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Network Feature Extraction for Regional Economic Development and Financial Agglomeration Analysis

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The feature components extracted by the ISA neural network have good mutual independence and good translation invariance, scale invariance and rotation invariance. It can better acquire hidden internal feature information and is successfully applied in the field of human behavior recognition. Through the optimization process, the ISA neural network can complete the learning phase to train the weight parameters. This paper analyzes regional economic development and financial agglomeration using machine learning algorithms and deep learning, and uses a spatial econometric model to empirically study the differences between financial industry agglomeration and regional economic development. This paper measures the degree of financial agglomeration and analyzes the degree of financial agglomeration of China's regional economy and integrates the empirical results. The paper provides a certain reference value for the development of the regional economy.

Keywords: Deep Learning; Network Feature Extraction; Deep Network; Financial agglomeration;

1. INTRODUCTION

In recent years, the financial industry has gradually become the core industry of China's economic development, and the financial industry plays an increasingly important role in the process of China's economic development [1]. Due to the financial agglomeration in China's financial industry, the economic activities of the industry have formed a certain concentration in a certain fixed space, which has led to more economic activities moving closer to this area [3–4]. Today, the number and scope of the financial industry are booming, and the accumulation of the financial industry has become more pronounced. In all countries of the world, large or small financial agglomerations are becoming increasingly formed [4]. China's financial industry is no exception. It has gradually formed a financial center with an eastern orientation, but the differences in the economic development of various regions in China have become more apparent [5–6]. The financial industry in each region is also very different. Studying the agglomeration of the financial industry and understanding its relationship with regional economic growth in China is important. The relationships involved are very practical.

Financial agglomeration is a form of expression in which industrial agglomeration is applied to the financial industry [7–8]. Financial agglomeration is an organization with agglomerated economic attributes [9]. It not only integrates financial markets, but also results in many vertical divisions

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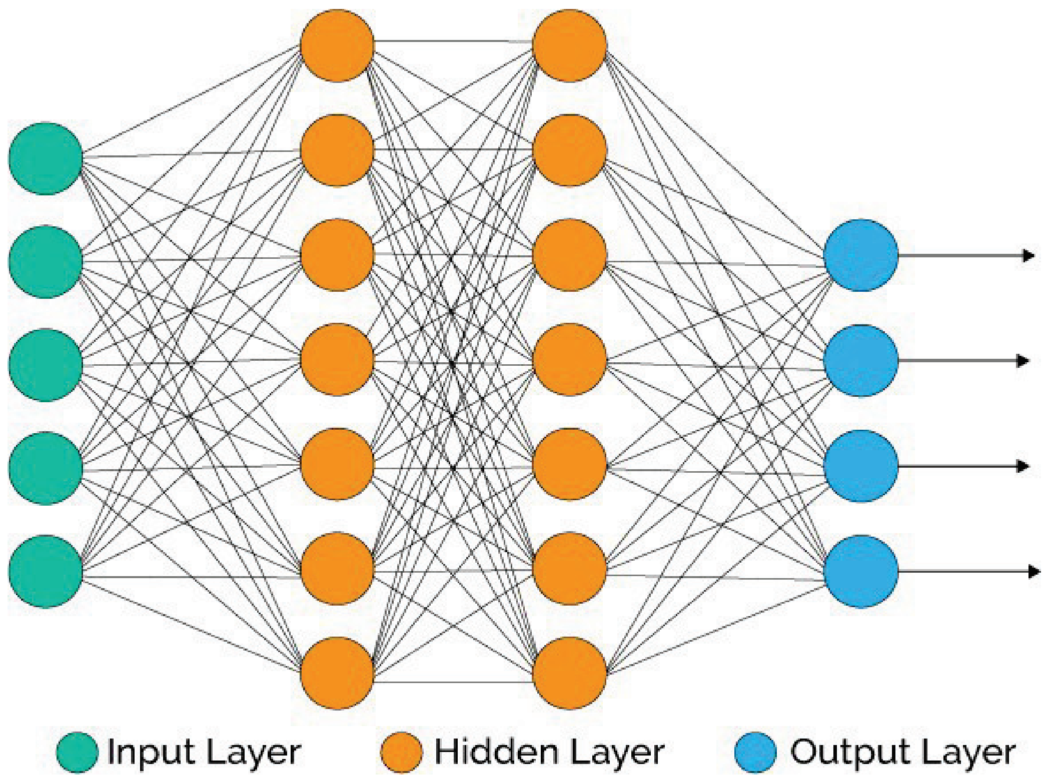

