

## Research Article

# The Harmonious Development of Big Data Industry and Financial Agglomeration in Guizhou

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Accepted 17 October 2019*Keywords*Big data industry  
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It has important practical and theoretical significance to study the coupling relationship and coordinated development between big data industry and financial agglomeration. This paper used 2015 cross-section data, the intuitionistic fuzzy analytic hierarchy process, the intuitionistic fuzzy number score function, the coupling model and the coupling coordination model to empirically research the coupling and coordination level between Guizhou big data industry and financial agglomeration. The empirical research shows that there is an obvious imbalance in the coordinated development and obvious spatial heterogeneity of big data industry and financial agglomeration in Guizhou. Only Guiyang and Zunyi can achieve the coupling and coordinated development of big data industry and financial agglomeration.

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This is an open access article distributed under the CC BY-NC 4.0 license (<http://creativecommons.org/licenses/by-nc/4.0/>).**1. INTRODUCTION**

The 18th national congress of the communist party of China clearly pointed out that scientific and technological innovation should be taken as the core of development and innovation-driven development strategy should be adopted to facilitate further economic growth, so as to provide a sustained driving force for the improvement of China's comprehensive national strength. As a strategic emerging industry, big data industry, with its innovative technology content, can well meet the needs of various enterprises and government agencies for data resources, meet the needs of various industries to follow the trend of Internet development, and make positive contributions to economic construction while the industry itself is developing continuously. At present, the big data industry in China presents a completely different development path from the traditional industry. China's big data industry is mainly concentrated in Beijing, Shanghai, Guangdong and other places with relatively developed economy, but the place with the most rapid development of big data industry is Guizhou, where the economic development and industrial foundation are relatively backward. This phenomenon indicates that compared with general industries, big data industry may have unique development influencing factors.

Domestic and foreign research achievements on the relationship between financial agglomeration and industrial development are relatively abundant. Galbis [1] proposed that the inhibited financial system would easily lead to the imbalance of industrial development in the region, and the constantly optimized financial structure would obviously promote the industrial development in the

region and improve the efficiency of resource allocation. Carlin and Mayer [2] studied the impact of various financial sub-industries on various industries from the perspective of financial structure, and found that market-oriented financial structure is conducive to the development of high-tech and high-risk industries. Sun and Li [3] used Moran Index and spatial geographic weighted regression model to study and believe that the optimization of domestic industrial structure is conducive to the agglomeration development of the financial industry, and the financial agglomeration, in turn, has some promoting effect on the industrial structure. Deng and Liu [4] studied the relationship between financial agglomeration and industrial structure upgrading in the eastern, central and western regions of China, and found that regional financial agglomeration had a significant positive impact on industrial structure upgrading. Through the analysis of the mechanism of action among financial development, industrial structure and economic development, Su and Xu [5] believe that regional financial agglomeration and financial development can support and promote the upgrading of regional industrial structure. Most scholars at home and abroad believe that financial agglomeration is conducive to optimizing industrial structure and promoting industrial development, so as to promote economic development in the region. However, the rise of big data industry is still a short period, and most of the researches are still at the level of major problems, development trend, competitive advantage and composition and policy system research that big data industry faces [6–10]. There is no systematic and authoritative theory and analysis on the factors influencing the development of big data industry, let alone theoretical and empirical research on the interaction and support between big data industry and financial agglomeration. Based on this, this study was to explore big data industry and financial agglomeration

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coupling between coordination mechanism, taking Guizhou province as a sample, using the Intuitionistic Fuzzy Analytic Hierarchy Process (IFAHP) and the coupling coordination model to empirically analyze the development level and coupling coordination level of big data industry and financial agglomeration. It is expected to put forward corresponding countermeasures and suggestions for the development of regional big data industry, which has certain practical and theoretical significance.

