

The Impact of Digital Inclusive Finance on the High-Quality Development of Guangdong's Real Economy: An Analysis Based on Spatial Econometric Models

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Abstract

The real economy is the lifeline of a country and the foundation for stable economic operation. Serving the real economy is the responsibility of the financial sector, and developing inclusive digital finance is essential for the real economy. This study aims to explore the impact mechanism and spatial spillover effects of inclusive digital finance on the high-quality development of the real economy in Guangdong Province. Panel data from Guangdong Province and its 21 prefecture-level cities from 2014 to 2020 are selected, and an indicator system for inclusive digital finance and high-quality development of the real economy is constructed. The study employs spatial econometric models for empirical analysis. The empirical results show that: 1) There is spatial dependence between inclusive digital finance and high-quality development of the real economy in Guangdong Province. The spatial correlation of inclusive digital finance development in each prefecture-level city generally shows a downward trend, while the spatial correlation of high-quality development of the real economy shows an overall upward trend. 2) The overall Pearl River Delta urban agglomeration has a high level of development in both inclusive digital finance and high-quality development of the real economy, which can radiate and drive neighboring regions. 3) There is polarization in the high-quality development of the real economy among prefecture-level cities in Guangdong Province, and the development pattern remains relatively unchanged, characterized by the distribution pattern of high-high agglomeration areas and low-low agglomeration areas. 4) Inclusive digital finance has a significant positive promoting effect on the high-quality development of the real economy in Guangdong Province, and the depth of inclusive digital finance usage is one of the important driving forces. 5) Inclusive digital finance has a negative spatial spillover effect on the high-quality development of the

real economy in Guangdong Province, indicating that the development of inclusive digital finance in one area may inhibit the high-quality development of the real economy in adjacent areas. 6) The breadth of coverage in different dimensions has a positive spatial spillover effect on the high-quality development of the real economy in Guangdong Province, while usage depth has a negative spatial spillover effect.

Keywords

Digital Financial Inclusion, Real Economy, Moran Index, Spatial Durbin Model

1. Introduction

The real economy is the foundation of a country's economy, the fundamental source of wealth creation, and a crucial pillar of national strength. The 19th National Congress of the Communist Party of China put forward the idea that "to build a modern economic system, we must focus on developing the real economy." The development of the real economy relies on the support of funds, and for the virtual economy represented by finance, finance serves as the lifeblood of the real economy and is the duty and purpose of the financial sector to serve the real economy. Currently, China's economic development and quality improvement have made significant progress, manifested in more intensive energy utilization, increasing environmental friendliness, and greater overall economic benefits (Lee et al., 2023). However, in recent years, the imbalance between the development of the real economy and the virtual economy in China remains prominent, leading to financial services not adequately supporting the development of the real economy. Therefore, to change the phenomenon of the real economy being overshadowed by the virtual economy, inclusive finance has been highly promoted and has added strong impetus to financial services for the real economy, enhancing the ability of finance to serve the real economy. With the support of emerging technologies such as artificial intelligence, blockchain, and cloud computing, the inclusiveness of digital inclusive finance allows for non-physical contact financial services to effectively overcome the barriers of traditional financial services, benefiting groups that were previously excluded from the traditional financial system (Sun & You, 2023). Its accessibility enables these groups to more conveniently access various financial products, services, and credit services (Zhang et al., 2023). Therefore, exploring how digital inclusive finance can better promote high-quality development of the real economy in the new era holds significant theoretical and practical significance.

2. Literature Review

The senior principles of Digital Inclusive Finance (DFI) were officially proposed

during the 2016 G20 Summit to accelerate the arrival of the digital finance era (Shen et al., 2021). Shen et al. and Ozili both defined digital inclusive finance as the deployment of digital means, which refers to providing excluded and underserved populations with access to and use of formal financial services through digital channels (Shen et al., 2021; Ozili, 2017). Since the emergence of digital inclusive finance, scholars both domestically and internationally have conducted extensive research on the subject. Xu et al. (2023) conducted a comparative study from the perspectives of innovation enthusiasm and innovation quality and found that the development of digital inclusive finance has a more significant impact on the quality of green technology innovation than on enthusiasm. Ma and Li (2021) used the difference generalized method of moments (GMM) to explore the impact of digital inclusive finance on agricultural ecological efficiency, and the study showed that digital inclusive finance has a significantly positive effect on agricultural ecological efficiency, providing robust financial impetus for the long-term balanced development of rural areas. Digital inclusive finance can also be an effective method to promote sustainable employment (Geng & He, 2021). Yi and Zhou (2018) found that the development of digital inclusive finance significantly promotes household consumption. The research by Wang (2023) indicates that digital inclusive finance can significantly promote rural revitalization, with traditional financial development playing a positive moderating role.

Moreover, some scholars have focused their research on the impact mechanism of digital inclusive finance on economic and social development. At the macro level, digital inclusive finance has a significant positive impact on the high-quality development of Chinese enterprises, thereby promoting the prosperity of the Chinese economy (Lee et al., 2023); Yakubi et al. (2022) investigated the impact of digital inclusive finance factors, including acquisition, usage, and quality, on the socioeconomic development of 77 low-income countries. The survey results showed that the components of digital inclusive finance have a significant positive impact on socioeconomic development, with varying degrees of influence, with acquisition and usage factors having a greater impact than quality factors. At the micro level, digital inclusive finance can promote innovation by driving entrepreneurship and vice versa, better realizing the value of enterprises (Beck et al., 2018; Tang et al., 2022). In big cities with concentrated financial resources, digital inclusive finance can greatly enhance the productivity of listed companies (Chen et al., 2022).