Figure 1 Neural network model.

and horizontal competitions, as related financial companies and enterprises, focusing on specific regions form stable and sustainable financial organizations. Financial agglomeration is the foundation of the formation of financial centers. It is the intermediate network of composite financial products [10]. It has the advantages of financial innovation and reduces financial risks that can bring profits to the financial industry, and it can also bring growth momentum to economic development [11]. Financial agglomeration is the concentration and extent of financial institutions with geographical and social proximity gathered in a certain area [12]. The definition of financial agglomeration can be analyzed from both dynamic and static aspects, and dynamic financial agglomeration is a process that emphasizes the rapid accumulation of financial advantages in areas where the network has natural and economic advantages under certain conditions.

Static financial agglomeration is a state in which a state forms a financial industry [13]. Different from traditional financial enterprises, static financial agglomeration does not emphasize the difference in competitiveness from within the organizational structure but emphasizes the specialized division of labor and enhances the competitiveness of enterprises through mutual competition [14–15]. In all regions of the world, the phenomenon of industrial agglomeration can be seen. When industrial agglomeration is gradually developed and perfected, the financial industry naturally joins the ranks, and this financial agglomeration is due to the financial industry's significant role in economic development. The new social phenomenon of financial agglomeration will naturally become a powerful driving force for economic development.

2. SPATIOTEMPORAL DEEP CONFIDENCE NETWORK

2.1 ISA Neural Network Model

Based on the theory of ISA independent subspace analysis, Le et al. integrated ISA independent subspace analysis into deep neural networks and combined it with convolution, stratification and other techniques to simulate the hierarchical response mode of human visual systems and the complex cell receptor field, which can make the neural network train and learn invariant features.

The feature components extracted by the ISA neural network have good mutual independence and good translation invariance, scale invariance and rotation invariance. It can better acquire hidden internal feature information and is successfully applied in the field of human behavior recognition.

The basic structure of the ISA neural network model is a neural network generation model with two hidden layers. The basic structure of the double hidden layer of the ISA neural network model is shown in Figure 1

In Figure 1, the input corresponds to a large number of collected training videos or image samples. In the figure, the first layer simulates the simple cells of the human brain visual cortex, and the second layer simulates the complex cells of the human brain visual cortex, and the output is the result of the transformation through mapping. At the same time, the first layer is also called the simple layer, and the second layer is also called the complex layer or the pooling layer.

We set the input of the ISA neural network to be X, that is, based on a large number of collected training videos or image samples, the sample matrix X is formed. At the same time, we assume that the total number of samples is N and each training sample is a column of X, i.e. $X = \{x_1, x_2, \cdots x_n\}$, which corresponds to the input circle node unit in Figure 1.

We assume that the response of the first layer is S, then the relationship between the input X and the first layer response S satisfies:

$$X = BS \tag{1}$$

Among them, B is a matrix characterizing the features of the primitive, and

$$B = \{b_1, b_2, \cdots b_k\}.$$

Each column in B is a feature primitive vector, which can be understood as the basic unit for characterizing a video or image. The S response can be understood as a set of first layer outputs, and each column of

$$S = \{s_1, s_2, \cdots s_k\}^T$$

can be understood as a feature coefficient vector that is used to represent the contribution of a feature primitive vector in B to a video or picture sample.