## 2. ANALYSIS OF INTERACTION BETWEEN BIG DATA INDUSTRY AND FINANCIAL AGGLOMERATION

According to the theory of manufacturers, labour factor, capital factor and technology factor are the main driving forces to promote industrial development, and the development of emerging industries has a huge demand for the three factors, especially the capital factor. Referring to China's big data industrial agglomeration areas, most of which are economically developed areas, and big data industry, as an emerging industry, its capital demand determines the development level of big data industry to a large extent. Therefore, it is speculated that the agglomeration of financial industry in a certain region can promote the development of local big data industry to a certain extent. The role of financial agglomeration in promoting the development of big data is mainly reflected in two aspects. On the one hand, as an emerging industry, big data industry is different from the traditional labour-intensive industry, its development requires a lot of capital-intensive research and development activities, which means that sufficient capital investment can effectively drive the structural adjustment and upgrading of big data industry and promote the development of big data industry. On the other hand, financial agglomeration can promote the benign development of big data industry. Specifically, the capital allocation function and screening mechanism of the financial market can always make investment funds flow to enterprises with growth space and development potential, so as to improve the use efficiency of investment funds, improve the factor productivity of big data industry and bring economic benefits, and finally promote the stable and healthy development of big data industry.

## 3. RESEARCH METHOD

### 3.1. Index System and Data Source

Based on the principles of scientificity, representativeness, comparability and accessibility, and references the results of Bai et al. [11], this study constructs an evaluation system for the coupling and coordinated development of big data industry–financial agglomeration system according to the mechanism and characteristics of the coupling and coordinated development of big data industry and financial agglomeration. The development level of financial agglomeration is described from the two dimensions of industry agglomeration level and industry development level of financial industry, banking industry, insurance industry and securities industry, including four first-level indicators and 13 second-level indicators. The industrial development level of big data in Guizhou is measured from two aspects of industrial scale and infrastructure level, including two first-level indicators and 12 second-level

indicators. In this study, cross-sectional data in 2015 were selected from statistical yearbooks of Guizhou prefectural cities, statistical yearbooks of Guizhou province, China banking and insurance regulatory commission, China securities regulatory commission, statistics bureau of Guizhou province, statistics bureau of Guizhou cities and official websites of governments.

### 3.2. Comprehensive Evaluation Steps based on IFAHP

Step 1: Data standardization. Indicators of the evaluation system for the coupling and coordinated development of the big data industry–financial agglomeration system are all efficiency indicators. The standardized formula is:

$$z_{ij} = \frac{(x_{ij} - \min x_j)}{(\max x_j - \min x_j)}, z_{ij} \in [0, 1],$$

$x_{ij}$  is the original index value,  $\max x_j$  and  $\min x_j$  is the maximum and minimum value of the original index.

Step 2: Construct the intuitive judgment matrix. By comparing the importance of indexes, the qualitative evaluation words of indicators are converted into intuitionistic fuzzy Numbers, and the intuitionistic judgment matrix is constructed  $R = (r_{ij})_{n \times n}$ . Among them,  $r_{ij} = (\mu_{ij}, \nu_{ij})(i, j = 1, 2, \dots, n)$ ,  $\mu_{ij}$  represent the membership degree,  $\nu_{ij}$  represent the non-membership degree,  $\mu_{ij} \in [0, 1]$ ,  $\nu_{ij} \in [0, 1]$ ,  $\mu_{ij} + \nu_{ij} = \pi_{ij}$ ,  $\pi_{ij} = 1 - \mu_{ij} - \nu_{ij}$  is the hesitation degree.

Step 3: Consistency test. The consistency of intuitionistic judgment matrix is tested by constructing consistency intuitionistic judgment matrix. If it passes the consistency test, skip to step 5. If not, proceed to step 4.

Step 4: Revise the intuitive judgment matrix which does not satisfy the consistency test. Set the parameter  $\sigma$  for iteration,  $\sigma \in [0, 1]$ , until it passes the consistency test.

Step 5: Calculate indicators weight. By using the operator of intuitionistic fuzzy number, the total weight of the combined second-level indicators and first-level indicators is obtained.

Step 6: The intuitionistic fuzzy number is obtained by combining index data with index weight.

