

# Analysis of the Impact of Digital Financial Agglomeration on the Economic Growth of Guangdong Province under the New Development Patterns

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## Abstract

Based on the background of the era under the new development pattern, this paper collects the relevant data of Guangdong from 2012 to 2021, chooses the measurement method of location entropy to analyze the degree of financial agglomeration of 21 prefectures in Guangdong, and establishes a regression model of the mechanism of the effect of financial agglomeration in Guangdong based on the data of financial agglomeration and the data of regional economic growth with the Cobb-Douglas production function, so as to study the impact of financial agglomeration on the economic growth of Guangdong. Based on the financial agglomeration data and regional economic growth data, a regression model of the effect mechanism of financial agglomeration in Guangdong is established on the basis of Cobb-Douglas production function to study the impact of financial agglomeration on economic growth in Guangdong. Secondly, the results of the study are comprehensively analyzed in depth, through which it can be seen that the scale effect and other benign effects of financial industry agglomeration in Guangdong Province contribute to the economic growth, but also have a certain degree of counterproductive effects, hindering the economic development of some regions. Finally, based on the conclusions of the study, we put forward countermeasures and suggestions to promote Guangdong's economic growth.

## Keywords

Financial Sector Agglomeration, Economic Growth, New Development Pattern, Guangdong, China

## 1. Introduction

The new development pattern is a major achievement of economic thought on socialism with Chinese characteristics in the new era, a positive choice and strategic deployment based on the great strategy of the country's comprehensive rejuvenation, and a strategic direction and realistic path for the high-quality development of China's economy in the Fourteenth Five-Year Plan and even for a considerable period of time in the future. Under the new development pattern, the state continues to emphasize the comprehensive deepening of reform. Finance, as one of the effective forms of resource allocation, plays an important role in economic development. The so-called finance refers to the economic activities in which market players utilize financial instruments to flow funds from the surplus side to the scarce side. Finance is an indispensable part of people's production and life, and can affect the present and future of a country.

Since the reform and opening up of China, Guangdong Province has experienced rapid economic development and has never fallen off the top spot in terms of GDP since 1989. In 2021, Guangdong's GDP will be 1.244 billion yuan, ranking first in the country, with a growth rate of 8.0%, exceeding the total of the last ten provinces in China's GDP, and its fiscal revenue will be the highest. In 2024, Guangdong's GDP accumulated to 9.99 trillion yuan, still ranking first in the country, with a growth rate of 4.8%. Guangdong is a representative province of uncoordinated regional development, and is currently accelerating the construction of a new development pattern of "one core, one region and one belt", trying to crack the bottleneck of unbalanced and insufficient development in order to realize coordinated regional economic growth. However, in recent years, the industrial structure of Guangdong Province is not enough to transform the kinetic energy, and the economic development has gradually encountered a bottleneck, so it is urgent to clarify the impact of the development of financial industry on economic growth in Guangdong Province. This paper proposes targeted countermeasures through the study of the financial industry in Guangdong Province to provide reference for the relevant departments, governmental decision-making and economic development of other regions.

## 2. Literature Review and Commentary

From the point of view of the three world cities of London, New York and Tokyo, these cities have become world financial centers as a result of the continuous concentration of the financial industry in their course of development. At the same time, the financial centers of these cities also promote the growth of regional economy to a large extent. In this context, a lot of discussions have been carried out internationally on the reasons for this phenomenon, its functioning mechanism and its macroeconomic effects. At the same time, with the acceleration of China's economic transition process, Shanghai, Beijing, Shenzhen and other developed metropolises also appeared in the trend of financial industry agglomeration. In recent years, China's academic circles have paid great attention to this problem,

and have drawn on international research results on this issue, on the basis of which they have carried out in-depth discussions on this issue. On the study of financial agglomeration on economic growth, scholars at home and abroad have never stopped their pace of exploration. For example, Powell (1915) put forward the concept of financial agglomeration for the first time in *The Evolution of the Money Market*, believing that the agglomeration effect of the financial industry is similar to “natural selection” in biology, “Survival of the fittest”. Thereafter. Since then, a number of scholars have conducted a great deal of theoretical and empirical research on the functions and role of finance, such as Gurley and Shaw (1955), who believe that the center of economic activity is the financial market. The quality and quantity of financial services can be a factor that partly explains the rate of economic growth. According to them, the quantity and quality of financial services can be a factor that partly explains the rate of economic growth. At the same time, the role of finance has been recognized through some scholars’ analyses of financial structure, financial repression, financial deepening and financial liberalization, and at the same time, people have begun to explore in depth the path of financial development. In particular, Goldsmith’s (1969) international analysis, which showed that the size of a country’s financial system and its economic growth were closely linked, served as the basis for empirical analysis of financial development and economic growth. After that, most scholars focused on the relationship between financial development and economic growth. After that, most scholars focus on the relationship between financial development and economic growth. For example, Ding et al. (2009) utilized the value of location entropy to conduct an empirical study on the spatial distribution of finance in China in three dimensions: banking, securities and insurance, and the results show that the spatial distribution of finance in China presents significant regional differences, and the degree of financial agglomeration in the eastern part of the country is higher than that in the central and western parts of the country. Secondly, using the location entropy value of some provinces from 2003 to 2007, the impact of financial agglomeration on regional economic development was empirically analyzed, and the results show that financial agglomeration has a significant pull effect on regional economic development, and the elasticity coefficients of banks on regional economic development are significantly higher than those of the securities agglomeration and the insurance agglomeration and their elasticity coefficients have been significantly increased, and that financial agglomeration has a significant impact on regional economic development, and that financial agglomeration in the eastern part of the country is more important than that of the central and western parts of China. Pang (2017) chose the sample data of six provinces concerned in 2004-2014, established a dynamic panel regression model, and used the estimation method of system GMM to empirically analyze these regions, and came to the conclusion that there are a lot of financial resources and other information resources are clustered together in these regions, and this phenomenon strengthens the efficient allocation of investment and financing in the financial system, which