In general, for the calculation of the first layer response S, the formula (1) needs to be modified as follows [24]:

$$S = WX \tag{2}$$

Among them,

$$W = B^{-1}$$

Is the inverse of the primitive feature matrix B, and the primitive features and weights have a corresponding relationship. Moreover, W is the weight combination of the first layer of the neural network, and the human brain cortical cell receptor field is characterized by W.

In the ISA neural network, the column components

$$\{s_1, s_2, \cdots s_k\}$$

of the k-number of S responses are not required to be independent of each other. We divide the entire column components of S into T groups equally, that is

$$\{s_t, t = 1, 2, \cdots, T\}.$$

The components within the group may not be completely independent of each other We assume that each group contains p number of column components, which exhibit complete independence, then the p-number of primitive vectors constructs a separate subspace.

We assume that the response of the second layer is Y, and the relationship between the output Y and the column component

$$\{s_1, s_2, \cdots s_k\}$$

of k numbers of the first layer S response satisfies:

$$Y = \sqrt{\sum\nolimits_{k \in S_t} (S_t)^2} \tag{3}$$

In accordance with the formula (3), the mapping process of the first layer output to the second layer response is completed, and the process of simulating the hierarchical convergence response of the simple brain cells of the human brain to the complex cells is completed.

In the training phase, the reference value V of the first layer and the second layer is often set as an empirical fixed value in practice. Therefore, the problem of optimizing the weight parameters in the ISA neural network is mainly for W. That is, it is only necessary to solve the optimization problem of the first layer weight W, and learn a good weight matrix W by training, and make the components of the second layer output response Y have independence. Its optimized objective function is [25]:

$$\min_{w} \sum_{n=1}^{N} \sum_{m=1}^{M} y_m (x_n; W, V)_s .t.WW^T = I \tag{4}$$

Through the optimization process of equation (4), the ISA neural network completes the learning and training of the weight parameter W. In the equation, the requirement for orthogonalization of W is limited, that is, the product that satisfies the W and W transposition is a unit matrix, which is used to ensure that the extracted features are more diverse. By solving the optimization problem of the above weight W, the training phase of the ISA neural network is completed.

2.2 Improved ISA Deep Network

We assume that there are n numbers of human behavior video samples in the video set and they are classified into L kinds of human behavior categories, that is

$$\{(x_1, y_1), \cdots, (x_n, y_n)\}, y_i \in R^L, 1 \leqslant i \leqslant n,$$

Among them, x_i represents the i-th video sample and y_i represents the behavior category number represented by the i-th video sample.

In accordance with the ISA neural network, the input human behavior video sample is converted into a corresponding feature vector, that is, the mapping of the sample space R^S to the feature space R^F is completed, and the process can be expressed as:

$$F(X) = [f_1, f_2, \cdots, f_n] = h([x_1, x_2, \cdots, x_n]) \tag{5}$$

In equation (5), f_i represents a feature vector corresponding to each human behavior video sample x_i, and h represents a mapping transformation from sample space R^S to feature space R^F via the ISA neural network.

In the human behavior recognition stage, after the feature extraction of the ISA neural network is completed, that is, after obtaining the feature vector, the feature vector is taken as an input, and a classifier such as SVM or Softmax is used for recognition and determination. Finally, the category number of the human behavior video to be tested is output, which is expressed as follows:

$$\phi(x_i) = [p_1, p_2, \cdots, p_L]^T \tag{6}$$

Among them, p_j denotes the confidence level identified as class j, $1 \leqslant j \leqslant L$, which can be understood as the magnitude of the probability value identified as class j, that is satisfied

