

# The Nonlinear Impact of Financial Agglomeration Development on the Development of Digital Economy

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**Abstract.** Digital economy is the main goal of China's future economic development, and financial agglomeration plays an important role in the development of digital economy. Therefore, based on 31 provincial and municipal data from 2013-2020, this paper investigates the impact of financial agglomeration on the development of digital economy from the perspective of financial agglomeration using Tobit. The results show that: (1) financial agglomeration development has a "U"-shaped relationship with the development of digital economy; (2) technological development, logistics development and higher regional economic level will have a positive impact on the development of digital economy; (3) the bloated management of enterprises will weaken the development of digital economy. Overall, this paper finds that financial agglomeration can have a non-linear effect on the digital economy, which in turn provides suggestions for regional digital economy development.

**Keywords:** Digital Economy; Financial Agglomeration; Entropy Method; Tobit.

## 1. Introduction

Digital economy development is an important task for China's development. The Fourteenth Five-Year Plan for the Development of Digital Economy proposes that it is necessary to continuously strengthen, improve and expand China's digital economy. Therefore, it is important to study the relationship between financial agglomeration and the development of digital economy to clarify the current situation of digital economy development.

In view of the importance of the development of digital economy, scholars have conducted a lot of research on this, among which some scholars have studied the spatially linked network structure of the development level of digital economy [1], and some other scholars have studied the influence role of other factors on digital economy. For example, some scholars have studied the impact on digital economy from the perspective of industrial structure optimization and upgrading [2], urbanization [3], and marketization [4], and some scholars have also investigated the influence of digital economy development from the perspective of full sample analysis and regional sample analysis [5]. Financial agglomeration is also one of the research hot spots, and some scholars have investigated the role of financial agglomeration on other factors, in addition to the literature on the impact of financial agglomeration on green economy efficiency [6], technological innovation [7], and the spatial and temporal characteristics of financial agglomeration and financial agglomeration effects [8].

The structure of the existing research mainly focuses on the study of the factors influencing the development of digital economy or the analysis of the influence path mechanism, and there is a lack of analysis of the influence of a single factor on the digital economy. The innovation of this paper is to analyze the impact of financial agglomeration on the development of digital economy from the perspective of financial agglomeration, and to study the "U"-shaped relationship between financial

agglomeration and the development of digital economy. This paper takes 31 provinces and cities in China as the research object, measures the development level of digital economy from 2013 to 2020 in 31 provinces and cities using entropy value method, and analyzes the influencing factors using Tobit model to study the non-linear influence of financial agglomeration development on the development of digital economy.

## 2. Basic introduction of the method

### 2.1. Tobit regression model

The Tobit regression model quantifies the relationship between the restricted explanatory variables and the explanatory variables, reflects the results of the analysis through regression coefficients, and adjusts the relationship between variables in the form of manual intervention to make the explanatory variables take on perfect values. Its basic structure is as follows.

$$y = \begin{cases} \beta^T x_i + e_i, & \text{if } \beta^T x_i + e_i > y_0 \\ 0, & \text{other} \end{cases} \quad (1)$$

$$e_i \sim N(0, \sigma^2), i = 1, 2, 3, \dots, n \quad (2)$$

where  $x_i$  denotes the explanatory variable,  $y_i$  denotes the explained variable,  $\beta^T$  denotes the unknown parameter vector, and  $\sigma^2$  is the parameter to be estimated. If  $y_0$  is subtracted from both sides of the model at the same time, the constant term of the transformed model is the original constant minus  $y_0$ . The resulting standard form of the model is called the Tobit model, and the more general sense of the model is as follows.

$$y_i^* = \beta^T x_i + e_i, (i = 1, \dots, N), \varepsilon_i \sim N(0, \sigma^2) \quad (3)$$

### 2.2. Entropy method

The entropy method is a method to determine the indicator weights based on the discrete degree of the data. When the information entropy of the data is smaller, the more information the data provides, and the corresponding indicator weights will be larger. The panel data containing years, cities, and indicators are objectively assigned weights for each indicator using the entropy method to derive the composite score of each city. In this article, the entropy value method is chosen to determine the weights of each indicator, and the specific model is as follows.