in turn obviously promotes the rational and high-end optimization and adjustment of industrial structure. After that, the research on financial aggregation and economic growth has turned to the spatial effect of the region, especially [Li et al. \(2018\)](#) and others have analyzed the spatial spillover effect of financial aggregation in the Beijing-Tianjin-Hebei region by using the partial differential method in spatial regression, and the results show that, in the Beijing-Tianjin-Hebei region, the improvement of the level of financial aggregation can obviously drive the economic development of the surrounding areas, and this effect is more important than that on the local more obviously. However, some scholars have argued that financial agglomeration does not simply promote economic growth. However, some scholars believe that financial agglomeration does not simply promote economic growth. [Zhao \(2016\)](#) studied the relationship between financial agglomeration and economic growth by constructing nonlinear models such as the panel threshold model, and the results show that this effect is nonlinear and the quadratic coefficient is negative, indicating that the path of financial agglomeration affecting economic development is to promote first and then inhibit. The study of financial agglomeration on the development of high quality economy in Shanghai. And [Li et al. \(2019\)](#), taking Shanghai as an example, empirically researched the long-term dynamic impact of financial agglomeration on the high-quality development of the economy and the problem of intermediary path by constructing a state space model and intermediary effect method on the basis of measuring the data of high-quality development of the economy, and came to the conclusion that the change of financial agglomeration has a negative impact on the high-quality development of the economy in the short term, and the long-term is dominated by the positive effect, which is the main conclusion. Nowadays, some scholars have started to study the impact of financial agglomeration on real economy. Nowadays, some scholars have begun the study of financial agglomeration on real economy, such as [Zhang et al. \(2022\)](#) and others have analyzed the mechanism of financial agglomeration on the development of real economy of the Yangtze River Delta city cluster by using the mediation effect test model, and concluded that there is a significant inverted “U” type relationship between financial agglomeration and real economic development of the Yangtze River Delta city cluster, and the level of science and technology innovation and regional financial development have significant mediation effect. It is concluded that there is a significant inverted “U” relationship between financial agglomeration and real economic development in the Yangtze River Delta city cluster, and the level of science and technology innovation and regional financial development has a significant intermediary effect. [Cai \(2023\)](#) took 279 regions in China as survey samples in 2016-2021, and used OLS regression model, static spatial panel model and dynamic spatial panel model to study the impact of financial industry agglomeration on the capital allocation of the real economy, and through the study, we came to the conclusion that the financial industry agglomeration has a positive impact on the capital allocation of the real economy, and that the level of openness, the level of government

intervention, the level of science and innovation, the level of human capital, the level of urbanization, the level of informationization, etc. have different degrees of impact on the allocation of real economy capital.

On the basis of combing and comparing the relevant literature at home and abroad, it is found that the current research on financial agglomeration at home and abroad mainly includes the elaboration of the concept of financial agglomeration, the measurement of the degree of financial agglomeration, the role of financial agglomeration on the industrial structure; from a variety of perspectives, it also includes the link between financial agglomeration and economic growth as well as the impact of financial agglomeration on the real economy, etc. From this, we can see that the academic circle has very rich theoretical achievements. In terms of research methodology, most scholars firstly adopt location entropy index to measure the overall degree of financial agglomeration in a region, but some researchers begin to incorporate spatial elements into it and form different matrix structures when constructing the spatial weight matrix. As far as the research theme is concerned, most of the literature focuses on examining the role of financial agglomeration in some developed regions on their regional economic development, while few scholars analyze it as an independent perspective in the whole Guangdong Province, for example. Therefore, this paper selects the relevant data of Guangdong in the past ten years, gives a systematic overview of the development history of financial agglomeration and Guangdong's economic growth, and analyzes the relationship between each variable and Guangdong's economic growth by constructing regression models, conducting smoothness tests and robustness tests, and then analyzes the relationship between each variable and Guangdong's economic growth. Then we analyze the relationship between each variable factor and Guangdong's economic growth, thus reflecting the influence of financial agglomeration on the development of Guangdong's existing situation over time, and finally drawing conclusions and providing useful suggestions for Guangdong's economic development.

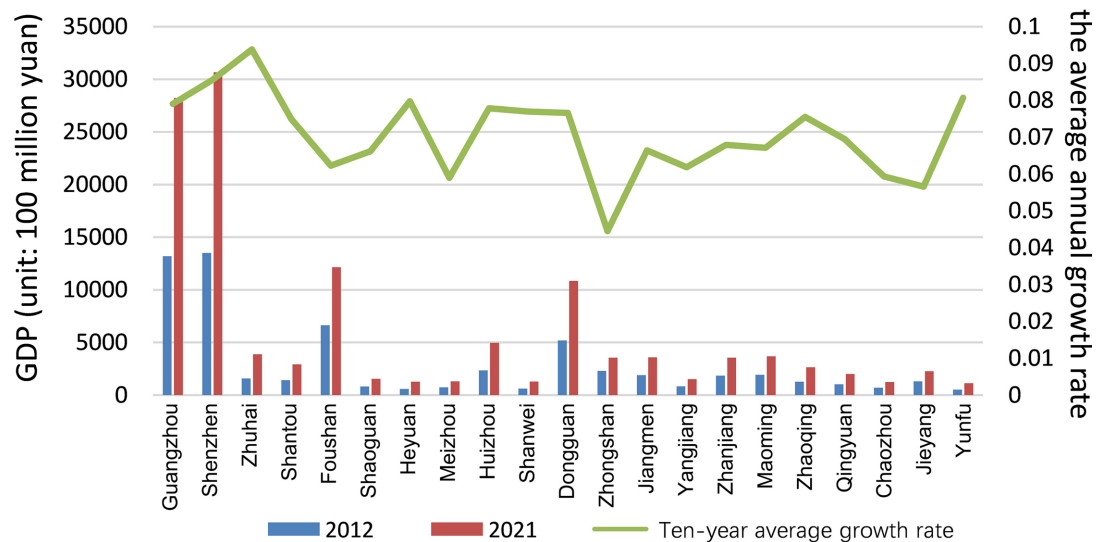
### **3. The Evolution of Development in Guangdong**