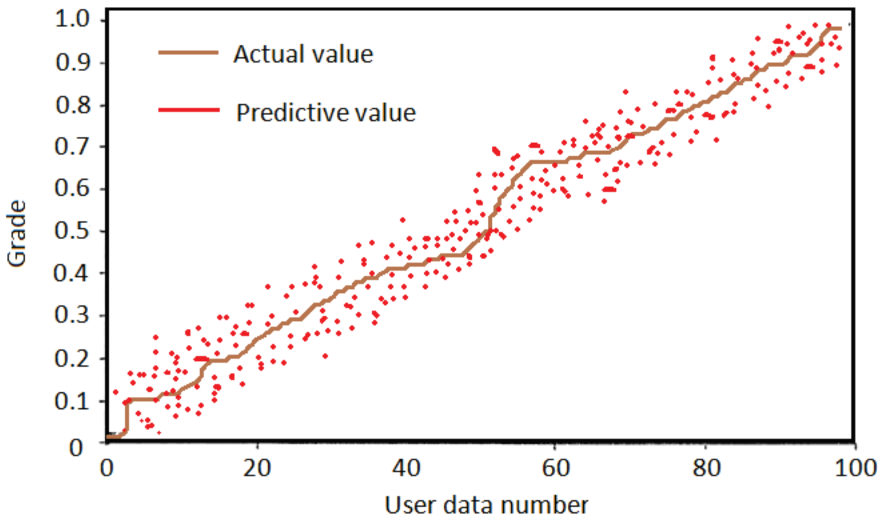

Figure 2 Trend distributions of financial aggregates relative to regional space.

$$\sum_{j=1}^{L} p_j = 1 \tag{7}$$

$\phi(x_i)$ is the result of the final identification category number of the input video x_i, which is the category corresponding to the maximum value of the confidence p_j, $1 \leqslant j \leqslant L$.

By the same ratio between the category number and the real category number identified by the statistics, the recognition accuracy of the human behavior recognition can be counted.

2.3 Research on Financial Aggregation Effect of Regional Economic Development

The theory of financial aggregation effects has not reached a unified conclusion or definition so far, but most scholars tend to understand it as a kind of diffusion, or a process of re-formation of certain kinds of things. The phenomenon of financial agglomeration exists in the form of a financial center at the beginning, thereby gradually improving the efficiency of payment and resource allocation across enterprises and regions through the convenience of financial centers, so that funds can be reduced on the one hand. On the other hand, during turnover it can effectively reduce the costs incurred by the transaction, and more importantly, ensure the timeliness of the information, so that economies of scale can be achieved, as shown in formula (8):

$$Effect(V_1, \cdots, V_k) = \sum_{i-1}^{k} Ecnomic(V_i, V_i) \tag{8}$$

(1) Analysis of the impact of financial agglomeration on regional economic development

The law of the resulting financial agglomeration effect is gradually decreasing. The agglomeration effect produced by the agglomeration effect is clearer when it is close to the agglomeration center because such areas can obtain more advantages. The agglomeration effect of space is concentrated in a certain area to a large extent, so that the influx of talent can be increased, and the efficiency of talent development and utilization can be enhanced, and the public infrastructure in the region can be further promoted, and the experience sharing and innovation ability in the region can be further promoted. The main reason for the formation of financial centers is attributed to the full correlation of concentration, and the degree of concentration depends on the degree of information aggregation, because financial transactions in areas with relatively concentrated information and resources become more frequent, and promote the formation of financial centers; on the other hand, in areas where financial information is relatively dispersed, the distribution of transactions between them depends mainly on the cost difference of the exchange. In recent years, due to the rapid development of the network, more and more breakthroughs have been made in the lower limit of financial transaction costs. At the same time, financial transactions have gradually shifted to the suburbs. This proves that financial activities are different trends in the geographical space that are both concentrated and decentralized, as shown in Figure 2.