In addition, scholars have conducted preliminary research from various perspectives to study how digital inclusive finance affects the development of the real economy. Cheng and Gong (2020) found that digital inclusive finance in China has a significant positive impact on the real economy, and its continuous development will promote economic growth. Xie et al. (2018) combined the digital inclusive finance index with data on newly registered enterprises and concluded that the development of digital finance significantly increases the activity of en-

entrepreneurial activities in enterprises. The improvement in the breadth of digital financial coverage, the depth of use, and the level of digital support services are all conducive to promoting entrepreneurial activities. Xu et al. (2023) proposed that the comprehensive development of digital inclusive finance can increase the enthusiasm of enterprises for green technology research and development, help them achieve high-quality development of green technology, and promote the development of the real economy. The imbalance in regional development has always been a significant feature of China's economic development, and addressing the imbalance can significantly promote the country's economic development. According to the research of Sun and You (2023), digital inclusive finance helps stimulate urban economic vitality, and the economic effects of digital inclusive finance have significant spatial spillover, meaning that innovation and entrepreneurial activities in one region can enhance the economic development vitality of neighboring regions. Li et al. (2022) studied the heterogeneity of the impact of digital inclusive finance on the income growth of farmers from the perspective of inter-provincial economic development level differences, and the research showed that digital inclusive finance has a positive spatial spillover effect on the income growth of farmers.

In conclusion, there are mainly two deficiencies in the research on digital inclusive finance and the high-quality development of the real economy. Firstly, the current literature lacks comprehensive research on the synergistic development of digital inclusive finance and the real economy, as well as regional differences. Most studies are focused on the national and regional levels, with relatively few studies conducted at the provincial and city levels. Secondly, the existing research on digital inclusive finance and the real economy mainly focuses on analyzing its single or partial effects on the real economy, such as household consumption, business innovation, etc., with limited emphasis on the direct impact of digital inclusive finance on the real economy in China. To address these research gaps, this study focuses on Guangdong Province and its cities, taking the high-quality development of the real economy in Guangdong Province as the research object. Panel data from Guangdong Province and its 21 cities from 2014 to 2020 are selected. Spatial econometric models are used to analyze the spatial agglomeration characteristics and effects of digital inclusive finance on the high-quality development of the real economy in Guangdong Province. This study explores the development patterns and interactions among cities and analyzes the effects and differences between regions, providing insights for promoting digital inclusive finance services to the real economy in various regions of Guangdong Province.

3. Model Principles and Research Design

3.1. Model Principles

1) Moran's Index

Moran's Index can be divided into Global Moran's Index and Local Moran's

Index. The Global Moran's Index measures whether there is spatial clustering between digital inclusive finance and the high-quality development of the real economy in Guangdong Province. The Local Moran's Index assesses the spatial clustering pattern of digital inclusive finance and the high-quality development of the real economy in Guangdong Province. The formulas for both are shown in Equations (5) and (6).

$$\text{Global Moran}' I = \frac{\sum_{i=1}^n \sum_{j=1}^n W_{ij} (D_i - D)(D_j - D)}{S^2 \sum_{i=1}^n \sum_{j=1}^n W_{ij}} \quad (1)$$

$$\text{Local Moran}' I = \frac{D_i - D}{S^2} \sum_{j=1}^n W_{ij} (D_j - D) \quad (2)$$

In the equations, S^2 is the score variance, W_{ij} represents spatial weights. In this study, we utilize the geographic binary adjacency matrix to investigate the dependence and spillover effects between digital inclusive finance and the high-quality development of the real economy. If two neighboring regions are connected, $W_{ij}=1$ will have a value, otherwise $W_{ij}=0$, D_i and D_j denote the attribute value of spatial regional unit i and j .

2) Spatial Econometric Models

In order to fully consider the influence of spatial factors, we further construct spatial econometric models to explore the impact of digital inclusive finance on the high-quality development of the real economy in Guangdong Province. Equation (3) represents the Spatial Autoregressive (SAR) model, Equations (4) and (5) represent the Spatial Error Model (SEM), and Equation (6) represents the Spatial Durbin Model (SDM). The specific models are as follows:

$$Y_{it} = \rho \sum_{j=1}^n W_{ij} Y_{jt} + \beta X_{it} + \mu + \varepsilon_{it} \quad (3)$$

$$Y_{it} = \beta X_{it} + \mu + v_{it} \quad (4)$$

$$v_{it} = \lambda M v_{it} + \varepsilon_{it} \quad (5)$$

$$Y_{it} = \rho \sum_{j=1}^n W_{ij} Y_{jt} + \beta X_{it} + \theta \sum_{j=1}^n W_{ij} X_{jt} + \mu + \varepsilon_{it} \quad (6)$$

ρ represents the spatial lag coefficient, indicating the degree of influence of the spatially lagged dependent variable on the current dependent variable. W_{ij} and M represent weight matrices. $W_{ij} Y_{jt}$ represents the spatial lagged dependent variable of the average observation in neighboring regions. β represents the coefficients of the explanatory variables on the dependent variable. $W_{ij} X_{jt}$ represents the spatial lagged explanatory variable of the average observation in neighboring regions. θ is the spatial autocorrelation coefficient. ε_{it} represents the impact of the spatial error term on the high-quality development of the real economy in Guangdong Province.

3.2. Index System and Data Sources

This paper utilizes the third-phase Digital Inclusive Finance Index from the Peking University Digital Finance Research Center to measure the development of digital inclusive finance in Guangdong Province and its prefecture-level cities. The financial development status is elaborated from three dimensions: coverage breadth (BRE), depth of usage (DEP), and degree of digitization (DIG). These dimensions effectively measure the level of digitalization and inclusiveness in financial development and have been widely applied in research related to digital inclusive finance. Therefore, this paper uses the three dimensions of the index to describe the level of development of digital inclusive finance, as shown in **Table 1**.