Step 1: Indicator selection. With  $r$  years,  $n$  cities, and  $m$  indicators, then  $X_{\theta ij}$  denotes the  $\theta$ -th year, the  $i$ -th prefecture-level city, and the  $j$ -th indicator.

Step 2: Standardization of metrics. Since different indicators have different scales and units, they need to be standardized.

Positive indicator standardization.

$$X'_{\theta ij} = \frac{X_{\theta ij} - X_{\min}}{X_{\max} - X_{\min}} \quad (4)$$

Negative indicator standardization.

$$X'_{\theta ij} = \frac{X_{\max} - X_{\theta ij}}{X_{\max} - X_{\min}} \quad (5)$$

Where,  $X_{\max}$ ,  $X_{\min}$  denote the maximum and minimum values of the  $j$ -th indicator in the  $i$ -th city  $r$  years. That is, the maximum and minimum values of each indicator for all years are taken.

After the standardization of indicators,  $X'_{\theta ij}$  takes the value range of [0,1], which indicates the relative size of  $X'_{\theta ij}$  in  $r$  years in  $n$  cities.

Step 3: Non-negative panning.

$$X'_{\theta ij} = X'_{\theta ij} + 0.001 \tag{6}$$

Step 4: Calculation of weights.

$$Y_{\theta ij} = X'_{\theta ij} / \sum_{\theta} \sum_i^n X'_{\theta ij} \tag{7}$$

Step 5: Calculation of entropy value.

$$S_j = -k \sum_{\theta} \sum_i^n (Y_{\theta ij} \ln(Y_{\theta ij})) \quad k = 1 / \ln(rn) \tag{8}$$

Step 6: Calculate the coefficient of variation. The  $j$ -th coefficient of variation of the indicator.

$$E_j = 1 - S_j \tag{9}$$

Step 7: Calculate the weights of indicator  $j$ .

$$W_j = E_j / \sum_j^m E_j \tag{10}$$

Step 8: Calculate the composite score under each year for each city. Product of indicator weights and standardized indicator values.

$$H_{\theta i} = \sum_j^m (W_j (X'_{\theta ij})^T) \tag{11}$$

### 2.3. Variable description

(1) Interpreted variable: Digital Economy development (ED)

Refer to Zhan Jing[9], Wang Kai[10]Such as research results, this paper selects the digital economy development is explained variables, which is divided into digital economy, digital economy application and digital economy innovation three primary indicators, at the same time for each level index to establish multiple secondary index, choose 11 secondary index at the same time this paper adopts the objective empowerment entropy method of the secondary index empowerment, enhance the reliability of the results, weight and build the index system as shown in Table 1.

**Table 1.** Evaluation index system and its weight of digital economy development

Target layer	Elements layer	Index layer	direction	unit	weight
Digital economy development	Digital economy foundation	Number of mobile phone households	+	Ten thousand households	3.776
		Number of fixed telephone households	+	Ten thousand households	4.485
		Telecom business volume	+	100 million	8.542
		The Internet broadband access port	+	Ten thousand	4.354
	Application of digital economy	The number of enterprises with e-commerce transaction activities	+	individual	7.746
		E-commerce sales volume	+	100 million	10.084
		E-commerce purchase volume	+	100 million	10.989
		Express business revenue	+	Wan Yuan	14.632
		Express business volume	+	Ten thousand pieces	16.178
	Digital economy innovation	Number of R&D personnel	+	human being	10.041
		R&D funds	+	Wan Yuan	9.172

On the basis of calculating the weight of 11 secondary indicators of digital economy development level, the total index of digital economy development level is further calculated.