Step 7: Using the score function:

$$U = \mu_F + \mu_F(1 - \mu_F - \nu_F)$$

to convert the intuitionism fuzzy number  $F$  into the comparable real number  $U$ , and the comprehensive evaluation value of the development level of big data industry and financial agglomeration is obtained. The larger  $U$  is, the higher comprehensive evaluation value is.

### 3.3. Coupling Degree Model and Coupled Coordination Model

The coupling coordination model includes coupling degree and coupling coordination degree to reflect the degree of interaction

and interaction among multiple systems. The coupling degree model of big data industry–financial agglomeration system is:

$$C = \frac{2(U_1 \times U_2)^{1/2}}{(U_1 + U_2)}$$

$C$  is the coupling degree and the value range is  $[0, 1]$ . When  $C = 0$ , it indicates that the two systems are mutually independent. When  $0 < C \leq 0.3$ , the system is in the stage of low-level coupling. When  $0.3 < C \leq 0.5$ , the system is in the antagonism stage. When  $0.5 < C \leq 0.8$ , the system is in the run-in stage; When  $0.8 < C \leq 1$ , the system is in the stage of high horizontal coupling.  $U_1$  and  $U_2$  are the comprehensive evaluation values of big data industry and financial agglomeration. If the two achieve coupling and coordinated development, when  $U_1 - U_2 > 0.1$ , it is the lag type of financial agglomeration lag. When  $U_2 - U_1 > 0.1$ , it is the lag type of big data industry. When  $0 \leq |U_1 - U_2| \leq 0.1$ , it is the synchronous type of financial agglomeration and big data industry. If the coupling between the big data industry and financial agglomeration is in a state of misalignment and recession, when  $U_1 - U_2 > 0.1$ , it is the damage type of financial agglomeration. When  $U_2 - U_1 > 0.1$ , it is the damage type of big data industry. When  $0 \leq |U_1 - U_2| \leq 0.1$ , it is the damage type of both financial agglomeration and big data industry.

When the comprehensive evaluation values of the two systems are similar but not high, only calculating the coupling degree will lead to the pseudo-evaluation results with high degree of collaborative development. Therefore, in order to accurately reflect the coupling and coordinated development degree of big data industry and financial agglomeration, the coupling and coordination degree model is further constructed:

$$D = (C \times T)^{1/2}, T = \alpha U_1 + \beta U_2$$

$D$  is the degree of coupling coordination and the value range is  $[0, 1]$ ,  $T$  is the comprehensive evaluation value of big data industry–financial agglomeration system, and  $\alpha$  and  $\beta$  are undetermined coefficients ( $\alpha + \beta = 1$ ), reflecting the contribution of big data industry and financial agglomeration to the coupling coordination of the overall system. Considering that both are equally important to the overall system,  $\alpha = \beta = 0.5$  is selected. When  $0.9 < D \leq 1$ , the degree of coupling coordination between big data industry and financial agglomeration is in high quality and coordinated development. When  $0.8 < D \leq 0.9$ , it is a good coordinated development. When  $0.7 < D \leq 0.8$ , it belongs to intermediate coordinated development. When  $0.6 < D \leq 0.7$ , it belongs to primary coordinated development. When  $0.5 < D \leq 0.6$ , it is barely coordinated development. When  $0.4 < D \leq 0.5$ , it is an endangered recession. When

$0.3 < D \leq 0.4$ , it is a mild disorder recession. When  $0.2 < D \leq 0.3$ , it belongs to intermediate disorder recession. When  $0.1 < D \leq 0.2$ , it is a severe disorder recession. When  $0 < D \leq 0.1$ , it belongs to extreme disorder recession.