3. ANALYSIS OF THE IMPACT OF FINANCIAL AGGLOMERATION ON REGIONAL ECONOMIC DEVELOPMENT

There has always been a resource theory in the financial industry. Some people regard finance as a resource in society. At the same time, we have discovered through research and discussion on China's basic national conditions that China also does have this kind of financial resources, which is coupled with the prevalence of economic globalization in recent years. As a unique form of existence, finance is scarcer and more strategic than natural resources. The reason why the so-called financial resource theory is formed is mainly because finance is a sub-portion of the same kind of economic system. It represents a new ecological form, a fusion and penetration of modern economies, and is a kind of more sustainable ecosystem, as shown in equation (9):

$$Organ(V_1, \cdots, V_2) = \sum_{i=1}^{k} \sum_{x_j \in V_i} |\kappa(x_j, \cdot) + c_i(\cdot)|^2_{H_k} \quad (9)$$

The perspective of financial resources focuses on the integration of the financial industry and geography. Both domestic and international studies have conducted an in-depth analysis of this issue. China mainly tends to study the overall theoretical evolution process, and foreign countries tend to study the motivation of integration. Economists have used the data provided by the World Bank to make a chart of financial flows, and to analyze the reasons for the formation of the overall financial flow. If the equity trading distance becomes longer, then the natural liquidity will be reduced, and the inherent endowments and advantages of the resources will be reduced. This situation will gradually increase the problem of information imbalance. The issue of financial geography has become the focus of our cash research, and we have used the geographical knowledge of space to show us the overall distribution and mobility of resources, and to construct a financial center by observing the financial structure and the use of financial geography. Regional financial cooperation provides the basis, as shown in formula (10):

$$Base(\alpha_i, y_i) = s_i \hat{K} \alpha_i + (y_i \tilde{K})^T \quad (10)$$

3.1 Methodology for Assessing Regional Economics of Financial Agglomeration and Economic Growth

The methods for assessing the degree of financial agglomeration are diverse. A comparative analysis of existing research reveals that the average researcher conducts research from both agglomeration and difference. The more representative measures include space coefficient method, location entropy coefficient method (LQ), etc. This paper summarizes the many methods mentioned above and follows the scope of the research and the availability of data.

3.1.1 Method for Evaluating Spatial Coefficient

The production formula of the spatial coefficient is inferred from the basic theory and definition of the Lorenz curve, and the index of this average degree is derived, and G is usually used as the reference. The formula of the spatial coefficient is shown in formula (11):

$$G = \sum_i (X_i - S_i)^2 \quad (11)$$

The meaning of X_i in formula (11) is the ratio of all employment in the i region to the national employment, and S_i indicates the ratio of financial employees in the i region to the national financial employment. According to the meaning of the equation, we can see that as the spatial coefficient decreases, it means that the better the financial industry in this region develops, the higher is the degree of financial agglomeration, so the value of the spatial coefficient cannot exceed one.

3.1.2 Location Entropy Coefficient Evaluation Method

The location entropy coefficient originally refers to the ratio of the economic profit produced by individual industries in a certain region to the overall national economic profit, which is calculated as follows:

$$LQ = \frac{E_{\mathrm{ij}}/E_i}{E_{kj}/E_k} \quad (12)$$

In formula (12), the symbol E_{ij} is the number of all employed persons solved by the financial industry j in the i region, and E_i is the total number of employed people we want to study; E_{kj} refers to all the financial industries in the country. The total employed population of E_k represents the total number of employed people in the country. According to the explanation of each symbol, we can see that formula (12) reflects the development of the financial industry in a certain region and the employment situation of the people and the overall development of the national financial industry by the total number of employed persons, and the location entropy coefficient method. The advantage lies in the ability to effectively measure the concentration of a certain financial industry and judge the proportion of employment in this industry to the total employment in the country. The greater is the result of the location entropy coefficient, and the better is the development of the financial industry in this region.

3.2 Financial Agglomeration Analysis Model of Financial Aggregation Effect on Regional Economic Development

The neoclassical economic growth model or the exogenous economic growth model can analyze the impact of different economic factors on economic growth. The economic growth model has several basic assumptions. Firstly, it is assumed that all social savings are converted into investment, and that is, the savings investment conversion rate is assumed to be 100%. The second is to assume that the marginal rate of return is reduced due to investment. It can also be understood that the scale return is a stable constant, and the capital and labor alternative Cobb Douglas production function is added to solve the economic growth rate and population growth rate. The contradiction between the economic growth models is shown in Figure 3.