(2) Explanatory variables: financial agglomeration (LQ)

This paper uses the degree of financial agglomeration in each area as the explanatory variable, and uses the location entropy to measure the relative professional degree of the financial industry in the 31 provinces and autonomous regions, It can avoid the influence of regional financial scale difference on the measurement results, and can effectively evaluate the agglomeration degree of financial industry in a single area. The value of location entropy is positively correlated with the degree of financial industry agglomeration in this area. Therefore, this paper uses location entropy to calculate the financial agglomeration index of 31 provinces and autonomous areas from 2013 to 2020, and this paper is calculated based on the financial industry employment personnel. As shown in equation (12), LQ is the localization entropy of financial aggregation, i denotes the region and j denotes the industry.

where  $X_{ij}$  is the number of employed persons in the financial industry in region i, and  $\sum_i \sum_j X_{ij}$  is the number of employed persons in all industries in all areas.

$$LQ = \frac{\sum_j X_{ij}}{\sum_i \sum_j X_{ij}} \bigg/ \frac{\sum_i X_{ij}}{\sum_i \sum_j X_{ij}} \tag{12}$$

(3) Control variables:

I. Number of patent applications filed by industrial enterprises above designated size (IP): including invention, utility model and appearance design. Reflect the scientific and technological and design achievements with independent intellectual property rights.

II. Per capita disposable income (DI) of all residents: the income that residents can use freely, marking the purchasing power of residents.

III. Number of legal entities of enterprise (LEE): including all kinds of enterprise legal persons receiving the Business License (or the new Business License), as well as sole proprietorship enterprises, partnership enterprises, etc.

IV. Area of road (AR): refers to the actual pavement area of the road and the pavement area of the squares, Bridges and tunnels connected with the road (when counted, the sidewalk area shall be counted separately). The sidewalk area is calculated according to the addition of the areas on both sides of the road, including the pedestrian street and the square, excluding the mixed road of people and cars.

**2.4. Data sources**

This paper is based on the study of 31 provinces and autonomous regions in China from 2013 to 2020. The relevant data are all from the National Bureau of Statistics, CSMAR database and China Statistical Yearbook from 2012 to 2020. The missing data was mainly filled by the statistical yearbooks of provinces and cities and the average of the past two years, with a total of 248 samples.

**3. Regression Results**

The empirical study in this paper shows the overall effect of financial agglomeration on the development of digital economy. The specific results are shown in Table 2. The results in column (1) of Table II show that without adding any control variables, for each unit of the increase of financial agglomeration in a certain region, the total digital economy development index in the region decreases by 0.083 units, which is significantly positive at the level of 10%. Article (2) is listed as the square item of the degree of financial agglomeration, and the influence effect of financial agglomeration on the development of digital economy is highly significant at the 1% level. In column (3) of Table II, the effect of financial agglomeration on the development of digital economy is examined in detail

after four control variables are added. The results show that the degree of financial agglomeration still has a negative impact on the development of digital economy, with an influence coefficient of -0.3732, and is highly significant at the level of 1%. At the same time, the number of patent applications of industrial enterprises above designated size, per capital disposable income of all residents and road area all promote the development of digital economy, and the influence coefficient is 0.0359, 0.0481 and 0.0423 respectively; while the number of corporate units has a slight inhibitory effect on the development of digital economy, and the influence coefficient is -0.0014, and the significance level is highly significant at 1%.

**Table 2.** Analysis of the regression results

ED	Tobit		
	(1)	(2)	(3)
LQ	-0.083 <sup>*</sup> (0.0457)	-1.2489 <sup>***</sup> (0.2994)	-0.3732 <sup>***</sup> (0.1364)
LQ <sup>2</sup>		0.5115 <sup>***</sup> (0.1299)	0.1692 <sup>***</sup> (0.0603)
IP			0.0359 <sup>***</sup> (0.0028)
DI			0.0481 <sup>***</sup> (0.0073)
LEE			-0.0014 <sup>***</sup> (0.0003)
AR			0.0423 <sup>***</sup> (0.0060)
Cons	0.2773 <sup>***</sup> (0.0499)	0.8948 <sup>***</sup> (0.1642)	0.1312 <sup>**</sup> (0.0777)
N	248	248	248

Pour: <sup>\*</sup> <sup>\*\*</sup> <sup>\*\*\*</sup> Represents the significance levels at 10%, 5%, and 1%, respectively.