## 4. EMPIRICAL RESULTS AND ANALYSIS

### 4.1. Empirical Research based on IFAHP

The empirical research results are shown in Table 1. According to the empirical research results based on IFAHP, the comprehensive evaluation value of big data industry in Guiyang is 0.6724, with the highest score, and the lowest score is from Anshun, which is 0.0436. The value of Zunyi, Southern Guizhou, Southeast Guizhou, Tongren, Southwest Guizhou, Bijie and Liupanshui is 0.5487, 0.1268, 0.1267, 0.1096, 0.0953, 0.2062 and 0.0660 respectively. The comprehensive evaluation value of financial agglomeration of Guiyang is 0.6442, followed by Zunyi, which the value is 0.3514. The value of Southern Guizhou, Southeast Guizhou, Tongren, Ansun, Southwest Guizhou, Bijie and Liupanshui is 0.0849, 0.0446, 0.0589, 0.0903, 0.0688, 0.0188 and 0.0519 respectively. The comprehensive valuation of big data industry and financial agglomeration of nine districts in Guizhou are large fluctuations. Only Guiyang and Zunyi achieves that the comprehensive evaluation of big data industry development level and financial agglomeration level is more than average, across the rest of the city are below average. It shows that big data industry development and the financial industry agglomeration are very unequal status in Guizhou.

### 4.2. Empirical Research based on Coupling Coordination Model

The coupling degree  $C$  of the two systems of the other eight districts is relatively stable, fluctuating within the range of 0.9012–0.9998, except for Bijie which is 0.5435. The gap between different districts is not obvious, and they are all in the high level coupling stage, indicating that there is a strong correlation between big data industry development and financial agglomeration in Guizhou province. However, in terms of coupling and coordinated development, only Guiyang and Zunyi have a coupling coordination degree  $D$  higher than the average level, which is 0.8007 and 0.6815 and within the acceptable range of the coupling and coordination criteria, while the other seven districts are all in the unacceptable range, indicating that there is a coupling coordination development imbalance

**Table 1** | The coupling coordination development level of big data industry and financial agglomeration

Districts	$U_1$	$U_2$	$C$	$T$	$D$	Coupling coordination level
Guiyang	0.6274	0.6442	0.9998	0.6413	0.8007	Good coordinated development
Zunyi	0.5487	0.3514	0.9863	0.4709	0.6815	Primary coordinated development
Southern Guizhou	0.1268	0.0849	0.9849	0.1081	0.3263	Mild disorder recession
Southeast Guizhou	0.1267	0.0446	0.9453	0.0956	0.3006	Mild disorder recession
Tongren	0.1096	0.0589	0.9423	0.0821	0.2781	Intermediate disorder recession
Ansun	0.0436	0.0903	0.9012	0.0769	0.2633	Intermediate disorder recession
Southwest Guizhou	0.0953	0.0688	0.9186	0.0683	0.2504	Intermediate disorder recession
Bijie	0.2062	0.0188	0.5435	0.1121	0.2468	Intermediate disorder recession
Liupanshui	0.0660	0.0519	0.9938	0.0594	0.2430	Intermediate disorder recession

between big data industry development and financial agglomeration in Guizhou province.

