and markets, playing a significant role in the sustainable and high - quality growth of regional economies. In this study, panel data from 31 Chinese provinces covering the period from 2013 to 2024 were gathered. Four econometric models, namely the fixed - effects model, the mediation effect model, the panel threshold model, and the spatial econometric model, were utilized to carry out an empirical examination of how rural financial service innovation affects regional economic development.The results show that rural financial service innovation has a remarkable positive influence on regional economic expansion. During this process, the regional innovation ability and the consumption level of residents act as indirect intermediaries. The internet penetration rate demonstrates a significant threshold effect. Once it exceeds 1.6341, the positive impact of rural financial innovation on economic development is further strengthened.There is a significant spatial correlation between rural financial innovation and regional economic development. Additionally, rural financial innovation has a positive spatial spill - over impact.Finally, this paper proposes corresponding strategies. These include enhancing the overall quality of banking financial services, establishing a risk - sharing mechanism, and promoting the coordinated development of inter - regional economies.*

KEYWORDS: *rural financial service innovation; regional economic growth; fixed-effect regression; mediation effect mechanism; panel threshold estimation; spatial econometric analysis*

1 Introduction

In the 21st century, the digital economy, serving as the primary impetus for economic growth, is globally reconfiguring the industrial framework and the mode of social operation. The significance of the digital economy extends beyond technological innovation; it also brings about a comprehensive transformation of the economic and social landscape [1]. As an essential element of the country's financial system, the progress of rural financial services is directly associated with the rejuvenation of the rural economy and the harmonious development between urban and rural regions [2].

Nonetheless, for an extended period, rural financial services have suffered from significant shortcomings in terms of coverage, service quality, and risk-management capabilities. Firstly, traditional financial institutions have a limited number of physical branches in rural regions, which restricts the reach of rural financial services. Secondly, farmers and rural enterprises typically lack standardized credit histories. As a result, financial institutions are confronted with

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a higher degree of information asymmetry and credit risk [3-7].

Concurrently, given that the rural economic framework is primarily composed of small-and medium-scale agricultural production and management entities, the dispersion and variety of capital requirements lead to a further elevation of service costs [8, 9]. The expansion of the digital economy offers a chance to tackle the issues mentioned earlier and foster innovation within the rural financial service framework.

The burgeoning fintech has significantly improved the accessibility and accuracy of financial services by utilizing digital technology tools. Technologies like large - scale data analytics, machine learning, distributed ledger technology, and cloud - based computing are utilized to develop a more comprehensive credit evaluation system.This is achieved by integrating and analyzing the unstructured data generated during farmers' production and operational activities. Based on user behavioral data, risk early-warning mechanisms can be established, which in turn boosts the ability to predict credit risks. Moreover, By establishing a distributed ledger, a more dependable, effective, and secure setting for transactions is provided for rural financial services [10-13].

In the period when the digital economy is expanding at a breakneck pace, the high - standard development of the regional economy is bound to be influenced by this new economic model. This new model spurs industrial advancement and transformation, refines the production elements, and generates the impetus for sustainable economic progress [14-16]. Technological innovation leads to the widespread movement of production factors and resources, shatters the information barriers, facilitates resource sharing, and drives the enhancement of human capital and the increase in production efficiency. All these aspects can serve as a dependable safeguard for the regional economy to transform and make breakthroughs towards high-quality development [17-20].

Furthermore, within the framework of economic globalization and the advancement of the digital economy, The connection between the advancement of financial services and the progress of the regional economy has become progressively intimate. [21, 22]. Assessing the actual influence of financial innovation on the development of the regional economy has emerged as a crucial measure for promoting the high - standard growth of the regional economy.

In this research, the regional economic growth is regarded as the outcome variable, whereas the degree of innovation in rural financial services acts as the predictor variable. After determining mediator variables, control variables, and threshold variables, a fixed - effects model, a mediation - effect model, a panel threshold model, and a spatial Durbin model are constructed separately. These models are formulated on the basis of the panel data of 31 provincial - level administrative regions in China covering the period from 2013 to 2024. Based on the outcomes of the model tests, the study analyzes how the degree of rural financial service innovation specifically affects the regional economic development level. Empirical analysis leads to certain conclusions, and based on these findings, relevant measures for promoting regional economic development are put forward.