#### **3.1. The Evolution of Economic Development in Guangdong**

##### **3.1.1. Overview of Economic Growth in Guangdong**

After the reform and opening up, Guangdong has become the front line of reform and opening up and the window for introducing western economy, culture, science and technology, since 1989, Guangdong Province has continuously ranked the first in the country in terms of GDP, and has become the first economic province of China, with the total economic output accounting for 1/8 of the country. as the front line of China's reform and opening up, Guangdong has been supported by the national strategy at the turning point of the history at the end of the past century, and has been ushering in the high-speed development, whether it is new industries such as real estate, internet, finance, or many mega enterprises have settled here. Whether it is real estate, internet, finance and other new

industries, or many mega enterprises have settled here. Excerpt from China News Service, during the past ten years, Guangdong's GDP has increased from 5.7 trillion yuan to 12.4 trillion yuan, and the total economic output has ranked first in China for 33 consecutive years. This paper examines the economic growth of the region through the GDP level of each city in Guangdong from 2012 to 2021, see **Figure 1**.



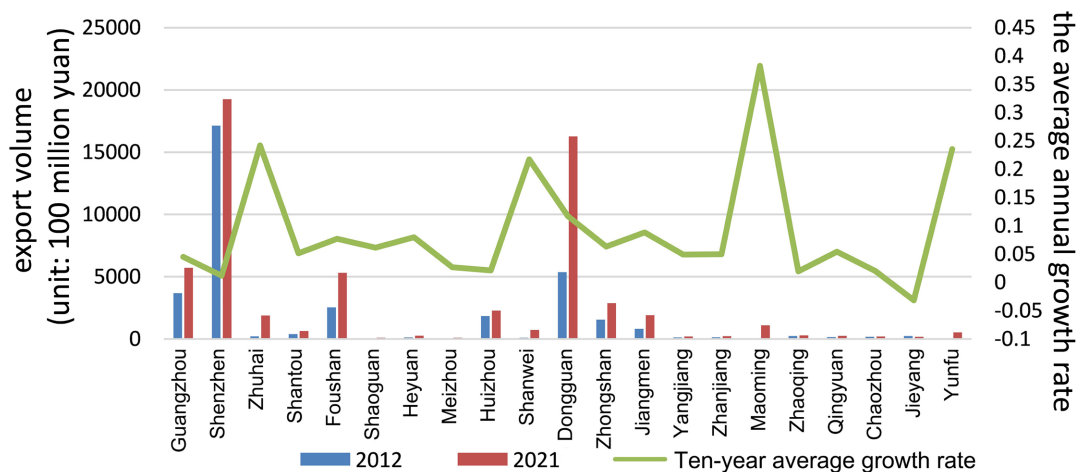
**Figure 1.** The relationship between the amount of change in economic growth in Guangdong cities over 10 years. Source: Statistical Yearbook of Guangdong Municipalities, 2012-2021.

As shown in **Figure 1**, during the ten-year period, the total value of economic growth was topped by Shenzhen, with a total of more than 3 trillion yuan, followed by Guangzhou, with a total of more than 2 trillion yuan. The GDP growth rate of Guangdong in the past ten years is in the middle to upper level in the whole country. In addition, the GDP of Guangdong cities has increased almost every year in the past ten years, and the growth rate is getting bigger and bigger compared with the same period of the previous year. Shenzhen's GDP level in 2021 is as high as 3066.485 billion yuan, and Guangzhou's GDP reaches 2823.197 billion yuan, which shows that cities with a high level of development are also relatively strong economically. From the average growth rate in the past ten years, Guangzhou and Shenzhen's growth rate is the fastest, compared to 2012, this decade, Guangzhou and Shenzhen's economic development have made great progress. In contrast, Shaoguan, Heyuan, Meizhou, Shanwei, Yangjiang, Zhaoqing, Qingyuan, Chaozhou, Jieyang, Yunfu, can be seen that their economic development in the future development still need to be greatly improved. In terms of economic development trend, the economic growth of the 21 cities in Guangdong has shown an obvious incremental trend during the ten-year period, and there are some differences in the total economic volume between different cities. From the level of growth rate, the average annual growth rate of cities with large economic scale is also higher, which shows that the city's economic development speed is fast, on the contrary,

the city with low average annual growth rate still has a lot of room to improve its economic development speed. It is believed that the development trend of Guangdong cities will be more stable in the future, gradually reducing the imbalance of development between regions.

### 3.1.2. Over of the Degree of Openness in Guangdong

There are many indicators to measure the degree of openness of a region, and this paper replaces the comparative relationship between the degree of openness and economic growth of Guangdong by the indicator of total exports, and obtains **Figure 2**.



**Figure 2.** The relationship between openness and economic growth in Guangdong cities over a 10-year period. Source: Statistical Yearbook of Guangdong Municipalities, 2012-2021.

As shown in **Figure 2**, the 10-year average growth rate of most cities is positive. However, compared with the advanced countries in the world, China's development is very unbalanced, for example, the degree of opening up of the financial industry in some regions of Guangdong is relatively poor, and there is no efficient mutual communication and service platform between different regions, nor is there a resource that can be shared and utilized. Here are some specific examples: 1) Uneven distribution of financial resources: As an economically developed area, the Pearl River Delta region has relatively abundant financial resources, whereas regions such as Eastern, Western, and Northern Guangdong are relatively lacking. This uneven distribution leads to difficulties in forming efficient communication and cooperation mechanisms between financial institutions in different areas. 2) Homogenization of financial products and services: Within Guangdong Province, financial institutions in different regions offer financial products and services that are homogenized. This homogenization results in intensified competition among financial institutions, while cooperation and resource sharing are relatively scarce. Therefore, the relevant departments in Guangdong need to make rational planning for the major cities in Guangdong; the major cities in Guangdong should also make joint efforts to establish a platform for sharing financial information,

so as to concentrate the potential capitals of the neighboring regions in the cities in Guangdong, thus reducing the unbalanced gathering of finances; at the same time, it is also necessary to promote the aggregation of the financial industry and gradually enhance its contribution to the economic growth of the local region.

