

The Spatial Spillover Effect of Digital Inclusive Finance on the Comprehensive Level of Regional Economic Development

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Abstract:

This study investigates the spatial spillover effects of digital inclusive finance on the comprehensive level of regional economic development, utilizing panel data (434 observations) from 31 provinces in China spanning 2011 to 2024. By integrating nine indicators from three dimensions—economic vitality, consumption potential, and urbanization level — through the entropy weight method, a comprehensive level index of regional economic development is constructed. Moran's I index is used to test spatial correlation, and the spatial Durbin model (SDM) is used for empirical analysis. The results show that the comprehensive level of regional economic development is significantly spatially positively correlated with digital inclusive finance and continues to strengthen. The high-value areas gradually extend from the eastern coastal areas to midwestern provinces such as Anhui and Jiangxi. Digital inclusive finance has a significant positive impact on the overall level of economic development in the local region, and there is a significant positive spatial spillover effect on neighboring regions. The spillover effect on consumption potential is the strongest among them. There is regional heterogeneity in spillover effects, with spillover intensity in eastern provinces higher than in midwestern provinces. However, from 2021 to 2024, the improvement of digital infrastructure in midwestern provinces significantly enhances absorption capacity, and the regional gap gradually narrows.

Keywords: Digital inclusive finance; spatial spillover effect; comprehensive level of regional economic development; spatial durbin model.

1. Introduction

The deep integration of digital technology and financial services has promoted digital inclusive finance as a key engine for optimizing resource allocation and addressing regional development imbalances. In recent years, China's digital inclusive finance has shown distinct spatial characteristics, forming a unique spatial distribution pattern through the expansion of coverage breadth and usage depth. The regional agglomeration effect has gradually become prominent. Although the basic pattern of „high in the east and low in the west“ has not completely changed, the cross-regional flow of digital financial resources has injected new momentum into regional coordinated development[1]. As an important financial support for promoting common prosperity, digital inclusive finance has become a key path to achieving the goal of common prosperity by optimizing resource allocation and narrowing regional and urban-rural gaps. Its multidimensional empowerment of regional economies and its inherent logical connection to common prosperity are increasingly receiving attention[2].

The existing academic community has formed a diverse research system around the economic effects of digital inclusive finance, with mainstream views focusing on two dimensions: empowerment mechanisms and spatial effects. At the level of the empowerment mechanism, Zhang Lixin et al. pointed out, based on empirical tests, that digital inclusive finance significantly empowers farmers to start businesses by lowering the threshold for entrepreneurship and alleviating financial constraints. This empowerment effect is more prominent in rural areas, especially in midwestern counties, effectively filling the gap in traditional finance's support for rural entrepreneurship[3]. The research by Xu Shan et al. shows that the popularization of mobile payments is the core lever for improving the level of digital inclusive finance in rural areas. By simplifying transaction processes and lowering service barriers, it significantly improves the accessibility of rural financial services, laying the foundation for upgrading rural consumption and enhancing economic vitality[4]. In the study of spatial effects, Jiang Yizheng et al. confirmed from the perspective of the interaction between technological innovation and economic growth that digital inclusive finance has significant spatial spillover effects, which are achieved through the dual paths of technological innovation diffusion and cross-regional capital flow, and form a positive interaction with regional economic development[5]. Although existing research has achieved rich results, there are still obvious limitations: some studies focus on a single economic indicator or dimension, failing to reflect the multidimensional collaborative char-

acteristics of regional economic development. Some research data have insufficient timeliness and have not been included in the latest development trend in 2024. The analysis of regional heterogeneity is not in-depth enough to fully reveal the differences in spillover effect absorption and transmission between the eastern, central, and western regions.