Following Zhang Lin's method, this paper defines the real economy as the economic sectors excluding real estate and financial markets, and constructs an index system to measure the high-quality development of the real economy in Guangdong Province. The selection of indicators for the high-quality development of the real economy in this paper is based on two principles: firstly, the indicators should cover the influential factors and evaluation criteria of the high-quality development of the real economy in Guangdong Province; secondly, the indicators should reflect the characteristics of the high-quality development of the real economy in Guangdong Province. In the process of data acquisition, this paper intends to use the statistical data of 2011-2020, but because the statistical yearbook of 2011-2013 in Guangdong province of Shenzhen, Yunfu statistics is not comprehensive, many counties and cities data are blank, the common missing data of missing data supplement method of missing data is difficult and large subjective influence, so on the premise of not affecting the empirical analysis results, select 7 years of time series data in this paper. Considering the representativeness of the indicators and the availability of data, this paper collects relevant data from sources such as the Statistical Yearbook of Guangdong Province, the Statistical Bulletin of Ecological Environment in Guangdong Province, Wind, and CSMAR for the 21 prefecture-level cities in Guangdong Province from 2014 to 2020. Taking into account economic development, social development, technological innovation, and ecological environment as the dimensions, this paper constructs an index system for the high-quality development of the real economy in Guangdong Province. The selected indicators and their calculation methods are shown in **Table 2**.

4. Empirical Analysis

4.1. Data Processing

To further explore the spatial correlation and characteristics of the high-quality development of the real economy in Guangdong Province and better leverage the driving role of advantaged regions, this paper uses spatial econometric models to further investigate the spatial effects between digital inclusive finance and

Table 1. Indicators of digital inclusive finance.

Primary Indicators	Secondary Indicators	Specific Indicators	
Coverage Breadth (BRE)	Account Coverage Rate	Number of Alipay accounts per ten thousand people	
		Proportion of Alipay users with linked bank cards	
		Average number of bank cards linked to each Alipay account	
Usage Depth (DEP)	Payment Services	Average number of payment transactions per person Average payment amount per person	
	Money Market Fund Services	Average number of Yu'e Bao purchases per person	
		Average amount of Yu'e Bao purchases per person	
		Number of Yu'e Bao users per ten thousand Alipay users	
	Credit Services	Personal Consumer Loans	Number of internet consumer loan users per ten thousand Alipay adult users Average number of loan transactions per person
		Small and Micro Enterprises	Average loan amount per person
		Small and Micro Enterprises	Number of internet small and micro business loan users per ten thousand Alipay adult users
			Average number of loans per small and micro business borrower Average loan amount per small and micro business borrower
	Insurance Services	Insurance Services Number of insured users per ten thousand Alipay users Average number of insurance per person Average insurance amount per person	
	Investment Services	Investment Services	Investment Services Number of internet investment users per ten thousand Alipay users
Average number of investment transactions per person			
Average investment amount per person			
Credit Services	Credit Services	Credit Services Average number of credit checks per person	
		Number of Alipay users per ten thousand using credit-based services (including payments, accommodations, transportation, social interactions, etc.)	
Digitalization (DIG)	Affordability	Average interest rate for small and micro business loans	
		Average interest rate for personal loans	
	Convenience	Proportion of transactions made using QR code payments	
		Proportion of transaction amounts made using QR code payments	
	Creditization	Creditization	Proportion of transactions made using Huabei installment payments
			Proportion of transaction amounts made using Huabei installment payments
		Proportion of Exempted Transactions in Sesame Credit (compared to the total deposit required)	
		Proportion of amounts exempted by Zhima Credit (compared to the total deposit required)	

Table 2. Index system for high-quality development of the real economy.

Primary Indicators	Secondary Indicators	Calculation Method or Data Source ⁱ	Unit
Economic Development	Economic Development Growth Rate of Real Economy	$(\text{Reported GDP} - \text{Output of Financial Industry} - \text{Output of Real Estate Industry}) - (\text{Base GDP} - \text{Output of Financial Industry} - \text{Output of Real Estate Industry}) / (\text{Base GDP} - \text{Output of Financial Industry} - \text{Output of Real Estate Industry}) \times 100\%$	%
	Total Industrial Output Value of Small and Micro Enterprises	EPS DATA	RMB 100 million
	Number of Small and Micro Industrial Enterprises	EPS DATA	Unit
	General Budget Expenditure of Local Finance	EPS DATA	RMB 100 million
	Industrial Structure Upgrade Coefficient	$\text{Percentage of Primary Industry} \times 1 + \text{Percentage of Secondary Industry} \times 2 + \text{Percentage of Tertiary Industry} \times 3$	non
Social Development	Social Development Per Capita Disposable Income of Residents	EPS DATA	Yuan
Technological Innovation	Technological Innovation R&D Expenditure as a Percentage of Regional GDP	$\text{R\&D Expenditure} / \text{Regional GDP} \times 100\%$	%
	Number of Three Types of Patent Authorizations	Guangdong Provincial Administration for Market Regulation (Intellectual Property Office) Count	count
	Growth Rate of Energy Consumption per Unit of GDP	$(\text{Reported Energy Consumption per Unit of GDP} / \text{Base Energy Consumption per Unit of GDP} - 1) \times 100\%$	%

the high-quality development of the real economy in Guangdong Province. Firstly, the entropy weighting method is used to objectively assign weights to each indicator of the high-quality development of the real economy, and then the linear weighting method is adopted to form the overall index of the high-quality development of the real economy. Secondly, to eliminate the influence of dimensionality and data range and preserve the relationships among the original data, all variables are normalized using the min-max normalization method before the empirical analysis. Descriptive statistics for each variable are shown in **Table 3**.