2 Study design

2.1 Rural financial services innovation and regional economic development level measurement

(1) Assessment of the degree of innovation in rural financial services

Rural financial service innovation entails the incorporation of novel concepts, approaches, and technologies within the financial realm to more efficiently address the distinct financial requirements of rural regions. During the course of rural financial service innovation, the diversification of financial products and services stands as a crucial factor. This involves the creation of suitable deposit, lending, insurance, and investment products for rural areas to satisfy the diverse financial demands of farmers.Moreover, the utilization of financial technology, such as mobile payment systems, online banking, and big - data analytics, also holds significant importance in rural financial service innovation. These technologies not only boost the efficiency and convenience of financial services but also assist financial institutions in gaining a better understanding of rural customers and providing them with more appropriate services.

(1) The development of an index system for the level of innovation in rural financial services

The indicator system for the innovation level of rural financial services is shown in Table 1. This system, which is constructed on the basis of previous studies, consists of three components: the scope, the standards, and the innovativeness of rural financial services.

Table 1: Index system for the innovation level of rural financial services

Primary indicator	Secondary indicator
Rural financial service span	Number of financial institutions per 10,000 residents
	Number of financial practitioners per 10,000 residents
	Number of financial practitioners per square kilometer
	The number of financial workers per square kilometer
Quality of rural financial services	Ratio of agricultural loans to regional GDP
	Per capita agricultural loan balance
Innovation of rural financial services	Support for agriculture

2) Calculation of the rating for the innovation degree of rural financial services

Using the factor score variable to classify and evaluate the sample for the study, according to the calculation formula:

$$F_{ij} = w_{j1}x_{1i} + w_{j2}x_{2i} + w_{j3}x_{3i} + \cdots + w_{jp}x_{pi},\ j = 1,2,3\cdots k \tag{1}$$

where x_{pi} is the value of p variable on the i th observation, and w_{jp} is the factor value coefficient between the j th factor and the p th variable. According to the calculation, the score of rural financial service innovation level is obtained.

(2)Evaluation of the degree of regional economic growth

The extent of regional economic development is indicated by the per - person gross domestic product (GDP) of each provincial area.

2.2 Research methodology

Drawing on theoretical scrutiny, considering the variations in the innovation extent of rural financial services among different regions, the impact of related diversity on the regional economic development level may display a non - linear relationship, and there are different results within various intervals. To avoid the actual divergence brought about by the artificial division of innovation level intervals, the threshold panel model can divide intervals according to the intrinsic features of the data. This is helpful for investigating the influence of related diversity on the regional economic development level under different degrees of innovation. First, a solitary - threshold model is established, and subsequently, it is extended to a multi - threshold model. The structure of the solitary - threshold model is as follows:

$$b_{i,t} = \mu_i + \theta x_{i,t} + \beta_1 rv_{i,t} I\left(g_{i,t} \le \gamma\right) + \beta_2 rv_{i,t} I\left(g_{i,t} > \gamma\right) + \varepsilon_{i,t} \tag{2}$$

where i denotes the region, t denotes the year, and $b_{i,t}$ and $rv_{i,t}$ denote the explanatory and interpretive variables, respectively. $x_{i,t}$ is the control variable and θ is the corresponding vector of coefficients. $g_{i,t}$ is the threshold variable and γ is the specific threshold value. $I(\cdot)$ is an indicator function, the expression in the parentheses is true and takes the value of 1, otherwise it takes the value of 0. μ_i is used to reflect the individual effect of each region, $\varepsilon_{i,t}$ is the random disturbance term, and the respective core variables will be specified in the following. In the threshold analysis process, the method of eliminating the individual effect μ_i by subtracting its within-group mean from each observation is first adopted to obtain the parameter estimates. For example:

$$b_{i,t}^* = b_{i,t} - \frac{1}{T}\sum_{t=1}^{T} b_{i,t} \tag{3}$$

The following model can be obtained by transformation:

$$b_{i,t}^* = \theta' x_{i,t}^* + \beta_1 rv_{i,t}^* I\left(g_{i,t} \le \gamma\right) + \beta_2 rv_{i,t}^* \left(g_{i,t} > \gamma\right) + \varepsilon_{i,t}^* \tag{4}$$

Further the full set of observations is cumulatively stacked and the matrix form is used to represent equation (4) as:

$$b^* = X^*(\gamma)\beta + \varepsilon^* \tag{5}$$

For a given threshold γ, an estimate of β is obtained using OLS estimation Eq. (5):

$$\beta(\gamma) = \left(X^*(\gamma)' X^*(\gamma)\right)^{-1} X^*(\gamma)' b^* \tag{6}$$

In turn, the corresponding residual sum of squares is obtained as:

$$S_1(\gamma) = \hat{e}^*(\gamma)' \hat{e}^*(\gamma) \tag{7}$$

where $\hat{e}^*(\gamma) = b^* - X^*(\gamma)\beta(\hat{\gamma})$ is the residual vector.