### 3.2. The Current Situation of Financial Industry Agglomeration in Guangdong

Location entropy, as an important factor to measure the degree of industrial agglomeration in a region, has been frequently adopted in most scholars' studies. To this end, the current situation of financial industry agglomeration in Guangdong can be analyzed through time and geospatial dimensions. By fully recognizing the characteristics of financial agglomeration in time and geospatial dimension, and by analyzing its temporal and spatial characteristics, the phenomenon of financial agglomeration in Guangdong can be better understood, so as to provide reference for the economic development of Guangdong (Table 1).

**Table 1.** Entropy table of financial industry location in Guangdong cities in 10 years.

locational entropy	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Guangzhou	1.12	1.05	1.23	1.15	1.22	1.23	1.19	1.15	1.01	0.98
Shenzhen	1.99	1.86	1.93	1.76	1.82	1.7	1.67	1.65	1.69	1.74
Zhuhai	0.96	1	1.05	1.08	1.19	1.19	1.24	1.22	1.31	1.38
Shantou	0.23	0.34	0.37	0.45	0.48	0.49	0.53	0.57	0.58	0.63
Foshan	0.58	0.54	0.64	0.51	0.51	0.54	0.55	0.57	0.57	0.58
Shaoguan	0.53	0.59	0.65	0.61	0.62	0.59	0.58	0.57	0.57	0.55
Heyuan	0.67	0.64	0.72	0.7	0.7	0.63	0.78	0.78	0.71	0.67
Meizhou	0.2	0.21	0.24	0.23	0.23	0.24	0.26	0.26	0.25	0.25
Huizhou	0.46	0.46	0.49	0.48	0.57	0.63	0.67	0.7	0.66	0.65
Shanwei	0.37	0.39	0.44	0.36	0.38	0.49	0.49	0.52	0.55	0.52
Dongguan	0.83	0.8	0.82	0.71	0.73	0.68	0.69	0.75	0.72	0.72
Nakayama	0.41	0.39	0.45	0.46	0.51	0.49	0.52	0.54	0.54	0.58
Jiangmen	0.56	0.55	0.77	0.68	0.65	0.62	0.61	0.84	0.84	0.81
Yangjiang	0.5	0.42	0.44	0.41	0.46	0.49	0.53	0.54	0.53	0.52
Zhanjiang	0.43	0.36	0.35	0.39	0.39	0.4	0.58	0.6	0.57	0.54
Maoming	0.23	0.28	0.3	0.34	0.37	0.39	0.42	0.46	0.48	0.53
Zhaoqing	0.21	0.19	0.2	0.22	0.22	0.23	0.23	0.23	0.22	0.2
Qingyuan	0.45	0.44	0.61	0.59	0.58	0.59	0.87	0.84	0.74	0.7
Chaozhou	0.62	0.57	0.55	0.54	0.53	0.56	0.54	0.52	0.53	0.52
Jieyang	0.23	0.23	0.26	0.26	0.28	0.38	0.4	0.34	0.36	0.36
Yunfu	0.64	0.68	0.72	0.61	0.59	0.56	0.57	0.57	0.52	0.52

Source of data: Guangdong Statistical Yearbook 2012-2021 after calculation.

As shown in the figure, the location entropy values of Guangzhou, Shenzhen and Zhuhai are basically more than 1 in each year, among which Guangzhou and Shenzhen have the highest location entropy values, and the location entropy values of each city as a whole show the trend of increasing year by year. The location entropy of Guangzhou is from 1.12 in 2012 to 0.98 in 2021, and that of Shenzhen is from 1.99 in 2012 to 1.74 in 2021, reflecting that with the passage of time, the degree of financial agglomeration in Guangzhou and Shenzhen has been stabilized at a high degree of agglomeration. In contrast, the entropy value of the financial industry in other cities is low, indicating that the level of financial industry agglomeration is not high enough. From the perspective of location, some areas in Guangdong are near the sea and some are inland, which shows that the transportation modes in the sea areas are more diversified than those in the land areas, and at the same time, the location entropy is also higher, such as Shenzhen and Guangzhou, and because of the rail transportation in the sea areas, the proximity to the ports, and the convenience of personnel mobility, so all of these factors contribute to the agglomeration of the financial industry in these areas, and thus promote the economic development of the cities.

## 4. An Empirical Analysis of Financial Sector Agglomeration on Regional Economic Growth in Guangdong

### 4.1. Model Setting and Variable Selection

#### 4.1.1. Model Setting

There are two main methods to examine the impact of financial agglomeration on regional economic growth: one is to use econometric methods to estimate the productivity of the financial industry or a certain enterprise, and then observe the relationship between the data obtained and the relevant variables selected in this paper; the other is to directly use the Cobb-Douglas production function to illustrate the impact of the relevant economic variables on productivity. The first method, due to the choice of a different calculation method, will produce a large error, which will cause a bias in the calculation results. Although the latter method is not absolutely correct, the formula of Cobb-Douglas production function, combined with the existing information, can well overcome the errors brought by the former method. Therefore, in order to explore the relationship between the level of financial agglomeration and regional economic growth, this paper starts from the Cobb-Douglas production function and sets the regional production function as follows.

$$Y_{it} = K_{it}^{\alpha} L_{it}^{\beta} Z_{it}^{\gamma} \text{ and } \alpha + \beta + \gamma = 1 \quad (1)$$

Among them,  $Y_{it}$  denotes the GDP of each region,  $K_{it}$  denotes the scientific and technological progress of each region,  $L_{it}$  denotes labor input by region, and  $Z_{it}$  denotes capital inputs by region.  $\alpha$  and  $\beta$  The Cobb-Douglas production function represents the output elasticity of labor and capital in each region. Through the Cobb-Douglas production function, the role of factors such as

technological progress, labor and capital on the economic development of Guangdong can be measured, which in turn can better reflect the important role it plays in promoting the actual economic development. Considering the fact that there are several factors with higher correlation that affect the degree of financial agglomeration in Guangdong, we add the variable of degree of openness to the outside world in Equation (2)  $SC_{it}$  and financial agglomeration variables  $QW_{it}$  STI variables  $KX_{it}$  human capital variables  $ST_{it}$ ,  $\gamma, \theta, \delta, \mu$  The output elasticity of each of the new variables is expressed separately, and the following function is obtained.