In this study, the overall index of the high-quality development of the real economy (TRE) is taken as the dependent variable, and the total index of digital inclusive finance (DFI) and its primary indicators are considered as important explanatory variables. In the empirical analysis, based on the geographical adjacency matrix ($W_{0,1}$), the Moran's I test is conducted using Stata 17.0 to examine the spatial autocorrelation of digital inclusive finance and the high-quality development of the real economy in Guangdong Province from 2014 to 2020. Subsequently, the corresponding models are selected for regression analysis.

Table 3. Descriptive statistics for each variable.

Variable	Mean	S.D.	Min	Max	N
TRE	0.1741	0.1676	0.0367	0.9188	147.0000
DFI	220.8669	44.9282	126.6100	319.2412	147.0000
BRE	211.6852	45.3125	130.3500	324.6705	147.0000
DEP	220.7161	55.5450	103.9300	316.9564	147.0000
DIG	251.4697	45.2672	144.3600	323.5537	147.0000

4.2. Spatial Autocorrelation Analysis

1) The Spatial Agglomeration Characteristics of Digital Inclusive Finance in Guangdong Province

The variable analysis was conducted on the geographical spatial adjacency weight matrix of the 21 prefecture-level cities in Guangdong Province. The global Moran's I index was calculated to explore the spatial clustering characteristics of digital inclusive finance development in Guangdong Province. The computed results are presented in **Table 4**.

According to **Table 4**, the global Moran index of digital inclusive finance in Guangdong province from 2014 to 2020 is positive, ranging from 0.492 to 0.531. The results are statistically significant at the 1% level, indicating spatial agglomeration characteristics. This means that the level of digital inclusive finance in different prefecture-level cities and the level of adjacent areas' digital inclusive finance tend to exhibit high-high agglomeration and low-low agglomeration patterns. The analysis of the global Moran index within the sample period suggests a decreasing trend in the spatial correlation of digital inclusive finance development among prefecture-level cities in Guangdong province.

Furthermore, local spatial autocorrelation analysis is used to measure the similarity levels between prefecture-level cities and their surrounding cities. The Moran index scatter plot visually represents the relationship between the digital inclusive finance development level of prefecture-level cities in Guangdong province and adjacent areas. By plotting the spatial correlation coefficient on the Moran index scatter plot, the real economy quality development level is divided into four quadrants: high-high concentration, high agglomeration, low-low agglomeration, and high-low agglomeration. These quadrants help identify and explain the relationships between each city and its adjacent cities. The scatter plots are shown in **Figure 1**, **Figure 2** (the license plate numbers of prefecture-level cities in Guangdong province are used to represent the corresponding cities, for example, A represents Guangzhou, B represents Shenzhen, C represents Zhuhai).

Based on **Figure 1** and **Figure 2**, it can be observed that there is no significant change in the spatial pattern of digital inclusive finance development among prefecture-level cities in Guangdong Province between 2014 and 2020, and there are no cities located in the high-low agglomeration quadrant. By comparing the

local Moran indices of digital inclusive finance in different quadrants in 2014 and 2020, it can be seen that cities in the third quadrant have generally moved towards the upper-right corner. This indicates that both the digital inclusive finance development level of the cities themselves and their adjacent cities have shown an upward trend. Cities in the high-high agglomeration quadrant and their neighboring areas are part of the Pearl River Delta urban agglomeration, with a higher level of digital inclusive finance development. They play a radiation-driven role in promoting the development of digital inclusive finance in adjacent regions and are also key areas for the development of digital inclusive finance to address the financing difficulties of micro and small enterprises. On the other hand, cities like Zhaoqing and most cities in eastern, western, and northern Guangdong show a relatively backward development in digital inclusive finance, exhibiting a low-low agglomeration trend. These cities urgently need to improve their digital inclusive finance development level.

Table 4. Guangdong province digital financial inclusion index global moran index.

Year	Moran's I	Z	P-value
2014	0.531	3.722	0.000
2015	0.496	3.498	0.000
2016	0.513	3.617	0.000
2017	0.495	3.505	0.000
2018	0.504	3.555	0.000
2019	0.492	3.486	0.000
2020	0.495	3.511	0.000

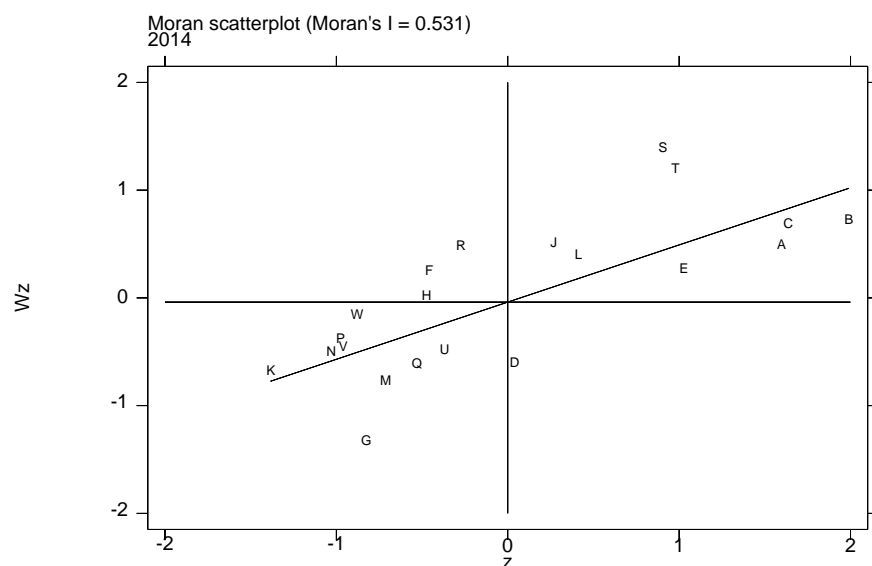


Figure 1. Local Moran scatter plot of digital inclusive finance in various prefecture-level cities of Guangdong Province in 2014.