Among them, the exogenous variables of this model are population growth rate and savings rate and technological progress rate, and endogenous variables are investment levels. The model has no investment expectations, so it avoids the instability between the guaranteed economic growth rate and the actual economic growth rate. It can be concluded that the economic growth is stable, and this is mainly due to its capital stock and technological innovation. Therefore, this paper firstly represents the capital stock expansion with the overall scale of finance, and secondly, the degree of financial agglomeration measured above is applied to the equation.

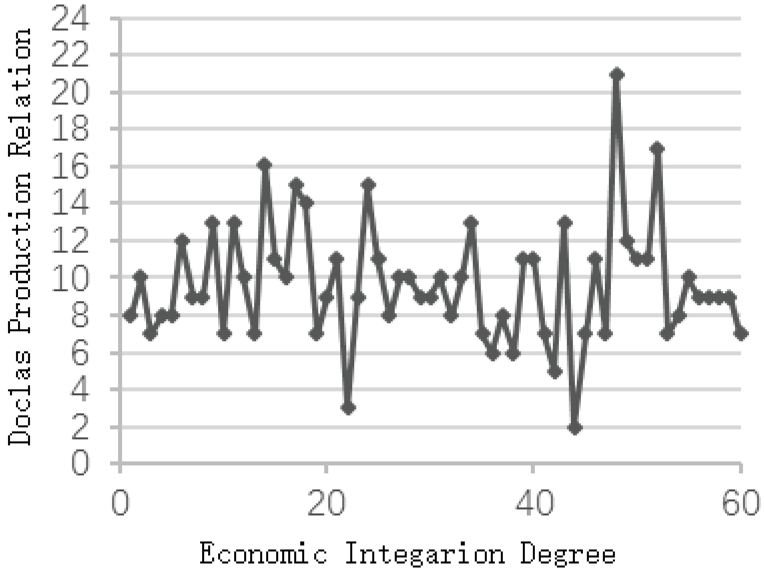

Figure 3 Cobb Douglas production function based on financial aggregation and economic growth.

The indicator of technological progress is mainly expressed by the overall capital utilization rate of the financial market. Since we should examine the overall impact of financial agglomeration on regional economic development, we cannot analyze the above indicators separately. In order to achieve significant results, we must adopt the product of financial agglomeration, financial scale, and capital utilization. To characterize regional economic development, it is necessary to build a model to determine how financial agglomeration affects economic development, as shown in equation (13):

$$GDPP = a + \beta 1LQ + \beta 2Ft + \beta 3Fe + \beta 4LFt \quad (13)$$

In formula (13), China's overall economic development level is represented by the indicator GDPP. Since the measurement of financial agglomeration uses the location entropy coefficient, it is expressed by LQ, because it is necessary to judge the relationship between the size of the financial industry and the utilization rate of financial funds and the economy. Therefore, the two are represented by Ft and Fe respectively, and the above mentioned that the analysis results are more explicit. This paper introduces the product variables of LQ and Ft and LQ and Fe, respectively, which are expressed as LFt. We can see that whenever economic activity occurs in a fixed time and space, and if we want to discuss the emergence of economic activities, we can not only focus on the time dimension, but also increase the consideration of the spatial dimension. So here, the spatial measurement model is the best choice for this article. From the formula, we can see the difference between the two. The so-called spatial lag model (SLM) focuses on the economic activities generated by each individual part and the adjacent area in each area, and space of error model (SEM) considers the effects of different regions when they interact with each other, or when there are differences due to different positions, it is shown in equation (14):

$$\text{District}(Y, \xi) = \text{tr}\left(W^{1/2} K W^{1/2}\right) + \sum_{i=1}^{k} \Phi_i(Y, \xi) \quad (14)$$

It can be seen in formula (14) that W represents the level of economic development in a certain region; and the autoregressive coefficient ξ represents the degree of influence of the observations displayed in the adjacent regions on the rest of the region. In the following, we also mainly use The spatial financial aggregation effect is determined between the dependent variables; K is the spatial error coefficient, which refers to the influence and extent of the observations of neighboring regions on the economy of the region, and also indicates the spatial dependence of the dependent variables.