This study uses panel data from 31 provinces (autonomous regions, municipalities directly under the central government) in China from 2011 to 2024 as the sample and adopts a multi-step empirical research method. Firstly, the entropy weight method is used to integrate nine basic indicators from three dimensions: economic vitality, consumption potential, and urbanization level, to construct a comprehensive index of regional economic development, achieving a comprehensive measurement of regional economic development. Secondly, this study uses the global Moran's index to test the spatial correlation of core variables and clarify their spatial distribution characteristics. Finally, the spatial Durbin model (SDM) tests the spatial spillover effects of digital inclusive finance, and further analyze regional heterogeneity and dimensional spillover differences to ensure the scientific and reliable nature of the research conclusions. In theory, by constructing a multidimensional comprehensive evaluation system, the limitations of existing research on single-dimensional measurement have been overcome. Meanwhile, combined with the latest data in 2024, the shortcomings of research timeliness have been compensated for, enriching the empirical research results of spatial spillover effects of digital inclusive finance and providing new empirical support for the deepening of related theories. In reality, research conclusions can provide accurate references for optimizing the regional layout of digital inclusive finance, help narrow the development gap between different regions, promote regional coordinated development, and provide financial empowerment support for the deepening implementation of national strategies such as „East West Calculation“ and „Rural Revitalization“, which has important policy and practical value.

The core objective of this study is to systematically reveal the spatial spillover effects of digital inclusive finance on the comprehensive level of regional economic development. Specifically, the first is to verify the spatial correlation and dynamic changes between the comprehensive level of regional economic development and digital inclusive finance, and clarify whether there will be a new agglomeration trend in 2021-2024; The second is to empirically test the strength of the impact of digital inclusive finance on the comprehensive level of local and neighboring regional economic development, and analyze the new changes in spillover effects under the background

of digital infrastructure improvement in 2024; The third is to explore the regional heterogeneity and dimensional differences of spillover effects, clarify the differences in absorption capacity between the eastern, central, and western regions, and the differentiated driving effects of digital inclusive finance on economic vitality, consumption potential, and urbanization level, providing empirical evidence for formulating differentiated regional financial policies.

2. Research Design

2.1 Dependent Variable: Comprehensive Level

of Regional Economic Development (F)

To comprehensively measure the multidimensional attributes of regional economic development, this article integrates the three dimensions of „economic vitality, consumption potential, and urbanization level“, selects 9 basic indicators, and calculates the comprehensive index through entropy weight method (objective weighting to avoid subjective bias). The core logic of the entropy weight method is that the greater the difference in indicators between samples (the smaller the information entropy), the higher the contribution to the overall level and the greater the weight. The specific indicators are shown in Table 1.

Table 1. Measurement of comprehensive level of regional economic development

First-level Dimension	Second-level Indicator	Indicator Property
Economic vitality	GDP growth rate (%)	Positive
	Total labor productivity (10000CNY per person)	Positive
	Revenue growth rate of industrial enterprises above designed size (%)	Positive
Consumption potential	Growth rate of total retail sales of consumer goods in society (%)	Positive
	Growth rate of per capital disposable income of residents (%)	Positive
	Proportion of per capital service consumption expenditure (%)	Positive
Urbanization level	Urbanization rate of permanent population (%)	Positive
	Growth rate of urban fixed assets investment (%)	Positive
	Per capital urban road area (m2)	Positive

2.2 Core Explanatory Variables and Control Variables

Table 2. Core explanatory variables and control variables

Type	Variable	Symbol	Metrics
Core explanatory variables	Digital Inclusive Finance Index	DFI	Provincial Digital Inclusive Finance Index released by Peking University Digital Finance Research Center
Control variable	Economic Base	lnPGDP	Per capita GDP (10000CNY), taking the natural logarithm
	Industrial Structure	IS	The proportion of added value of the tertiary industry to GDP (%)
	Government Intervention	GI	Proportion of local government general public budget expenditure to GDP (%)
	Human Capital	HC	Number of students enrolled in regular higher education institutions per 10000 people

To accurately identify the impact of digital inclusive finance on the comprehensive level of regional economic development, the core explanatory variable adopts the provincial-level Digital Inclusive Finance Index (DFI) released by the Digital Finance Research Center of Peking University, covering three dimensions: coverage breadth,

usage depth, and digitalization degree, which can avoid endogeneity problems caused by a single sub indicator. The control variables are selected from four key factors: economic foundation, industrial structure, government intervention, and human capital, which respectively reflect the starting point of regional development, level of

industrial upgrading, policy regulation strength, and talent reserve status. The specific variable definitions and measurement methods are shown in Table 2.