From the perspective of explanatory variables, the degree of financial agglomeration will affect the development of digital economy. The reason is that when the degree of financial agglomeration in a region is high, it will have a negative impact on the green economy, and thus inhibit the development of digital economy to a certain extent. At the same time because in the short term regional financial investment mainly focus on services or the short-term output is high industry, less infrastructure investment in digital economy, and when the financial industry in the future, the industry more standard and want to obtain long-term development will increase investment in digital economy, so short-term will cause negative effects, long-term positive effects, namely the financial agglomeration regression coefficient is negative, but the financial agglomeration square term regression coefficient is positive, consistent with the expected results.

From each control variables, the more the number of patent applications of industrial enterprises above the scale means more intellectual property rights and can promote the development of regional e-commerce; the more per capita disposable income of all residents, the more money the residents will have to spend on the e-commerce platform, and the e-commerce consumption increases significantly; the larger the road area, the more can improve the turnover and distribution of express delivery, making the express business volume and express business income increase sharply. The above three control scalars can promote the construction of regional digital economy, among which the disposable income of all residents and road area have the strongest effect, because these two are fundamental control variables. When incomes are low, spending power declines, making it difficult to boost the digital economy, and when roads are very small. At the same time, the more the number of corporate enterprises, the greater the relative development of digital economy, because in the short term, the growth rate of e-commerce enterprises is much smaller than the growth rate of the overall enterprises. Therefore, the number of corporate units in the short term will play a slight inhibitory role in the development of digital economy, and the above are consistent with the expected results.

## 4. Summary

### 4.1. Conclusions

Based on the connotation of financial agglomeration and digital economy development, this paper selects 31 provincial and municipal panel data from 2013 to 2020, and firstly analyzes financial agglomeration and digital economy development by using Tobit method; then, analyzes four control variables: the number of patent applications filed by industrial enterprises above designated size, per capital disposable income of all residents, number of legal entity of enterprise, road area and their impact on the development of digital economy. The results are as followings: (1) There is a U-shaped relationship between financial agglomeration development and digital economy development, in which financial agglomeration development first inhibits and then promotes. (2) The increase of financial agglomeration inhibits the development of digital economy, but the addition of other control variables reduces the inhibitory effect of financial agglomeration to a certain extent. (3) Among the four control variables, only the number of enterprise legal entities has a negative relationship with the digital economy. (4) The number of patents and disposable income per capita are positively correlated to the development of digital economy, and the improvement of technology level and regional economic development can promote the construction of digital economy.

Therefore, a higher degree of financial agglomeration does not mean higher quality of economic development. Excessive pursuit of financial agglomeration does not necessarily bring positive effects for regional economic development. In addition, the policy recommendations are listed below.

### 4.2. Recommendations

To promote the development of the digital economy, this paper lists the following policy recommendations.

(1) While vigorously attracting financial enterprises, the government should also pay attention to the flow of the effects of financial agglomeration and keep the degree of financial agglomeration within a reasonable range.

(2) Do a good job of infrastructure construction and continuously improve the road traffic and other access systems. Urban infrastructure is to serve the daily operation and social and economic development of the city, and is the basic condition for the survival and development of a city. Only with continuous improvement of infrastructure can we better meet the development requirements of the digital economy.

(3) It can appropriately increase the fiscal budget expenditure to promote the growth of scale economy, create more enthusiasm for investment, encourage innovation and stimulate economic vitality, meanwhile, the income of residents can be improved to a certain extent to add impetus to the development of digital economy.

(4) Promote the efficient and reasonable flow of resources, give appropriate policy subsidies, promote some financial enterprises to the middle economic development areas, try to avoid the phenomenon of the more developed economies in developed areas and ignore the middle-developed areas, and promote the coordinated development of regional resources.

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