This paper aims to study whether the concentration of China's financial industry has a financial agglomeration effect on the regional economy. Therefore, we need to set the dependent variable as the development degree of China's regional economy. In addition to considering the accuracy of data and the convenience of selection, this paper selects the per capita GDP of each province as the explanatory variable, and uses GDPP to refer to it, in units of 10,000 Yuan. In addition to the variables being interpreted, there are core explanatory variables in the model, and product explanatory variables for ease of observation, and accurate control variables for overall measurement. Moran's, I index measurement method is the most commonly used method in autocorrelation test. This paper will use GeoDa1 software to draw the scatter plot of financial agglomeration in each province. As shown in Figure 4, the horizontal axis represents the level of financial agglomeration and the vertical axis represents the adjacent region.

4. CONCLUSION

Financial agglomeration has a significant role in promoting economic activities. While financial agglomeration is widespread in China, this promotion of economic activities is also producing a positive financial agglomeration effect. Because the uniqueness of China's economic development indicates that there is a correlation between economic

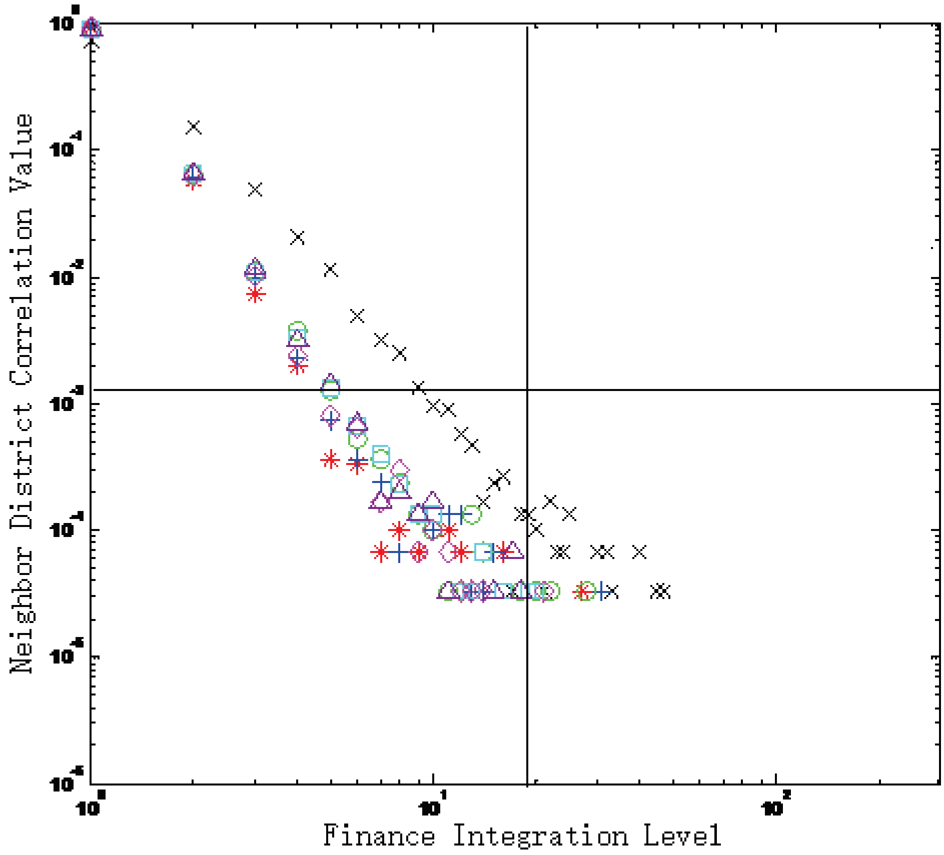

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Figure 4 Spatial autocorrelation test of financial agglomeration.

activities in various provinces and cities, the spatial dependence and financial aggregation effects of adjacent regions are very clear. Similarly, we can understand that the level of economic development in an adjacent area of a given area will affect its economic development level to a large extent. This conclusion can be derived from the sign and significance of the regression coefficient of the GDP of the explanatory variable GDPP, so the development of the local economy and the overall level of its neighbors are highly connected. The research results of this paper have certain guiding value for regional economic development.