$$Y_{it} = a + \alpha L_{it} + \beta Z_{it} + \gamma SC_{it} + \theta QW_{it} + \delta KX_{it} + \mu ST_{it} \quad (2)$$

By taking logarithmic treatment on both sides of Equation (3), the conclusion of the study can be made more significant, and finally the following expression is obtained.

$$\ln Y_{it} = a + \alpha \ln L_{it} + \beta \ln Z_{it} + \gamma \ln SC_{it} + \theta \ln QW_{it} + \delta \ln KX_{it} + \mu \ln ST_{it} \quad (3)$$

Because, when collecting specific data on the influential factors under study, this paper uses the current searchable factors with high correlation to replace them. The location entropy, as a relatively special variable, requires data processing and arithmetic, so only six variables,  $Y, L, Z, SC, KX, ST$ , are logarithmically processed to establish the empirical regression model of panel data. In addition, in order to make the analytical conclusions of the experiment more reliable, we also carry out the smoothness test and cointegration analysis for each variable factor. Finally, the semi-log panel econometric model is set up as follows.

$$\ln Gdp_{it} = a + \alpha \ln Edu_{it} + \beta \ln TZ_{it} + \gamma \ln SC_{it} + \theta \ln QW_{it} + \delta \ln KX_{it} + \mu \ln ST_{it} + \varepsilon_{it} \quad (4)$$

Among them,  $Gdp_{it}$ ,  $Edu_{it}$ ,  $TZ_{it}$ ,  $SC_{it}$ ,  $QW_{it}$ ,  $KX_{it}$ ,  $ST_{it}$  denote the proxies for each variable of economic growth, labor input, capital input, openness to the outside world, financial agglomeration, scientific and technological innovation, and human capital, respectively.  $i$  denotes a specific city in Guangdong, and  $t$  denotes the time year.  $\alpha, \beta, \gamma, \theta, \delta, \mu$  are the effect values of each variable of labor input, capital input, openness to the outside world, financial agglomeration, scientific and technological innovation, and human capital on the regional economic growth of Guangdong, respectively.  $a$  and  $\varepsilon_{it}$  denote the intercept term and the random perturbation term, respectively.

#### 4.1.2. Variable Selection and Data Description

The selection of relevant variables in this study mainly includes seven variables such as real economic growth, labor input, capital input, degree of openness to the outside world, degree of financial agglomeration, scientific and technological innovation, and human capital.

Economic growth variables. Regional GDP is an indicator that can fully reflect the comprehensive economic strength of a country or a region, and nowadays, the use of GDP to measure the economic growth of a region has been familiarized long ago. Therefore, this paper adopts the GDP of 21 prefecture-level cities in

Guangdong Province as the explanatory variable, and logarithmizes it to get  $\ln Gdp$ .

Labor input variables. As a direct source of productivity, labor force plays an indispensable role in promoting the economic development of Guangdong. At the same time, Guangdong is a top-ranked region in China, therefore, Guangdong attracts a large number of manpower to be employed in Guangdong, so this paper adopts the total annual employment population of Guangdong cities as a measure of labor input in China, using the  $Edu_{it}$  indicated.

Capital investment variables. Nowadays, there are a lot of studies on fixed investment and economic growth in the literature, and many authors of the literature also take fixed asset investment as an important factor to promote economic development, and this paper believes that it may have a relatively good degree of contribution, therefore, this paper selects the fixed asset investment in each city of Guangdong Province as a relevant measurement index, which is measured by  $Tz_{it}$  indicated.

Openness to the outside world variable. Openness to the outside world is realized through trade and investment, it should be emphasized that trade and investment and finance are inseparable, Guangdong relies on its location advantage to export a large amount of goods to the outside world, which improves the contribution of the degree of openness to the outside world to the total economy of Guangdong. This paper refers to the literature of [Li and Liu \(2017\)](#) to measure the level of Guangdong's openness to the outside world by the value of regional merchandise exports, which is measured by  $SC_{it}$  said.

Financial agglomeration variables. The economic development of Guangdong Province will be affected by various effects and channels of financial industry agglomeration, such as spillover effect, external effect, scale effect, radiation effect, etc., and due to the fact that each city within Guangdong is located in a different location, the distribution of resources is relatively unbalanced, resulting in a large economic disparity between the cities, and the location entropy can intuitively reflect the situation of the financial industry agglomeration in each city, so this paper refers to [Lu \(2022\)](#) to take the location entropy of 21 prefecture-level cities in Guangdong Province as a measure of the concentration of the financial industry in each prefecture-level city, as an explanatory variable of the model, the indicator is used, the  $QW_{it}$  said.

Science and technology innovation variables. There is a close relationship between scientific and technological innovation and capital investment, and the financial innovation required by the financial support and the aggregation of financial institutions is inextricably linked, at the same time, scientific and technological innovation for the development of financial institutions to provide a guarantee of modern information technology, but also due to the large changes in the annual investment in scientific research and technology in Guangdong, so this paper refers to the literature of [Yin and Luo \(2023\)](#) to use the science and technology expenditures to measure the Guangdong's degree of scientific and technological

innovation, which is measured by  $KX_{it}$  said.

Human capital variables. Among the many factors affecting economic growth, human resources also play a crucial role. By organizing and analyzing the referenced literature, it can be seen that when the degree of financial agglomeration of a region is getting higher and higher, the siphoning effect on high-level financial talents will also get stronger and stronger. Because of the rapid movement of population and rational allocation of resources in Guangdong, most college graduates and other high-quality professional talents will choose to develop in Guangdong. Therefore, this paper refers to the reference of Li Kang, Du Jiang (2022) to adopt the regional number of college students in school to measure human capital, which is used by  $ST_{it}$  said.