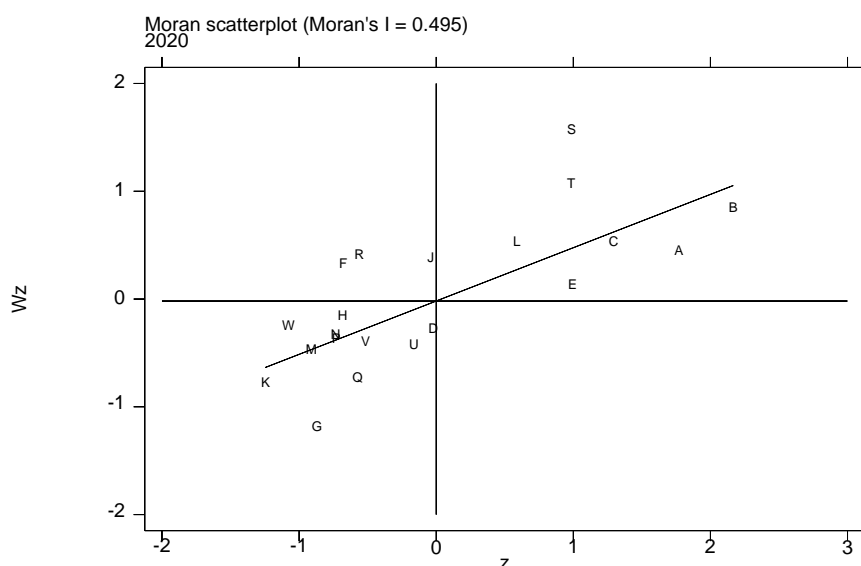


Figure 2. Local Moran scatter plot of digital inclusive finance in various prefecture-level cities in Guangdong Province in 2020.

Specifically, in 2014 and 2020, the digital inclusive finance development level of Shantou City was located on the negative y -axis and moved towards the positive direction, indicating an improvement in the digital inclusive finance development level of its adjacent cities. Zhaoqing City shifted from the second quadrant in 2014 to the third quadrant in 2020, indicating a slight decrease in the digital inclusive finance development level of its adjacent cities. Jiangmen City moved from the first quadrant in 2014 to the positive y -axis in 2020, indicating a decrease in its own digital inclusive finance development level.

2) Spatial Agglomeration Characteristics of the High-Quality Development of the Real Economy in Guangdong Province

Through the Moran's I index, it can be observed that there is a significant spatial dependence in the development of digital inclusive finance in Guangdong province. Similarly, the global Moran's I index of the overall quality development level of the real economy can be used to analyze spatial agglomeration. The calculation results are shown in **Table 4**.

According to **Table 5**, the global Moran's I index of the overall quality development level of the real economy in Guangdong province from 2014 to 2020 is positive, showing positive spatial correlation at a 10% significance level and overall exhibiting an upward trend. Due to regional disparities in economic development in Guangdong province, as well as the monopolization of science and technology innovation resources by a few prefecture-level cities, there is an indirect impact on people's lives and social development, resulting in a widening gap in the development of high-quality real economy among prefecture-level cities. The more developed prefecture-level cities, in order to expand markets or reduce costs, export products and services to neighboring prefecture-level cities, thereby exerting a radiation effect and driving the improvement of the high-quality

Table 5. Global moran's I index of the overall quality development level of the real economy in Guangdong province.

Year	Moran's I	Z	P-value
2014	0.305	2.417	0.008
2015	0.296	2.405	0.008
2016	0.300	2.494	0.006
2017	0.328	2.706	0.003
2018	0.314	2.604	0.005
2019	0.345	2.806	0.003
2020	0.352	2.875	0.002

development level of the real economy in adjacent areas. At the same time, the promotion of “dual circulation” to drive regional integration development has accelerated the flow of economic, technological, and other factors within the province, further strengthening the spatial correlation of the high-quality development level of the real economy in Guangdong province.

As shown in **Figure 3**, **Figure 4**, most prefecture-level cities in Guangdong Province are located in the first and third quadrants, indicating a polarization in the high-quality development of the real economy among these cities, and there is no significant change in the development pattern over time. In 2014 and 2020, cities such as Foshan, Zhuhai, Guangzhou, Zhongshan, Dongguan, and Shenzhen are located in the first quadrant. Most of these cities belong to the Pearl River Delta urban agglomeration and have a strong radiation effect, serving as centers for high-quality development of the real economy. Cities in the third quadrant such as Maoming, Heyuan, Jieyang, Chaozhou, Shantou, Yangjiang, Shanwei, Meizhou, and Zhanjiang exhibit a low level of agglomeration, indicating that their high-quality development of the real economy is similar to their neighboring areas and relatively low. Cities in the second quadrant, including Qingyuan, Jiangmen, and Shaoguan, have a relatively low level of high-quality development of the real economy themselves but are surrounded by cities with higher levels of development.

Specifically, in 2014 and 2020, the city of Huizhou had a position on the positive vertical axis, and the position of Huizhou in 2020 was higher than that in 2014, indicating an improvement in the high-quality development of the real economy in its neighboring cities. In 2020, the city of Zhaoqing had a position on the negative horizontal axis, indicating a slight decrease in the high-quality development of the real economy in its neighboring cities compared to the city of Zhaoqing in 2014, which was located in the second quadrant. The city of Yunfu had a position on the negative horizontal axis in 2014, while in 2020, it was located in the third quadrant, indicating a decrease in the level of high-quality development in its neighboring cities.