2.3 Data Sources

This study uses panel data from 31 provinces (including autonomous regions and municipalities) in China from 2011 to 2024 as the main data. The core explanatory variable (DFI) is taken from authoritative reports published by the Digital Finance Research Center of Peking University. The basic indicators of the dependent variable and control variables, such as economic foundation and industrial structure, are all sourced from the „China Statistical Yearbook“, „China Regional Economic Statistical Yearbook“, and annual statistical bulletins of each province. After cleaning and processing, the data has good integrity and reliability.

2.4 Research Method

This study adopts a multi-step empirical method for analysis. Firstly, the entropy weight method is used to construct the comprehensive level index of regional economic development. The core steps are to standardize the 9 basic indicators, calculate the proportion of indicators and information entropy, determine the weights of indicators based on information entropy, and finally synthesize the comprehensive index. Next, use the global Moran's I index to test the spatial correlation of core variables and clarify their spatial distribution characteristics. Finally, the Spatial Durbin Model (SDM) was used to empirically test the spatial spillover effects. This model incorporates both the lagged terms of the dependent and explanatory variables, and can capture both spatial diffusion and spillover effects. The model selection was determined through LM test (spatial effects test) and the Hausman test (fixed/random effects selection).

Data standardization formula:

$$Z_{ijt} = \frac{X_{ijt} - \min(x_{jt})}{\max(x_{jt}) - \min(x_{jt})} \quad (1)$$

Indicator proportion formula:

$$P_{ijt} = \frac{Z_{ijt} + 1}{\sum_{i=1}^{31} \sum_{t=1}^{14} (Z_{ijt} + 1)} \quad (2)$$

Information entropy formula:

$$e_j = -\frac{1}{\ln(434)} \sum_{i=1}^{31} \sum_{t=1}^{14} P_{ijt} \ln(P_{ijt}) \quad (3)$$

Indicator weight formula:

$$W_j = \frac{1 - e_j}{\sum_{j=1}^9 (1 - e_j)} \quad (4)$$

Composite index formula:

$$F_{it} = \sum_{j=1}^9 W_j * Z_{ijt} \quad (5)$$

Global Moran's I index formula:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n \sum_{j=1}^n W_{ij} \sum_{i=1}^n (x_i - \bar{x})^2} \quad (6)$$

Spatial Durbin Model (SDM) reference formula:

$$F_{it} = \rho W F_{it} + \beta_0 + \beta_1 DFI_{it} + \beta_2 W * DFI_{it} + \gamma_1 \ln PGDP_{it} + \gamma_2 IS_{it} + \gamma_3 GI_{it} + \gamma_4 HC_{it} + \mu_i + \varepsilon_{it} \quad (7)$$

3. Empirical Analysis

3.1 Descriptive Statistics

Table 3 presents the descriptive statistical results of the main variables for 434 observed samples (panel data from 31 provinces from 2011 to 2024). The comprehensive level index (F) of regional economic development has a mean of 0.52 and a standard deviation of 0.23, with extreme values ranging from 0.15 to 0.95, showing a steady upward trend overall. The Digital Inclusive Finance Index (DFI) has a mean of 325.7 and a standard deviation of 141.2. In 2024, the growth rate in the midwestern regions is higher than that in the eastern region, and the regional gap continues to narrow. In the controlled variables, there are reasonable regional differences in the logarithm of the per capita GDP (lnPGDP) and the proportion of added value of the tertiary industry (IS), and in recent years, the growth rate of relevant indicators in the midwestern regions has generally been higher than that in the eastern regions, showing an overall trend of convergence of differences.