On this basis, the interactions between financial agglomeration and economic development in Guangdong are empirically analyzed by using the China Statistical Yearbook 2011-2022 and the Guangdong Statistical Yearbook 2011-2022 and the statistical yearbooks at the prefecture and municipal levels of Guangdong, and by taking into account the scientific research, foreign trade and finance of the cities in Guangdong. After collecting and organizing the data, the data are statistically analyzed and the relevant conclusions are drawn. It should be noted that, due to the large number of cities, the data of individual cities (e.g. Yunfu) are incomplete, and for the sake of the research needs, appropriate processing has been carried out, mainly by referring to the data of other indicators, and making up through the moving smoothing method.

**Table 2** descriptive statistics for the corresponding variables are given based on the relevant data found.

**Table 2.** Descriptive statistics of the seven variable indicators.

variables	Sample	Mean	standard deviation	Min	Max
lnGdp	210	7.783	0.973	6.262	10.331
QW	210	0.629	0.356	0.19	1.99
lnEdu	210	5.501	0.677	4.598	7.163
lnTZ	210	16.323	0.754	14.52	18.258
lnSC	210	6.38	1.554	3.761	9.866
lnKX	210	11.509	1.71	7.162	16.638
lnST	210	10.549	1.286	7.834	14.161

Source: Calculated from the Guangdong Statistical Yearbook 2010-2020.

**Table 2** reports descriptive statistics for the regression sample, which includes the sample, mean, standard deviation, minimum and maximum values. The reported results indicate that the indicators of gross municipal product used in the sample of this paper have a certain degree of volatility and can be analyzed in a regression.

## 4.2. Empirical Analysis of Financial Agglomeration on Economic Growth in Guangdong

### 4.2.1. Smoothness Test

Before modeling and analyzing the panel data, it is necessary to satisfy the condition that the series is in a smooth state. In order to test the smoothness of the seven influencing factors related to Guangdong's economic growth selected in the previous section, this paper has conducted the HT test for the variables lnGdp, QW, lnEdu, lnTZ, lnSC, lnKX, lnST, and the results are shown in **Table 3**.

**Table 3.** Stability tests.

variables	Statistic	<i>z</i>	<i>P</i>	whether or not it is smooth
lnGdp	0.4667	1.1768	0.8804	no
QW	0.2490	-1.6171	0.0529	no
lnEdu	0.5141	1.7851	0.9629	no
lnTZ	0.5292	1.9787	0.9761	no
lnSC	0.3824	0.0955	0.5380	no
lnKX	0.3914	0.2110	0.5835	no
lnST	0.6929	4.0788	1.000	no
$\Delta$ lnGdp	0.1293	-8.6677	0.000	yes
$\Delta$ QW	-0.0296	-4.1564	0.000	yes
$\Delta$ lnEdu	-0.0169	-10.8870	0.000	yes
$\Delta$ lnTZ	0.1882	-7.7729	0.000	yes
$\Delta$ lnSC	0.0878	-2.7530	0.003	yes
$\Delta$ lnKX	-0.0513	-4.4154	0.000	yes
$\Delta$ lnST	0.2146	-7.3712	0.000	yes

Among them, according to the requirement that the *P*-value of the smoothness test should be lower than 0.005 to be smooth, the seven variables selected in this paper, including lnGdp, QW, lnEdu, lnTz, lnSC, lnKX, lnST, whose corresponding *P*-values are greater than 0.005, accept the original hypothesis, which indicates that the original series of the seven variables are not smooth series. In order to further verify the smoothness of each variable, first-order differencing is carried out in this paper. It is found that the *P*-values of lnGdp, QW, lnEdu, lnTZ, lnSC, lnKX, lnST are all less than 0.005, so the original hypothesis is rejected, and the first-order differencing of the factors of the variables is a smooth series through the smoothness test.

From the test results, it can be seen that the series of the seven relevant variables selected in this paper are all first-order smooth series, which provides higher feasibility for the study of this paper, for which regression models can be established to study the relationship between them.

#### 4.2.2. Analysis of Empirical Results

In order to analyze the impact of financial agglomeration on economic growth in Guangdong, this paper takes the degree of financial industry agglomeration as the core variable, and uses labor input, capital input, degree of opening up to the outside world, scientific and technological innovation and human capital as the control variables, and statistically analyzes the selected relevant variables by establishing a regression model, and the regression results are shown in **Table 4**.

As shown in **Table 4**, in model (2), without considering other control variables, it can be concluded that on average, every 1 percentage point increase in the level of financial agglomeration can promote Guangdong's economic development by 1 percentage point, and it can be seen that financial agglomeration has an important positive impact on promoting Guangdong's economic development.

In model (3)-(6), labor input, capital input, degree of openness to the outside world, scientific and technological innovation, human capital and other influencing factors are added gradually. Finally, through the model (6), it is concluded that the explanatory variables are all significant at the 5% significant level, so the regression model can be written as follows.

$$\ln Y = -0.995 + 0.21QW + 0.538 \ln Edu + 0.323 \ln TZ + 0.0862 \ln SC + 0.0681 \ln KX + 0.103 \ln ST + \mu \quad (5)$$

**Table 4.** Model regression results.

variables	(1)	(2)	(3)	(4)	(5)	(6)
QW	1.094*** (6.46)	0.786*** (6.16)	0.402*** (4.37)	0.277** (3.21)	0.209** (2.66)	0.210** (2.84)
lnEdu		1.064*** (13.16)	0.694*** (11.10)	0.619*** (10.62)	0.602*** (11.66)	0.538*** (10.69)
lnTz			0.478*** (16.83)	0.422*** (15.14)	0.349*** (11.80)	0.323*** (11.30)
lnSC				0.111*** (6.00)	0.0960*** (5.48)	0.0862*** (5.17)
lnKX					0.0766*** (5.32)	0.0681*** (4.96)
lnST						0.103*** (4.93)
_cons	7.094*** (35.98)	1.433*** (3.38)	-4.083*** (-8.86)	-3.391*** (-7.73)	-2.857*** (-6.86)	-2.995*** (-7.62)
N	210	210	210	210	210	210

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ ; values in parentheses are standard errors of the coefficients.