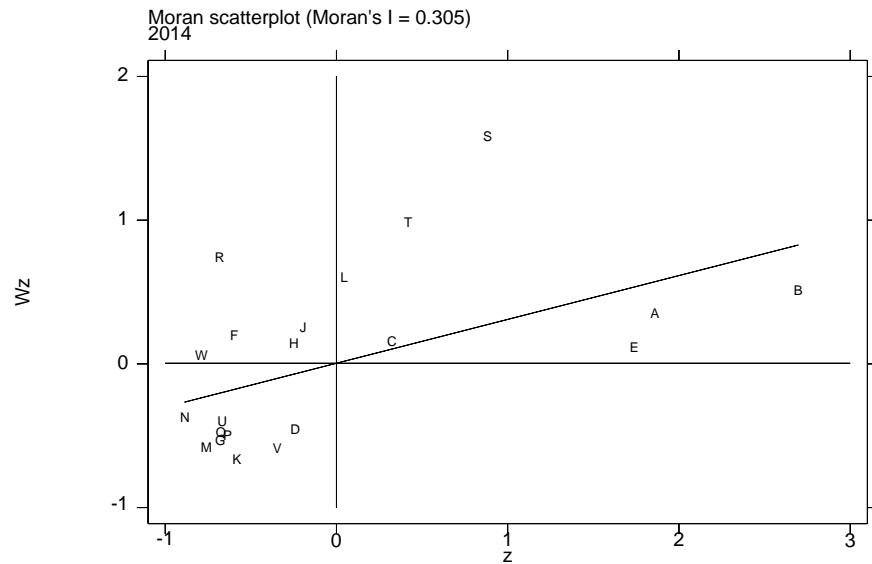


Figure 3. The scatter plot of the Moran's Index for the high-quality development of the real economy in various prefecture-level cities of Guangdong Province in 2014.

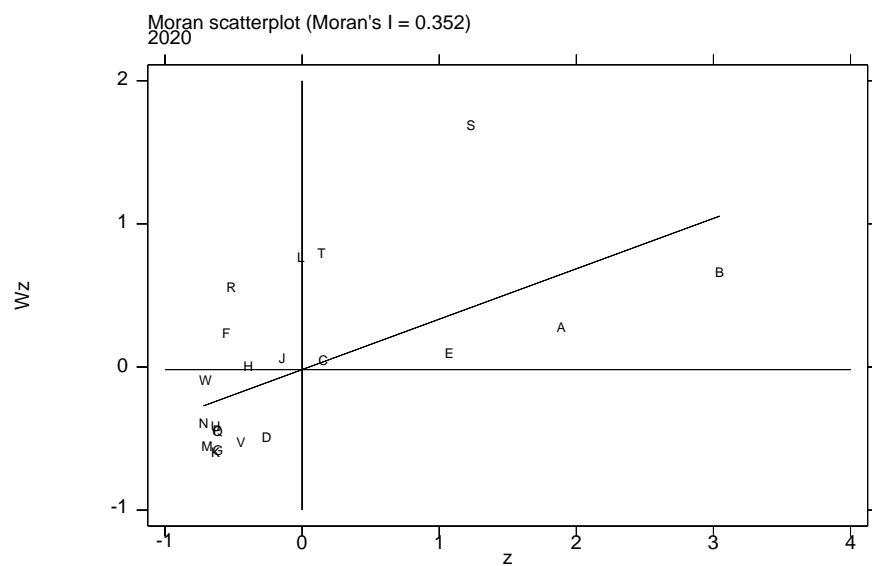


Figure 4. The scatter chart of moran Index for high-quality development of real economy in prefecture-level cities of Guangdong Province in 2020.

3) Radiation Effect of the High-Quality Development of the Real Economy in Guangdong Province

This study measures the correlation between the high-quality development index of the real economy of prefecture-level cities in Guangdong Province and their neighboring cities using local Moran's index and calculates the significance of the index. The prefecture-level cities that pass the significance test for local Moran's index in 2014 and 2020 are shown in **Table 6**. Firstly, in both 2014 and 2020, Dongguan, Shenzhen, and Guangzhou, which belong to the high-high agglomeration type, have local Moran's index significance levels below 10%, indi-

cating that these three cities maintain a high level of high-quality development in the real economy and form a cluster of high-level high-quality development, exerting a significant positive radiation effect on neighboring cities. The high economic development level of Shenzhen, Guangzhou, and Dongguan, their advanced manufacturing industry clusters, strong technological innovation capabilities, favorable regional innovation and business environments, and high degree of openness to investment, make these cities a priority consideration for national strategies. High-end and emerging industries, professional talents, financial resources, etc., tend to concentrate in these cities, forming a high-high agglomeration area for high-quality development of the real economy. Secondly, the local Moran's index significance level of Meizhou in 2014 is 10%, while it is not significant in 2020, indicating an improvement in the radiation effect of the high-quality development of the real economy in Meizhou. Overall, the trend of polarization in the high-quality development of the real economy among prefecture-level cities in Guangdong Province has not changed, manifested in the distribution pattern of high-high agglomeration areas and low-low agglomeration areas.

4.3. Selection of the Spatial Metrology Model

Spatial autocorrelation analysis reveals that there is spatial dependence in both the digital inclusive finance and high-quality development of the real economy in Guangdong Province. Following the approach of [Anselin \(1990\)](#), this study selects the optimal spatial econometric models for the comprehensive index of digital inclusive finance, coverage breadth, usage depth, and digitization level.

Under the geographic adjacency matrix, this study employs the Lagrange Multiplier (LM) test and robust LM test, and the results are presented in [Table 6](#). In models 1, 2, and 3, both the LM test and robust LM test pass the significance level of 1% or 5%. However, in model 4, the robust LM test for the Spatial Error Model (SEM) is significant, while the robust LM test for the Spatial Autoregressive Model (SAR) is not significant. Therefore, the SEM model is chosen for model 4, while the remaining models can use the Spatial Durbin Model (SDM).