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REFERENCES

1. Jon Adams, Jane Frawley, Amie Steel, Alex Broom, David Sibbritt. Use of pharmacological and non-pharmacological labour pain management techniques and their relationship to maternal and infant birth outcomes: Examination of a nationally representative sample of 1835 pregnant women[J]. Midwifery. 2015(4)
2. Helen Hall, Romy Lauche, Jon Adams, Amie Steel, Alex Broom, David Sibbritt. Healthcare utilisation of pregnant women who experience sciatica, leg cramps and/or varicose veins: A cross-sectional survey of 1835 pregnant women[J]. Women and Birth. 2016(1)
3. Holger Cramer, Lesley Ward, Amie Steel, Romy Lauche, Gustav Dobos, Yan Zhang. Prevalence, Patterns, and Predictors of Yoga Use[J]. American Journal of Preventive Medicine. 2016(2)
4. Amie Steel, J on Wardle, Helene Diezel, Kate Johnstone, Jon Adams. Educating for collaboration: The outcomes of an interprofessional education workshop for complementary and alternative maternity care providers[J]. Advances in Integrative Medicine. 2014(1)
5. Sofia Hedlund, Hans Nilsson, Markus Lenz, Tobias Sundberg. Effect of Chiropractic Manipulation on Vertical Jump Height in Young Female Athletes with Talocrural Joint Dysfunction: A Single-Blind Randomized Clinical Pilot Trial[J]. Journal of Manipulative and Physiological Therapeutics. 2014(2)
6. Keith E. Maskus, Rebecca Neumann, Tobias Seidel. How national and international financial development affect industrial R&D[J]. European Economic Review. 2011 (1)
7. Shi X. Research on influence of regional financial agglomeration on economic growth[J]. Jiangsu Science & Technology Information, 2017.
8. Zheng J F, Zeng B, Kong L C, et al. A Study on Economic Growth Effect of the Coordinated Development of Urbanization and Financial Agglomeration——A Case of the Yangtze River

Economic Belt[J]. East China Economic Management, 2017.

9. Jin H, Zhang W R. System Dynamics Simulation of the Effect of Financial Agglomeration on Regional Economic Growth——Based on the Perspective of Factor Flow[J]. Journal of Hebei University, 2016.
10. Li Y, Shi X, Li H. Research on Financial Agglomeration to Spatial Spillover Effects of Economic Growth in Beijing-Tianjin-Hebei Region[J]. Economy & Management, 2018.
11. Zhang T, Sun Y. Financial Agglomeration and Regional Economic Growth: A Comparative Study Based on Sub-provincial Cities[J]. Macroeconomics, 2018.
12. Xiao-Ming W U, Yang L, Liu L. An Empirical Study on the Impact of Sichuan Petrochemical Industry Agglomeration on Regional Economic Growth[J]. Soft Science, 2017.
13. Zhou H P, Yuan-Yuan L I, Rui-Jing L I. The Spatial Effect of Financial Agglomeration on Regional Economic Growth[J]. Modern Finance and Economics-Journal of Tianjin University of Finance and Economics, 2016.
14. Liao K, Peng G, Liu F, et al. Financial Resource Agglomeration and Economic Growth of Hunan Wuling Mountain Area[J]. Science & Management, 2016.
15. Shao A, University H. The Empirical Research of Financial Industry Agglomeration and Economic Growth in Hefei[J]. Journal of West Anhui University, 2016.