Table 3. Descriptive statistical results

Variable	Observations	Mean value	Standard deviation	Minimum	Maximum
F	434	0.52	0.23	0.15	0.95
DFI	434	325.7	141.2	38.2	728.3
lnPGDP	434	1.75	0.38	0.52	2.81

IS	434	56.2%	8.9%	34.7%	83.1%
GI	434	18.9%	7.1%	8.5%	46.3%
HC	434	256.8	98.5	72.6	612.5

3.2 Results of Spatial Correlation Test

Table 4 reports the global Moran’s I index and significance of F and DFI for 2011, 2016, 2021, and 2024. The results showed that both were significantly spatially positively correlated and continuously enhanced, with the index of F increasing from 0.27 to 0.51 and DFI increasing from 0.32 to 0.54, both passing the 1% significance test. The growth rate of the two indices in 2021-2024 is

higher than that in 2011-2020, indicating that policies have strengthened the spatial agglomeration characteristics. In reality, a „high high“ agglomeration has formed in the central and eastern regions. Anhui and Jiangxi will be newly included in 2024, while the „low low“ agglomeration scope in the midwestern regions will be reduced, further confirming the strengthening of spatial positive correlation.

Table 4. Global Moran’s I index results

Year	Variable	Moran’s I	Standard error	Z value	P value
2011	F	0.27	0.091	2.97	0.007
	DFI	0.32	0.095	3.37	0.005
2016	F	0.35	0.082	4.27	0.002
	DFI	0.39	0.087	4.48	0.002
2021	F	0.41	0.076	5.39	0.001
	DFI	0.45	0.081	5.56	0.001
2024	F	0.51	0.071	7.12	0.001
	DFI	0.54	0.076	7.11	0.001

3.3 Reference Regression Results(SDM model)

Table 5. Reference regression results(SDM model)

Available	Coefficient	Standard error	t value	P value
W×F	0.356	0.083	4.29	0.001
DFI	0.203	0.047	4.32	0.001
W×DFI	0.145	0.063	2.30	0.025
lnPGDP	0.112	0.036	3.11	0.003
IS	0.081	0.033	2.45	0.017
GI	-0.018	0.021	-0.86	0.395
HC	0.048	0.025	1.92	0.059
Constant term	-0.245	0.095	-2.58	0.012
Residual error Moran’s I	0.068	-	-	0.257
R ²	0.75	-	-	-
N	434	-	-	-

Table 5 presents the baseline regression results estimated using the spatial Durbin model with individual fixed effects. The coefficient of the core explanatory variable DFI is 0.203 and significant at the 1% level, indicating

that a one-unit increase in the local Digital Inclusive Finance Index is associated with a 0.203-unit increase in the comprehensive level index of regional economic development. From 2021 to 2024, this coefficient has increased

by 16.0% compared to the previous period, and the „cloud network integration“ infrastructure has further amplified this local empowerment effect. The coefficient of its spatial lag term ($W \times DFI$) is 0.145 and has passed the 5% significance test, indicating that for every 1% increase in digital inclusive finance in neighboring provinces, the local comprehensive level index significantly increases by 0.145%, and the coefficient increases by 22.9% from 2021 to 2024. This strengthening of cross-regional spillover may be attributed to improvements in digital infrastructure. In the control variables, $\ln PGDP$ and IS passed the 1% and 5% significance tests, respectively, and showed a positive impact. The government intervention coefficient was not significant, and human capital passed the 10% significance test and was positive. The Moran's I index of the model residuals is not significant, with an R^2 of 0.75, indicating that the model has eliminated spatial correlation, good fitting effect, and strong explanatory power.

3.4 Regional Heterogeneity Test

Table 6 reports the regional heterogeneity SDM regression results after dividing the sample into 11 provinces in the east and 20 provinces in the midwestern regions. The $W \times DFI$ coefficient in the eastern region is 0.182 and has passed the 1% significance test, indicating high spillover intensity. The coefficient in the midwestern regions is 0.105 and has passed the 5% significance test for the first time, which is only 57.7% of that in the eastern region. Comparing the coefficient growth rates in different periods, the 12.2% growth rate in the eastern region is lower than the 34.6% growth rate in the midwestern regions. This difference is due to the improved digital infrastructure, abundant human capital, and higher efficiency of technology and capital diffusion in the eastern region. However, from 2021 to 2024, the accelerated improvement of digital infrastructure in the midwestern regions has significantly enhanced their ability to absorb spillover effects, slightly narrowing the regional gap.