Table 6. The prefecture-level cities and their types of local Moran index in 2014 and 2020.

Cluster Type	City	Year 2014	Year 2020
High-High Agglomeration	Dongguan City	1.421***	2.124***
	Shenzhen City	1.313**	1.955***
	Guangzhou City	0.589**	0.454*
Low-Low Agglomeration	Meizhou City	0.504*	0.438

Note: *, **, *** are significant at the levels of 10%, 5% and 1%, respectively.

Subsequently, the Hausman test is conducted on different models to determine whether fixed effects or random effects should be adopted for each model. The results of the Hausman test are shown in **Table 7**.

Finally, robustness tests are conducted on the models. The likelihood ratio (LR) test is used to determine whether the SDM models used in models 1, 2, and 3 degenerate into SEM models or SAR models. The final results show that the SDM model in model 2 degenerates into the SAR model.

4.4. Further Analysis: Analysis of Spatial Effects

The impact of the comprehensive index of digital inclusive finance, coverage breadth, depth of usage, and digitization level on the high-quality development of the real economy in Guangdong Province under the adjacency matrix is shown in **Table 8**.

The regression results from **Table 9** indicate that the spatial autocorrelation coefficients for Model 1 and Model 3 are 0.6160 and 0.6852, respectively. Model 2 has a spatial lag coefficient of 0.5527, and Model 4 has a spatial error coefficient of 0.4884. All four coefficients are positive and statistically significant at the 1% level, indicating the presence of spatial spillover effects in the influence of digital inclusive finance on high-quality development of the real economy in Guangdong Province. The coefficient for the spatially weighted digital inclusive finance composite index is 0.0064, which is also significant at the 1% level. These results suggest that the development of digital inclusive finance in neighboring areas can significantly impact the high-quality development of the local real economy.

Table 7. Hausman test results.

	LM-Error	Robust LM-Error	LM-Lag	Robust LM-Lag	Hausman	Model
Model 1	33.543***	72.682***	15.925***	55.065***	8.66**	RE
Model 2	26.920***	57.949***	5.8878**	36.916***	0.88	RE
Model 3	33.556***	47.279***	25.437***	39.160***	0.16	RE
Model 4	26.903***	3.465*	25.689***	2.252	14.75***	FE

Note: *, **, *** are significant at the levels of 10%, 5% and 1%, respectively.

Table 8. LR Model test results.

	SDM Degenerates to SAR	SDM Degenerates to SEM	Model Selection
Model 1	39.58***	37.02***	SDM Model
Model 2	0.53	3.23*	SAR Model
Model 3	36.53***	31.85***	SDM Model
Model 4	-	-	SEM Model

Note: *, **, *** are significant at the levels of 10%, 5% and 1%, respectively.

Table 9. The results of the baseline regression analysis for each dimension.

Variable	Model 1	Model 2	Model 3	Model 4
DFI	0.0068*** (7.6100)			
BRE		0.0004*** (3.81000)		
DEP			0.0035*** (6.8700)	
DIG				0.0017*** (6.4800)
W×DFI	0.0064*** (−7.2300)			
W×DEP			−0.0033*** (−6.4600)	
rho	0.6160*** (8.9200)	0.5527*** (6.8800)	0.6852*** (10.9100)	
lgt_theta	−1.6753*** (−8.1900)	−2.0857*** (−11.0000)	−2.0179*** (−10.3700)	
sigma2_e	0.0011*** (7.6000)	0.0014*** (7.5400)	0.0010*** (7.4700)	0.0009*** (8.2700)
lambda				0.4884*** (5.5500)
Log-likelihood	240.9890	220.1202	237.9434	297.2184
R-sq	0.6640	0.3201	0.3874	0.0485
obs	147	147	147	147

Note: *, **, *** are significant at the 10%, 5% and 1% levels, respectively, with z values in parentheses.

Furthermore, the coefficients for the digital inclusive finance composite index, coverage breadth, usage depth, and digitization level are all positive and statistically significant at the 1% level, indicating a significant positive effect of digital inclusive finance on high-quality development of the real economy in Guangdong Province. Among them, the coefficient for usage depth of digital inclusive finance is relatively higher compared to other explanatory variables. This suggests that the growth of usage depth is an important driver of high-quality development of the real economy in Guangdong Province. This may be attributed to the fact that small and micro enterprises, as the main driving force behind the real economy, can benefit from the expansion of usage depth by accessing a wider range of financial services offered by digital inclusive finance. This can enhance the resilience of small and micro enterprises and their potential to con-

tribute to economic growth, providing a favorable service environment for economic development and significantly promoting high-quality development of the real economy in Guangdong Province.

On the other hand, the significance level of the coefficient for coverage breadth of digital inclusive finance on high-quality development of the real economy in Guangdong Province is limited. This suggests that the current level of coverage breadth and accessibility of digital inclusive finance has a relatively weaker impact on high-quality development of the real economy. Further analysis indicates that after reaching a certain level, the expansion space for coverage breadth becomes limited, and the high-quality development of the real economy will no longer rely primarily on the expansion of coverage breadth of digital inclusive finance.

Furthermore, it should be noted that when the spatial regression coefficient for the quality development of the real economy in Guangdong Province is non-zero, the partial differentiation method (LeSage & Pace, 2009) should be used to decompose the total effect of the explanatory variables into direct and indirect effects. The specific decomposition results can be found in Table 9.