The corresponding $S_1(\gamma)$ value is obtained by minimizing Eq. (7), and the estimate of γ is further obtained, i.e.:

$$\gamma(\hat{\gamma}) = \underset{\gamma}{\operatorname{argmin}}\, S_1(\gamma) \tag{8}$$

This leads to $\hat{\beta} = \hat{\beta}(\hat{\gamma})$, the residual vector $\hat{e}^* = \hat{e}(\hat{\gamma})$, and the residual sum of squares $\hat{\sigma}^2 = \sigma^2 \hat{\gamma}$. After the end of the parameter estimates, it is still necessary to test: first, whether the threshold effect is significant or not, and second, Whether the estimated threshold aligns with its actual value. For test one, the original hypothesis is $H_0 : \beta_1 = \beta_2$, the alternative hypothesis is $H_1 : \beta_1 \ne \beta_2$, and the test statistic is:

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{9}$$

where S_0 is the residual sum of squares obtained under the original hypothesis H_0. Under the hypothesis H_0, the threshold γ is unrecognizable, so the distribution of the F_1 statistic is non-standard, and Hansen suggests that the asymptotic distribution be obtained using the "Bootstrap" scientific method to construct the P value. The hypothesis for the second test is $H_0 : \hat{\gamma} = \gamma_0$, and the corresponding likelihood ratio test statistic is:

$$LR_1(\gamma) = \frac{S_1(\gamma) - S_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{10}$$

The distribution of this statistical measure is also non - typical, and the non - rejection region of it can be computed by applying the formula, which rejects the original hypothesis when $LR_1\left(\gamma_0\right) > c(\alpha) = -2\ln(1-\sqrt{1-\alpha})$, with α denoting the level of significance. The critical value of the LR statistic is 7.35 when α is at the 5% significance level.The above assumptions are based on a single-threshold analysis. In the instance of a double - threshold, a similar approach can be taken for treatment, and the model can be established:

$$\begin{aligned} b_{i,t} &= \mu_i + \theta x_{i,t} + \beta_1 rv_{i,t} I\left(g_{i,t} \le \gamma_1\right) + \beta_2 rv_{i,t} I\left(\gamma_1 < g_{i,t} \le \gamma_2\right) \\ &+ \beta_3 rv_{i,t} I\left(g_{i,t} > \gamma_2\right) + \varepsilon_{i,t} \end{aligned} \tag{11}$$

The approach for estimation involves initially making an assumption that the $\hat{\gamma}_1$ estimated in the single-threshold model is known, and then perform a search for γ_2, which is ultimately obtained:

$$S_2^r\left(\gamma_2\right) = \begin{cases} S\left(\hat{\gamma}_1, \gamma_2\right) & if \ \hat{\gamma}_1 < \gamma_2 \\ S\left(\gamma_2, \hat{\gamma}_1\right) & if \ \gamma_2 < \hat{\gamma}_1 \end{cases} \text{ And } \hat{\gamma}_2 = \arg\min_{\gamma_2} S_2^r\left(\gamma_2\right) \tag{12}$$

$\hat{\gamma}_2$ is asymptotically valid, but $\hat{\gamma}_1$ does not have this property. By fixing $\hat{\gamma}_2$ for $\hat{\gamma}_1$ again, the optimized consistent estimator $\hat{\gamma}_1$ can be obtained.

2.3 Selection of variables

(1) Explained variables

The economic expansion at the provincial scale, measured by the per - capita gross domestic product (GDP) of every province, serves as a marker of regional economic progress (PE - GDP).

(2) Core explanatory variables

The Innovation Degree of Rural Financial Services (IDRFS) functions as an assessment index framework that is intended to gauge the degree of innovation within rural financial services. It assesses the innovation level of these services from three distinct perspectives: the breadth (Scope), the standard (Quality), and the degree of novelty (Innovation) of the rural financial services.

(3) Intermediary variables

In this paper, regional innovation capacity (Inn) and residents' consumption level (Csm) are selected to test the mediating effect.

(4) Selection of Control Variables

To enhance the precision and reliability of the empirical findings, this research refers to the existing research literature. It also considers the development needs of China's particular national conditions. Then, it chooses five variables as control variables. These variables are the concentration of innovative talents (Relq), the level of human capital (Hum), the scale of government expenditure (Gov), the population density (Dens), and the degree of industrial development (Indus).

(5) Threshold variables

Internet Access (Inter). Internet technology presents an opportunity Regarding the advancement of digital financial services. By capitalizing on the advantages of Internet information technology, digital finance has broadened its service range. In this research, the rate of Internet accessibility is chosen as a threshold variable. This is done to carry out a more in - depth and all - encompassing examination of its influence on the degree of innovation in rural financial services in the digital economy context.