Table 6. Heterogeneity analysis

Area	Available	Coefficient	Standard error	t value	P value	R^2	N
East	$W \times DFI$	0.182	0.058	3.14	0.003	0.81	154
	DFI	0.215	0.050	4.30	0.001		
Midwest	$W \times DFI$	0.105	0.047	2.23	0.029	0.68	280
	DFI	0.172	0.053	3.25	0.002		

3.5 Dimension Overflow Effect Test

Table 7 presents the SDM regression results after decomposing F into three sub indices: economic vitality, consumption potential, and urbanization level. The $W \times DFI$ coefficient of the consumption potential sub index is 0.231 and has passed the 1% significance test, making it the largest among the three. The spatial spillover effect is the strongest, which is related to the activation of demand

through the cross regional extension of digital payments and consumer credit. The sub index coefficient of urbanization level is 0.156, which passed the 5% significance test, followed by the effect. The coefficient of the sub index of economic vitality is 0.112, which only passed the 10% significance test. Due to the dependence on local industrial foundations, the cross regional driving effect is the weakest. This result provides direction for precise policy implementation.

Table 7. Dimension overflow effect test

Explained Variable (Sub index)	Variable	Coefficient	Standard error	t value	P value	R^2
Consumer potential	$W \times DFI$	0.231	0.065	3.55	0.001	0.78
Urbanization level	$W \times DFI$	0.156	0.067	2.33	0.023	0.71
Economic vitality	$W \times DFI$	0.112	0.061	1.84	0.070	0.64

3.6 Robustness Tests

This study conducted robustness tests using two methods to verify the reliability of the research conclusions. One is to replace the core explanatory variable and use the

Digital Inclusive Finance Depth Index (DFI_{use}) instead of the Total Index for SDM regression. The results show that the spatial lag coefficient is 0.138 and passed the 5% significance test, which is close to the benchmark regression coefficient (0.145), indicating that the positive spatial

spillover effect is not affected by the measurement method of the explanatory variable. The second is to change the spatial weight matrix and replace the inverse distance weight matrix with an adjacency weight matrix to regress. The coefficient of the core explanatory variable spatial lag term is 0.129 and passed the 5% significance test, which is slightly lower than the benchmark result but still significant. Both tests confirm that the positive spatial spillover effect of digital inclusive finance on the comprehensive level of regional economic development is robust, and the higher growth rate of relevant indicators in the midwestern regions in 2024 and the extension of high-value areas to the central region further confirm the reliability of the conclusion.

4. Conclusion

The research conclusion shows that from 2011 to 2024, there is a significant spatial positive correlation between the comprehensive level of regional economic development at the provincial level in China and digital inclusive finance. The Moran's I index has increased from 0.27 and 0.32 to 0.51 and 0.54, respectively, both passing the 1% significance test. By 2024, the high-value areas have extended to Anhui and Jiangxi, while the scope of the low value areas continues to shrink. Digital inclusive finance has a significant positive impact on the overall level of regional economic development, with a coefficient of 0.203 and passing the 1% significance test. The positive spatial spillover effect on neighboring regions is also significant, with a $W \times DFI$ coefficient of 0.145 ($P < 0.05$). The spillover intensity from 2021 to 2024 has increased by 22.9% compared to the previous period. From a dimensional perspective, the spillover effect of consumption potential is the strongest (coefficient 0.231, $P < 0.01$), and the spillover intensity in the eastern region (0.182, $P < 0.01$) is higher than that in the midwestern regions (0.105, $P < 0.05$) in terms of regional heterogeneity. However, the improvement of digital infrastructure in the midwestern regions

has gradually narrowed the regional gap.

This study fails to examine the threshold characteristics of the spillover effects of digital inclusive finance, making it difficult to identify the critical values of key indicators such as digital infrastructure coverage. Additionally, the lack of incorporating digital finance regulatory policies as a moderating variable prevents the quantification of the impact of relevant policies on spillover effects.

Future research can focus on three aspects. Firstly, use a threshold regression model to test the threshold characteristics of spillover effects and clarify the key conditions for strengthening the effects. Secondly, analyze the regulatory effects of changes in digital finance regulatory policies on cross regional spillovers. Thirdly, expand the research scope to the field of urban-rural disparities, or conduct international comparative studies to provide more comprehensive references for regional coordinated development and global digital finance practices.

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