**Table 4** reports the results of the benchmark regression. The first column reports the univariate regression results of location entropy on GDP, and the

regression coefficient of location entropy is 1.094 and significant at the 1% level ( $\beta = 1.094$ ,  $t = 6.46$ ); the second column reports the univariate regression results after the two-way fixed effects of city and year, and the regression coefficient of location entropy is 0.786 and significant at the 1% level ( $\beta = 0.786$ ,  $t = 6.16$ ); the third to sixth columns gradually add labor input, capital input, openness, science and technology innovation, and human capital influences. The third to sixth columns gradually add labor input, capital input, degree of openness, scientific and technological innovation, human capital influencing factors. The regression shows that the financial agglomeration effect enhances the growth of Guangdong economy. From the perspective of economic meaning, the regression result in the sixth column shows that when there is financial agglomeration, Guangdong's economic growth increases by 0.21 in the average sense, which is equivalent to about 37% of the mean value of GDP; from the perspective of control variables, other variables also favor Guangdong's economic growth.

On this basis, regression analysis reveals that financial agglomeration has a promoting effect on Guangdong's economic growth. Every 1 percentage point increase in financial agglomeration can promote Guangdong's economic growth by 1.09 percentage points, which shows that the increase in the degree of financial agglomeration can effectively promote the high-quality development of Guangdong's economy, but there is still a lot of room for improvement. Through studying the relationship between control variables and regional economic growth, it is concluded that labor input, fixed asset investment, degree of opening up to the outside world, scientific and technological innovation and the number of university students play a certain role in promoting the development of Guangdong's economy, as follows.

First, labor input has a significant effect on Guangdong's economic development, with every 1 percentage point increase in labor input increasing economic growth by 0.538 percentage points. This suggests that in Guangdong, the growth of human capital can better utilize the advantage of "siphoning", thus enhancing the competitiveness of the regional financial market and, to some extent, promoting the development of Guangdong Province.

Secondly, the effect of fixed asset investment on Guangdong's economic growth is significantly positive, with every 1% increase in capital investment increasing economic growth by 0.323 percentage points. This shows that, compared with several other variables, the pulling effect of fixed asset investment on our country is relatively small, but it also shows a certain positive effect. At the same time, it also shows that the more capital investment, the more investors will be attracted, this phenomenon is a kind of benign cycle.

Thirdly, the impact of the degree of openness to the outside world on the economy also shows a positive influence, for every 1 percentage point increase in the value of exports of goods, it can lead to an increase in economic growth of 0.0862 percentage points. This shows that there is a significant positive correlation between the value of goods exports and the level of financial agglomeration, and the

higher the degree of positive correlation, the greater the promotion effect on Guangdong's economic development.

Fourthly, every 1% increase in investment in science and technology innovation will raise the economic growth by 0.0681 percentage points, which shows that Guangdong's support in science and technology innovation is still very small, which requires Guangdong's regions to continuously improve the capacity of science and technology innovation, cultivate more scientific and technological innovation talents, and at the same time, continuously encourage science and technology-related industries to take the road of refinement and depth.

Fifthly, an increase of 1 per cent in the number of university students will boost economic growth by 0.103 percentage points. This shows that the effect of high-quality human resources on Guangdong's economic growth is not yet obvious, and it is necessary to further explore and expand its influence on economic growth in the subsequent development. However, combining with the data of location entropy itself, we can still see that the promotion effect of western and northern Guangdong is relatively small, mainly because the southeastern region, especially the labor force represented by the Pearl River Delta, has higher quality and standard, which can better promote the economic growth of the region; while the western and northern regions of Guangdong are relatively backward in terms of economic development, some laborers who originally had a high level of skills continue to influx to developed regions, so that the western and northern regions of Guangdong are not yet able to promote the economic growth of the region, and thus, they have to be further explored to expand their influence on economic growth. At the same time, some laborers with high skill level keep moving to some developed areas, so the remaining laborers in western and northern Guangdong are those with lower education level and skill quality, which will have less and less effect on the local economy.

#### 4.2.3. Robustness Tests

The financial industry correlation rate refers to the ratio of the scale of financial industry to the GDP of a region, which is an important indicator reflecting the degree of financial industry agglomeration. Therefore, in order to test whether the above regression results are robust, this paper measures the level of financial industry agglomeration in Guangdong by measuring the financial correlation rate, and then analyzes the promotional effect of this indicator on economic growth, so it carries out a step-by-step regression analysis, and the results are shown in **Table 5**.

As shown in **Table 5**, at the 1% significant level, every 1% increase in the financial correlation rate has an effect of 0.115 percentage points on the degree of financial agglomeration in Guangdong, which indicates that financial agglomeration has a positive impact on the economic development of Guangdong, and cities with high financial correlation rate have a larger scale of the financial industry and the total economic volume accordingly, which further promotes the development of the Guangdong economy. Generally speaking, the results of this regression

analysis are in line with the prediction of the previous article, so the conclusion of the study is somewhat robust.

**Table 5.** Estimated results of the stepwise regression of the model.

variables	(1)	(2)	(3)	(4)	(5)	(6)
QW	0.484*** (17.38)	0.415*** (13.31)	0.205*** (6.88)	0.185*** (6.82)	0.140*** (5.16)	0.115*** (4.33)
lnEdu		0.759*** (9.17)	0.603*** (9.05)	0.542*** (9.03)	0.568*** (10.72)	0.526*** (10.15)
lnTz			0.382*** (12.12)	0.328*** (10.96)	0.297*** (9.73)	0.286*** (9.68)
lnSC				0.112*** (6.61)	0.101*** (6.13)	0.0932*** (5.79)
lnKX					0.0579*** (3.97)	0.0547*** (3.89)
lnST						0.0867*** (3.99)
_cons	6.575*** (38.57)	2.571*** (5.92)	-2.277*** (-4.22)	-1.732*** (-3.50)	-1.848*** (-4.03)	-2.209*** (-4.95)
N	210	210	210	210	210	210

### 4.3. Conclusion

In this paper, the panel data model of financial industry in Guangdong Province from 2012 to 2021 is used for empirical analysis. The model shows that the scale effect and other benign effects of financial industry agglomeration in Guangdong Province are helpful to economic growth, but undeniably there is also a certain degree of counterproductive, hindering the economic development of some areas, such as not regulated in a relatively long period of time did not lead to the development of backward areas, resulting in backward areas can not keep up with the economic development. From the above experimental analysis, combined with the reality of economic growth and financial development in Guangdong Province, the following issues are summarized.