2.4 Model construction

(1) A static - effects model formulated to stimulate regional economic development via the advancement of rural financial services

In order to investigate the direct impact of rural financial service innovation on regional economic development and whether there is a regional difference in the influence of rural financial service innovation on regional economic development, this paper constructs the following baseline regression model:

$$PE-GDP_{it}=\alpha_0+\alpha_1 X_{it}+\alpha_j Z_{it}+\lambda_i+\varepsilon_{it} \tag{13}$$

where subscript i denotes individual $(1\le i\le n)$, subscript t denotes time $(1\le t\le T)$, $n=31$ in this paper, α_0 denotes the intercept term, X denotes the level of innovation in Rural Financial Services Innovation Level (RFSIL) and its subdimensional indices (Breadth, Mass, and Innovate), respectively. Z denotes a series of relevant control variables, α_1 denotes the coefficients of the explanatory variables, α_j denotes the coefficients of a series of control variables, respectively, λ_i denotes the province fixed effects, and ε_{it} is the error term.

(2)The model of the mediating effect of rural financial service innovation on regional economic development

Rural financial service innovation will have an impact on regional economic development through regional innovation capacity (Inn) and residents' consumption level (Csm). This paper constructs an intermediary effect model for research analysis. The testing steps are as follows: Based on the significant result of coefficient α_1 in the regression model of rural financial service innovation level $RFSIL_{it}$ on regional economic development level $PE-GDP_{it}$, linear regression equations of rural financial service innovation level $RFSIL_{it}$ on the intermediary variable Mediator and linear regression equations of rural financial service innovation level $RFSIL_{it}$ and the intermediary variable Mediator on regional economic development level $RFSIL_{it}$ are respectively constructed. The existence of the intermediary effect is determined by observing the significance of estimated coefficients β_1, γ_1, γ_2, etc. The specific model is as follows:

$$Mediator_{it} = \beta_0 + \beta_1 RFSIL_{it} + \beta_j Z_{it} + \lambda_i + \varepsilon_{it} \tag{14}$$

$$PE - GDP_{it} = \gamma_0 + \gamma_1 Difi_{it} + \gamma_2 Mediator_{it} + \gamma_j Z_{it} + \lambda_i + \varepsilon_{it} \tag{15}$$

where Mediator denotes the regional innovation capacity and the consumption level of residents respectively, $RFSIL_{it}$ is the regional economic development level, and $PE - GDP_{it}$ is the rural financial service innovation level.

(3) Panel threshold model of rural financial service innovation affecting regional economic development

With the advent of the digital era, new digital financial models relying on Internet technology are gradually integrating into people's daily lives. Considering that the degree of Internet development might exert a non - linear effect on the progress of rural financial service innovation and the consequent impact on regional economic development, this paper constructs the following panel threshold model to explore the structural change of the promotional effect:

$$\begin{aligned} PE - GDP_{it} &= \gamma_0 + \gamma_1 RFSIL_{it} \cdot I\left(Q_{it} \le \eta_1\right) + \gamma_2 RFSIL_{it} \cdot I\left(\eta_1 < Q_{it} \le \eta_2\right) \\ &+ \cdots + \gamma_{m+1} RFSIL_{it} \cdot I\left(Q_{it} \ge \eta_m\right) + \theta Control_{it} + \lambda_i + \varepsilon_{it} \end{aligned} \tag{16}$$

where $Inter_{it}$ is selected as the threshold variable for Internet penetration and γ is the corresponding threshold value. Where $RFSIL_{it}$ is the threshold dependent variable, $I(\cdot)$ is the schematic function, Q_{it} is the threshold variable $Inter_{it}$, η is the threshold value, and γ_i denotes the coefficient of influence of the explanatory variables in different intervals, when $\gamma_{m-1} \ne \gamma_m$ indicates the existence of threshold effect.

(4) Spatial measurement model design

The present research intends to assess the influence of innovation in rural financial services on regional economic growth from a spatial viewpoint. It uses an economic distance matrix that exhibits distinct economic features as the base matrix. In order to identify the most suitable spatial econometric model, this study conducts the Hausman test, the Lagrange Multiplier (LM) test, the Likelihood Ratio (LR) test, and the Wald test to improve the accuracy of the empirical data. After careful analysis, the Spatial Durbin Model (SDM) is selected as the optimal option. Consequently, only the results of the Spatial Durbin Model are presented. As a result, only the panel configuration of the Spatial Durbin Model is shown:

$$\begin{aligned} & PE - GDP_{it} \\ &= pW \times PE - GDP_{it} + \beta_1 ur_s + \beta_2 vr_s + \beta_3 Re\lg_s + \beta_4 Gov_s + \beta_5 Hum_s \\ &+ \beta_6 Dens_s + \beta_7 Indus_s + \alpha_1 eur + \alpha_2 evr_s + \alpha_3 eRe\lg_s + \alpha_4 eGov_s \\ &+ \alpha_5 eHum_s + \alpha_6 eDens_s + \alpha_7 eIndus_s + v_i + u_t + \varepsilon_s \end{aligned} \tag{17}$$

where p, α, and β are the estimated coefficients of the model, W is the distance-economy matrix, v_i and u_t are the individual and time fixed effects, respectively, e is the random effect, and e_s is determined by the error term in the spatial lag and the random error term.

2.5 Data Origins and Handling

The research makes use of panel data that covers 31 provinces, autonomous regions, and municipalities in Mainland China from 2013 to 2024, leaving out Hong Kong, Macao, and Taiwan. The relevant initial data are obtained from the official website of the National Bureau of Statistics (NBS), past China Statistical Yearbooks, and statistical yearbooks of provincial - level administrative entities. Any data gaps were dealt with by means of interpolation techniques. Table 2 showcases the descriptive statistics for each variable. A total of 325 samples were chosen for each variable to conduct descriptive statistical analysis.

Table 2: Descriptive statistics

Variable		N	Mean	SD	Min	Max
Explained variable	PE-GDP	325	17526.52	8065.22	5521.41	50786.52
Interpretation variable	RFSIL	325	5.212	0.632	2.214	6.214
	Breadth	325	5.112	0.863	0.641	6.214
	Mass	325	5.214	0.632	1.214	6.521
	Innovate	325	5.554	0.654	2.142	6.124
Control variable	Relq	325	0.036	0.061	0	0.325
	Hum	325	9.142	1.253	4.523	12.412
	Gov	325	29.523	20.362	10.352	136.52
	Dens	325	92.124	11.563	41.635	100
	Indus	325	1.632	1.235	0	12.263
Mediation variable	Inn	325	1.36	0.741	0.563	5.214
	Csm	325	2.541	0.365	1.852	3.641
Threshold variable	Inter	325	0.114	0.063	0.014	0.342

3 Analysis of Empirical Findings

3.1 Baseline Regression Outcomes

To undertake a more comprehensive inquiry into the immediate influence of rural financial service innovation on regional economic growth, a set of tests, specifically the F - test and Hausman test, are performed. Following these tests, the fixed - effects model is ultimately chosen. The results of the baseline regression are displayed in Table 3. In this table, Model (1) denotes a random - effects model (RF), whereas Model (2) signifies a fixed - effects model (FE). The findings of the F - test and Hausman test reveal that the fixed - effects model outperforms the random - effects model. Moreover, the core explanatory variables have successfully cleared the significance test. Consequently, the fixed - effects model is employed as the panel data model for this study.The estimation results of the panel fixed - effects model are shown in Column (2) of the table. The results from the regression analysis demonstrate that innovation in rural financial services can stimulate regional economic growth. The regression coefficient of rural financial service innovation (PE - GDP) is 47.536, and it is statistically significant at the 1% level.By implementing and spreading Internet - related technologies, rural financial service innovation can leverage its characteristics of low cost, high speed, and wide reach. This helps to improve the availability of financial services, enabling small and micro enterprises, traders, and the working - age population to access financial services, thereby promoting regional economic development.Regarding the control variables, the regression coefficients of the concentration of innovative talent (Relq), the level of human capital (Hum), and population density (Dens) are all positive and have passed the 1% significance test. This implies that these variables make a significant contribution to regional economic development. In contrast, the regression coefficients of the scale of government expenditure (Gov) and the level of industrialization (Indus) are negative and highly significant at the 1% level. This suggests that both factors have a certain adverse effect on regional economic development. It could be that as the scale of government expenditures expands and the level of industrialization increases, the funds accessible to long - tail customer groups through inclusive financial means decline. This may result in under - consumption, which then has a negative influence on regional economic development.

Table 3: Benchmark regression

Variable	(1) RF	(2) FE
PE-GDP	34.523*** (18.524)	47.536*** (20.145)
Relq	-0.013 (-0.741)	0.036 (1.742)
Hum	25314.563*** (5.412)	20045.654*** (3.524)
Gov	-13652.412 (-1.452)	-14752.852*** (-3.524)
Dens	1152.635*** (5.241)	3652.415*** (3.524)
Indus	-13654.521 (-1.521)	-25523.421*** (-3.524)
-cons	-18563.524*** (-3.524)	31452.569*** (3.524)
R^2	0.856	0.352
N	325	325
F = (8635) = 301.524, P = 0.000		
X^2 (6) = 1965.524, P = 0.000		

It should be noted that *** and ** indicate that the regression coefficients are statistically significant at the 1% and 5% significance levels, respectively. The values inside the parentheses signify the t - statistics, as shown below.