- (1) Guiyang belongs to the high level stage of coupling and good coordination development type of big data industry and financial agglomeration. The comprehensive evaluation of big data industry, the comprehensive evaluation of financial agglomeration and coupling coordination degree of both are much higher than the rest of districts. Moreover, there is little difference between the development level of big data industry and financial agglomeration, so it belongs to the synchronous development type of big data industry and financial agglomeration. This indicates that in the process of big data industrial development, the financial industry agglomeration of Guiyang can offer good support for its development, and the big data industry at the same time can promote the development of regional financial industry agglomeration, the coordinated development of both promote each other to form a good situation.
- (2) Zunyi belongs to the high-level coupling stage and primary coordinated development type of big data industry and financial agglomeration. Its comprehensive evaluation value of big data industry, comprehensive evaluation value of financial agglomeration and their degree of coupling and coordination are only second to the provincial capital Guiyang. Moreover, the degree of coupling coordination is close to the intermediate coordinated development, indicating that the big data industry and the financial industry in Zunyi can achieve the coordinated development of the two. But the big data industry value is greater than the financial agglomeration, the integrated evaluation and the difference between the two is  $>0.1$ , so it belongs to the financial agglomeration lag type. This phenomenon shows that financing needs of some big data enterprises may not being met, which limit the development of big data industry in the area.
- (3) Southern Guizhou and Southeast Guizhou belong to big data industry and the financial agglomeration high coupling phase and mild disorder recession types, which  $D$  value is 0.3263 and 0.3006. Big data industry and the financial agglomeration development level difference is not big, belong to the big data industry and financial agglomeration joint damage type. Although the coupling level is high, there are many big data enterprises in Southern Guizhou and Southeast Guizhou without corresponding financial support. At the same time, the limited development of big data industry itself may also hinder the agglomeration of financial industry in the region, making the big data industry and financial agglomeration in Southern Guizhou and Southeast Guizhou restrict each other and fail to achieve joint and coordinated development.
- (4) Tongren, Anshun, Southwest Guizhou, Bijie and Liupanshui belong to the intermediate disorder recession type of big data industry and financial agglomeration, which  $D$  value is 0.2781, 0.2633, 0.2504, 0.2468 and 0.243. The coupling of big data industry and financial agglomeration in Bijie is in the running-in stage, and there is a big gap in the comprehensive evaluation value between the two, which belongs to the type of financial agglomeration lag. The development level of big data industry and financial agglomeration in the other four districts is approach, they are in the stage of high level coupling and the type of common damage of big data industry and financial

agglomeration. Showed that it is not only the majority of big data business financial needs are not being met in Tongren, Anshun, Southwest Guizhou, Bijie and Liupanshui, result to the development of big data industry in the region is greatly restricted, and the low level of development of big data industry may also cause the outward dispersion of regional financial industry. The development level of big data industry and financial agglomeration level in five districts both needs to be greatly increased.

## 5. CONCLUSION AND SUGGESTIONS

### 5.1. Conclusion

Based on the coupling coordination mechanism of big data industry and financial agglomeration, this paper established the coupling coordination development evaluation index system of big data industry and financial agglomeration. Then using the IFHAP to calculate the big data industry and the financial agglomeration evaluation index weight and total weight at all levels. Finally, it combined with the coupling coordination model and 2015 cross-section data of each districts of Guizhou to measure the coupling coordination degree between big data industry and financial agglomeration. By analyze the coupling coordination development condition, we can conclude that:

- (1) From the perspective of overall, the coupling coordination development level of big data industry and financial agglomeration in Guizhou is low and span to five levels, and the regional difference is more apparent. It has an obvious spatial heterogeneity.
- (2) From the perspective of space, in terms of coupling stage, except for Bijie, the other eight districts in Guizhou province all achieve the high-level coupling of big data industry and financial agglomeration. The coupling of big data industry and financial agglomeration in Bijie is in the running-in stage. But in terms of the coordinated development stage, only Guiyang and Zunyi can achieve coupling coordinated development of big data industry and financial agglomeration. The condition of Southern Guizhou and Southeast Guizhou are in the mild disorder recession of big data industry and financial agglomeration, while other five districts and regions, Tongren, Anshun, Southwest Guizhou, Bijie and Liupanshui, are all in the intermediate disorder recession.

### 5.2. Suggestions

After several years of development, big data industry in Guizhou has a certain scale. In the process of construction and development in the future, it still needs further improvement.

On the one hand, Guizhou should draw lessons from foreign advanced experience of the development of big data industry. At the same time, digestion and absorption of the successful model of Guiyang big data exchange. Guizhou should vigorously introducing big data industry demonstration enterprise, while should also actively build infrastructure of big data industry. For laying a solid foundation for the development of big data industry, Guizhou should try best to build up comprehensive national big data (Guizhou) pilot zone, and developing a path for big data industry with Guizhou characteristics.



On the other hand, with the increasing integration of big data technology and traditional industries, Guizhou should take advantage of the development momentum of big data industry and use big data to meet the development needs of government departments, social institutions, enterprises and individuals, which can help to achieve the economic development transformation of various industries in the province and improve the quality and efficiency of economic growth.

## CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

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