According to Table 10, the total effect of the local digital inclusive finance development on the high-quality development of the real economy is 0.0009. This means that for every 1% increase in the level of digital inclusive finance development, the high-quality development of the real economy will increase by 0.0009%. The direct effect derived from the decomposition is 0.0062, slightly smaller than the regression coefficient of Model 1 (0.0068). This is because the direct effect includes the influence of the local digital inclusive finance development on the spatially related digital inclusive finance development in other regions, which in turn affects the local region through a “feedback effect” (Jiao, 2021). The indirect effect derived from the decomposition is -0.0053 , which means that for every 1% increase in the digital inclusive finance development in neighboring regions, the high-quality development of the local real economy decreases by 0.0053%. This indicates a negative spatial spillover effect of digital inclusive finance on the high-quality development of the real economy in Guangdong Province.

Therefore, for the local region, digital inclusive finance can optimize the development environment of the local real economy industry, promote the development of the local real economy industry, and thus contribute to high-quality

Table 10. Effect decomposition of the model.

Model	Direct Effect	Indirect Effect	Total Effect
Model 1	0.0062***	-0.0053 ***	0.0009***
Model 2	0.0005***	0.0005***	0.0010***
Model 3	0.0032***	-0.0026 ***	0.0006***

Note: *, **, *** are significant at the 10%, 5% and 1% levels, respectively.

development of the real economy. However, for neighboring regions, the increase in digital inclusive finance development may result in a competition effect among regions that outweighs the synergy effect (Jiao, 2021). Under the promotion of digital inclusive finance in the local region, the local real economy industry experiences improvement but ultimately exerts a certain inhibitory effect on the high-quality development of the real economy in neighboring regions.

In terms of the coverage breadth of digital inclusive finance, the total effect, direct effect, and indirect effect are all positive at a significance level of 1%. This indicates that for every 1% increase in the coverage rate of digital inclusive finance in neighboring regions, the high-quality development of the local real economy can increase by 0.0005%. It suggests that the coverage breadth of digital inclusive finance has a positive spatial spillover effect on the high-quality development of the real economy. The reason behind this may be that the coverage breadth of digital inclusive finance can break the spatial and temporal barriers of industrial factor flow, accelerate the diffusion of digital financial services, and when the coverage breadth reaches a certain level, digital technologies, capital, labor, and other factors begin to flow to neighboring regions, promoting the development of the real economy in those regions and achieving high-quality development.

Regarding the depth of usage in digital inclusive finance, the direct effect and total effect are significantly positive, but the indirect effect is significantly negative. This indicates that the depth of usage in digital inclusive finance has a negative spatial spillover effect on the high-quality development of the real economy. This may be because the depth of usage in digital inclusive finance can promote financial innovation in the local region, leading to the emergence of diversified financial products and services. However, it is still constrained by factors such as regional economic imbalances, incomplete digital inclusive finance service systems in different regions, and issues of “information asymmetry” between regions.

5. Conclusion and Suggestions

In order to explore the mechanism and spatial effects of digital inclusive finance on the high-quality development of the real economy in Guangdong Province, this study selects panel data from 21 prefecture-level cities in Guangdong Province from 2014 to 2020. It constructs an indicator system for digital inclusive finance and high-quality development of the real economy and applies spatial econometric models for empirical research. The main findings are as follows:

- 1) There is spatial dependence between digital inclusive finance and the high-quality development of the real economy in Guangdong Province. The spatial correlation of digital inclusive finance development in each prefecture-level city shows a decreasing trend overall, while the spatial correlation of the high-quality development of the real economy shows an increasing trend overall.

- 2) The overall Pearl River Delta city cluster has a high level of development in

both digital inclusive finance and the high-quality development of the real economy, and it can have a radiating effect on neighboring areas.

3) There is polarization in the high-quality development of the real economy among the prefecture-level cities in Guangdong Province, and the development pattern remains relatively stable, characterized by the distribution pattern of high-high agglomeration areas and low-low agglomeration areas.

4) Digital inclusive finance has a significant positive impact on the high-quality development of the real economy in Guangdong Province, and the growth of the depth of usage in digital inclusive finance is one of the important driving forces for the high-quality development of the real economy in Guangdong Province.

5) Digital inclusive finance has a negative spatial spillover effect on the high-quality development of the real economy in Guangdong Province, indicating that the development of digital inclusive finance in a local area can inhibit the high-quality development of the real economy in neighboring areas.

6) The coverage breadth dimension has a positive spatial spillover effect on the high-quality development of the real economy in Guangdong Province, while the depth of usage dimension has a negative spatial spillover effect. Based on the above research conclusions, the following optimization suggestions are proposed:

Based on the above research findings, this paper proposes the following optimization suggestions:

1) Fully utilize the radiating effect of high-quality development of the real economy and consider the interconnectivity between cities. Adopt a “point-to-point” assistance model based on different industrial patterns and development situations. Leverage the radiating effect of high-high agglomeration cities to promote communication and cooperation between high-high agglomeration areas and other areas. Facilitate the flow of financial elements between cities to achieve regional coordinated development of the real economy.

2) Maximize the spillover effect of digital inclusive finance under spatial interaction. Regions should focus on developing related infrastructure for digital inclusive finance, attracting funds, talents, and technologies. Actively play the leading role of the government and leverage the “Belt and Road” initiative in China to gradually establish a diverse, stable, and sustainable investment and financing system. Expand the coverage of digital inclusive finance, enhance its level of digitization, improve the accessibility of financial services, and realize the “digital dividend”.

3) Promote the deep development of digital inclusive finance and foster multi-party collaboration. Build a comprehensive and multi-level service system for the development of digital inclusive finance through the support of relevant government-enterprise interaction platforms. Improve specialized service areas and functions to meet the various demands of enterprises. Provide policy support and align regional policies to support small and medium-sized enterprises (SMEs) that are specialized, innovative, and have unique characteristics. Unleash the vitality of digital inclusive finance in driving technological innovation for

enterprises, thus empowering and energizing the high-quality development of the real economy.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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