3.2 Mediated effects modeling results

Table 4 presents the findings of the test regarding the mediating effect of rural financial services innovation on regional economic development. First, we examine whether the improvement of regional innovation capacity acts as a mediating factor in the process by which rural financial service innovation drives regional economic development. In the regression results of models (2) to (6), model (2) shows that when the two mediating variables - regional innovation ability and population consumption level - are not considered, The regression analysis reveals that the total impact of rural financial service innovation on the regional economic development level amounts to 30.252, and this is significant at the 1% level.Models (3) and (4) utilize the Bootstrap sampling test method, taking around 4,000 samples to evaluate the mediating function of regional innovation ability (Inn). The regression coefficient of rural financial service innovation in model (4) exhibits statistical significance at the 1% threshold. In accordance with the principle of the correlation of mediating effects, it can be inferred that there is a partial mediation effect.The likely reason for this result is that the progress and spread of rural financial service innovation improve the allocation of financial resources, increase the opportunities and means for credit resource supply, and to a certain extent, alleviate the financing difficulties encountered by small and micro - enterprises. This, then, enhances the regional innovation ability, surmounts the previous production and development obstacles, and propels the regional economic development. In other words, rural financial service innovation can indirectly facilitate regional economic development.Next, We conduct an investigation into the mediating role of the residents' consumption level. Based on the test outcomes, it is clear that the regression results in models (5) and (6) are statistically significant. However, the regression coefficient of rural financial service innovation in model (6) is not significant. This indicates a full mediation effect. That is, rural financial service innovation removes geographical constraints, stimulates residents' consumption, and thereby indirectly promotes regional economic development.

Table 4: Intermediate effect test

Variable	(2)	(3)	(4)	(5)	(6)
PE-GDP	30.252*** (16.523)	2.863*** (3.524)	26.586*** (20.142)	25.635*** (16.524)	0.814 (0.963)
Inn	-	-	1.856** (19.566)	-	-
Csm	-	-	-	-	1.152*** (50.548)
N	325	325	325	325	325
R^2	0.907	0.763	0.952	0.922	0.996
ΔR^2	0.901	0.755	0.953	0.981	0.996
F	F (8306) = 342.521, P = 0.000	F (8306) = 122.1, P = 0.000	F (8306) = 756.321, P = 0.000	F (8306) = 436.524, P = 0.000	F (8306) = 3265.521, P = 0.000
	Mediation effect	95% confidence interval		Sig	Test conclusion
Inn	1.8356***(19.635)	0.015~0.123		Yes	Partial intermediary
Csm	1.184**(50.236)	0.325~0.417		Yes	Complete mediation

3.3 Threshold model results

Starting with the model setup detailed previously, the initial aspect to investigate is the quantity of thresholds. The Bootstrap approach is employed to conduct 600 rounds of repeated sampling. Subsequently, single - threshold, double - threshold, and triple - threshold analyses are carried out, and the following results are obtained. The findings of the threshold effect model are presented in Table 5.Based on the results of the threshold effect model test, it is evident that the single - threshold effect satisfies the 10% significance standard, while the results of the double - threshold and triple - threshold tests do not have statistical significance. Thus, from this assessment, it can be inferred that the Internet penetration rate exhibits a first - order threshold effect.After designating the Internet penetration rate as the threshold variable, the impacts of other variables on regional economic development are largely in line with the results of the panel model regression. When the Internet penetration rate serves as the threshold observation variable, the positive effect of rural financial service innovation on regional economic development is less prominent when the observed value is below 1.6341, indicating a relatively low level of Internet penetration.These results suggest that when the Internet penetration rate is at a low level, the influence of rural financial service innovation on regional economic development is limited. Only when the Internet penetration rate attains a certain high level can it further generate a scale effect and strengthen the positive impact of rural financial service innovation on regional economic development.

Table 5: Threshold effect model results

Threshold	F	P	Threshold value	95% confidence interval	
Single threshold	60.25	0.0063	1.6341		
Double threshold	23.45	0.25	-	-	-
Triple threshold	8.52	0.7236	-	-	-

3.4 Spatial modeling results

This research aims to ascertain if a spatial correlation exists between the advancement of rural financial services and the development of the regional economy. To this end, it utilizes the economic distance matrix of per - capita GDP, which showcases distinct economic characteristics, As the fundamental framework for calculating the global Moran's index, the results of this measurement are shown in Table 6. Once an initial evaluation was carried out using the global Moran's index, it was discovered that there exists a particular spatial association between regional economic growth and the innovation of rural financial services. Moreover, the P - value is lower than 0.05.