First, on the whole, the economy and financial industry of Guangdong Province have shown rapid development, but there are great differences in the development of economy and financial industry among different cities. Compared with the whole country, Guangdong's GDP is among the highest in the country, and the growth rate is also one of the best in the country, but the growth rate is beginning to slow down. The development of Guangdong's financial industry and certain sectors has exceeded the national average, but its financing channels are mostly limited to the Pearl River Delta (PRD) region, and there are great differences in financing channels between regions. The Pearl River Delta region and the western

and northern parts of Guangdong Province are under the control of financial policies, and funds will always flow into those places where they can gain the greatest benefits, so this has resulted in an obvious funding gap between western and northern Guangdong Province and the Pearl River Delta. In western and northern Guangdong, the irrational movement of financial personnel has hindered inter-regional development and made the development differences between regions more obvious. At the same time, the imbalance in the balance of deposits and loans in western and northern Guangdong has somewhat constrained the transformation of financial assets into social investment in western and northern Guangdong.

Secondly, the empirical study of the model reveals that the indicators of financial aggregation and various indicators in Guangdong Province show a relatively consistent growth trend and a relatively stable development trend at a higher level. From the comparative analysis of the impact effect, it is under the difference between the Pearl River Delta region and the western and northern regions of Guangdong, the integration of the financial industry in Guangdong Province and the direct promotion of regional economic development can be realized, so the government departments should promote the integration of the financial industry of the reality of the economy, to give full play to the effect of economies of scale, to accelerate the development of the various regions of Guangdong Province, the ratio of the input of material resources and manpower in the regions to achieve a more rational promotion of rapid economic growth. Rational promotion of rapid economic growth.

## 5. Responses and Recommendations

Based on the relevant problems revealed in the empirical analysis, this paper gives corresponding policies and suggestions in the following aspects for the main problems faced in the development of Guangdong's financial industry at present.

In today's fast-changing environment, businesses, government agencies and non-profit organizations alike are facing unprecedented challenges and opportunities. In order to respond effectively to these challenges and to seize the opportunities, specific responses and recommendations are provided below in eight key areas to promote overall development and sustainability.

### 1) Policy optimization directions

Clarify development goals: Set clear, quantifiable long-term development goals to ensure consistency between policy and strategic direction.

Decentralization: Reducing unnecessary administrative interventions and increasing flexibility and efficiency in policy implementation.

Incentive mechanism construction: Establish positive incentive mechanisms to encourage innovation, green development and social responsibility practices.

Improvement of laws and regulations: According to the development trend of the industry, relevant laws and regulations will be revised and improved in a timely manner to ensure fair competition and market order.

## 2) Technological innovation measures

Increased investment in R&D: Increase investment in basic research and applied R&D to support key core technology breakthroughs.

Industry-university-research cooperation: Promote close cooperation among enterprises, universities and scientific research institutions to accelerate the transformation of scientific and technological achievements.

Digital transformation: Promote the application of digital and intelligent technologies in production, management and services to enhance efficiency and quality.

Green technological innovation: Developing low-carbon and environmentally friendly technologies to reduce resource consumption and environmental pollution.

## 3) The talent development program

Reform of the education system: Restructuring of education, strengthening of the vocational and lifelong education system, and training of personnel to meet market demands.

Introducing high-end talents: Introducing preferential policies to attract domestic and foreign high-level talents and teams to settle in the city.

Internal training: Establish a perfect internal training system to improve the professional skills and comprehensive quality of employees.

Innovative incentive mechanisms: Establish incentive mechanisms for talents, encourage innovation and creativity, and stimulate the vitality of talents.

## 4) Resource allocation adjustments

Optimizing resource allocation: Dynamically adjusting the allocation of resources in accordance with development needs and market changes, and improving the efficiency of resource use.

Strengthening infrastructure: Increasing investment in infrastructure and upgrading the level of transportation, communications, energy and other infrastructure.

Financial support for innovation: Guiding financial institutions to increase their support for innovative enterprises and projects and to broaden financing channels.

## 5) Market expansion strategies

Precise market positioning: Analyze the market demand in depth and define the target market and customer groups.

Diversified marketing channels: Utilizing online and offline channels to expand brand influence and market share.

Internationalization strategy: Actively participate in international competition and cooperation, develop overseas markets and enhance international competitiveness.

## 6) Risk management mechanisms

Risk assessment and early warning: Establish a sound risk assessment system to identify potential risks and issue early warnings in a timely manner.

Emergency response mechanism: Formulate a comprehensive emergency response plan to ensure a rapid and effective response when emergencies occur.

Insurance and risk diversification: Rational use of insurance instruments to diversify and reduce risk losses.

#### 7) Public communication programs

Transparent management: Enhance the transparency of decision-making and implementation, disclose relevant information in a timely manner, and accept public supervision.

Interactive communication platform: Establishment of various forms of interactive communication platforms to listen to public opinions and suggestions and enhance credibility.

Popularization of science and education: Strengthen public awareness and educational activities to enhance public understanding of and support for policies and technologies.

#### 8) Continuous assessment and feedback

Establishment of an evaluation system: A scientific and reasonable evaluation index system will be set up to regularly evaluate the effectiveness of the implementation of various policies and measures.

Data-driven decision-making: Utilizing big data and artificial intelligence technology, we conduct in-depth analysis of assessment data to provide a basis for decision-making.

Dynamic adjustment and optimization: Based on the assessment results and feedback, policies and measures will be adjusted and optimized in a timely manner to ensure the successful achievement of the objectives.

In summary, through the comprehensive implementation of the countermeasures and recommendations in the eight areas mentioned above, the competitiveness and sustainability of organizations or enterprises can be effectively enhanced, laying a solid foundation for the realization of higher-quality development.

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## Conflicts of Interest

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

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