Table 6: Global Moran index

Year	PE-GDP	P	Year	PE-GDP	P
2013	0.363	0.002	2019	0.366	0.024
2014	0.376	0.015	2020	0.373	0.028
2015	0.396	0.001	2021	0.368	0.005
2016	0.367	0.026	2022	0.377	0.022
2017	0.388	0.033	2023	0.369	0.003
2018	0.366	0.006	2024	0.382	0.002

In order to guarantee the reliability of the research, this paper separately presents the results of the models that incorporate the neighboring matrix, geographical distance matrix, and economic distance matrix. The results of the spatial Durbin model are presented in Table 7. From the ultimate findings, it is evident that rural financial service innovation has a positive spill - over impact. Moreover, the results are largely alike under the influence of three distinct weight matrices, which demonstrates the stability of the model.

Table 7: Spatial Dubin model results

Variable	Adjacency matrix	Geographic matrix	Economic matrix	Adjacency matrix	Geographic matrix	Economic matrix
Main						
RFSIL	0.0805*** (5.23)	0.0914*** (5.63)	0.0574*** (3.5)	-	-	-
Relq	0.0365*** (4.25)	0.0368*** (4.52)	0.0365*** (4.11)	0.0269*** (3.74)	0.0265*** (3.44)	0.0236*** (3.01)
Gov	0.173*** (6.25)	0.155*** (5.26)	0.152*** (5.22)	0.183*** (6.24)	0.149*** (6.14)	0.142*** (6.52)
Hum	0.00852*** (3.52)	0.00954*** (3.52)	0.00145 (0.65)	0.0136*** (4.52)	0.0125*** (3.42)	0.00452*** (2.41)
Dens	0.00965*** (3.415)	0.0152*** (4.25)	0.00863*** (3.41)	0.00847*** (2.52)	0.0145*** (3.52)	0.00635*** (2.14)
Indus	-0.152*** (-3.63)	-0.0852*** (-2.52)	-0.0756*** (-2.52)	-0.125*** (-4.52)	-0.0865*** (-3.52)	
Wx						
RFSIL	0.152*** (3.5)	0.425*** (3.52)	0.0756*** (2.63)	-	-	-
Relq	0.0253 (1.25)	0.158*** (4.25)	0.00854 (0.63)	0.0635 (1.52)	0.176*** (4.52)	0.00741 (0.63)
Gov	0.0763 (0.85)	0.415* (1.85)	-0.015 (0.36)	0.136 (1.52)	0.446** (1.53)	0.0152 (0.41)
Hum	0.0365*** (4.15)	0.06351*** (3.52)	0.0254*** (6.52)	0.0254*** (2.51)	0.0635*** (3.52)	0.0254*** (5.24)
Dens	0.0253** (2.52)	0.0365*** (2.52)	0.00965* (1.75)	0.0263** (2.52)	0.0425*** (3.52)	0.01452* (1.52)
Indus	0.0635 (-0.24)	-0.541** (-2.56)	-0.0675 (-1.52)	-0.00563 (-0.004)	-0.456** (-2.42)	-0.0563 (-1.53)
N	325	325	325	325	325	325
R^2	0.652	0.542	0.693	0.634	0.453	0.667

4 Conclusion

The study makes use of panel data from 31 provincial - level areas in China covering the period from 2013 to 2024. It applies standard regression models, mediating effect models, threshold effect models, and spatial econometric models to demonstrate the impact of rural financial service innovation on regional economic growth.The results are presented as follows:

(1) Rural financial service innovation exerts a notable positive influence on fostering regional economic development.

(2) Rural financial service innovation can indirectly contribute to regional economic development by boosting regional innovation capabilities and stimulating residents' consumption.

(3) When the rate of internet access is used as the threshold variable, the effectiveness reaches its peak when the rate of internet access surpasses the threshold of 1.6341. In contrast, when the rate drops below this value,The invigorating impact of innovation in rural financial services on the growth of the regional economy has weakened.

(4) In terms of spatial aspects, the advancement of rural financial services generates a positive spill - over effect, which helps to enhance the economic development level in adjacent areas.

In light of these discoveries, this research paper presents the subsequent viewpoints:

To begin with, innovation in rural financial services exerts a substantial spatial spillover impact. In order to boost the regional economic development status, every region ought to determine the collaborative associations considering its own competitive advantages,It resides within the connection between the upstream and downstream segments of the industrial supply chain. By developing diversified industries, regions can optimize the allocation of resource factors and the industrial structure, thereby achieving the goal of enhancing the regional economic level.

Secondly, the concentration of innovative talents should be adjusted rationally. The rate of Internet access is of great significance in driving regional economic growth. Nevertheless, the government ought to control the Internet access rate in each province. This is to prevent the "polarization effect" that might take place when the Internet access rate is extremely high, which could result in the waste of resources.

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References

[1] Li, R., Rao, J., & Wan, L. (2022). The digital economy, enterprise digital transformation, and enterprise innovation. Managerial and Decision Economics, 43(7), 2875-2886.

[2] Maitra, D., & Upadhyay, P. (2017). Fostering rural financial services through technology: The case of FINO PayTech. Asian Case Research Journal, 21(01), 81-117.

[3] Zegarra, L. F. (2019). Information asymmetries and agricultural credit: Evidence from the pre-banking era in Lima, 1825-1865. Agricultural Finance Review, 79(2), 217-233.

[4] Priyadi, U., Utami, K. D. S., Muhammad, R., & Nugraheni, P. (2021). Determinants of credit risk of Indonesian Sharīʿah rural banks. ISRA International Journal of Islamic Finance, 13(3), 284-301.

[5] Jun, W. (2021). The present and future of China's new rural financial institutions. American International Journal of Business Management, 4(6), 18-21.

[6] Mahmud, A. U., & Tulla, A. F. (2024). Rural Financial Landscape in Bangladesh: Who is More Convenient for Rural Enterprises—Banks or Microfinance Institutions?. Asia-Pacific Journal of Rural Development, 34(2), 190-208.

[7] Li, Y. (2024). Research on the Rural Financial Service System in China. Asia Pacific Economic and Management Review, 1(4), 43-53.

[8] Sitdikova, L., Mukhametgalieva, F., Mukhametgaliev, F., & Bukharbayeva, A. Z. (2020). Structural changes in the rural economy. In BIO Web of Conferences (Vol. 27, p. 00115). EDP Sciences.

[9] Zhang, W., Xia, X., Zhu, Y., Zhao, S., & Zhou, Z. (2024). Rural financial institutions, access to credit and production inputs of rural households. Finance Research Letters, 70, 106298.

[10] Biallas, M., & O'Neill, F. (2020). Artificial intelligence innovation in financial services. Int. Financ. Corp, 85(6), 1-8.

[11] Liu, Y. (2022). Rural financial mobile service management system based on big data. Mobile Information Systems, 2022(1), 3316460.

[12] Zhang, X. (2024). Enhanced Agricultural Financial Services through Cloud Computing: A New Paradigm of Security and Efficiency. Research on World Agricultural Economy, 555-566.

[13] Shah, P. (2025). Decoding the Role of Blockchain in Financial Inclusion: Evidence from Rural Credit Ecosystems in India. AEIDA: Journal of Multidisciplinary Studies, 2(1), 34-43.

[14] Aniqoh, N. A. F. A. (2020). The role of digital economy to enhancing sustainable economic development. International Journal of Social Science and Business, 4(4), 519-527.

[15] Su, J., Su, K., & Wang, S. (2021). Does the digital economy promote industrial structural upgrading?—A test of mediating effects based on heterogeneous technological innovation. Sustainability, 13(18), 10105.

[16] Pan, W., Xie, T., Wang, Z., & Ma, L. (2022). Digital economy: An innovation driver for total factor productivity. Journal of business research, 139, 303-311.

[17] Malecki, E. J. (2018). Technological innovation and paths to regional economic growth. Growth policy in the age of high technology, 97-126.

[18] Zhang, F., Wang, Y., & Liu, W. (2020). Science and technology resource allocation, spatial association, and regional innovation. Sustainability, 12(2), 694.

[19] Ding, C., Liu, C., Zheng, C., & Li, F. (2021). Digital economy, technological innovation and high-quality economic development: Based on spatial effect and mediation effect.

Sustainability, 14(1), 216.

[20] Bu, Y., Yu, X., & Li, H. (2024). Digital economy and regional innovation: unveiling the spatial dynamics and human capital influence in China. Digital Policy, Regulation and Governance, 26(5), 583-599.

[21] Lebedinskaya, O. G., Timofeev, A. G., & Kurnikova, M. V. (2019). Regional Coverage with Banking Services and Regional Economic Health. In SHS Web of Conferences (Vol. 62, p. 02007). EDP Sciences.

[22] Cernisevs, O., Surmach, A., & Buka, S. (2022). Analysis of Aspects of the Regional Economy in the Digital Economy, Using the Example of Financial Services. Review of Economics and Finance, 20, 203-207.