Convergence measurement and convergence mechanism test of financial development in China

1   Introduction

Unbalanced regional development is one of the factors restricting China's economic growth. Convergence hypothesis, as the main analysis tool of development gap, focuses on measuring the degree of narrowing the gap between economies at the level of aggregate, and give a explanation for the causes of the gap between regions. Many scholars try to use the convergence hypothesis to measure China's economic convergence, so as to explain the gap in economic development between regions in China (Wang qiaoru, 2020). However, scholars have not paid enough attention to the "financial reasons" behind this phenomenon. The financial system can accelerate capital accumulation and technological innovation by optimizing capital allocation and reducing information costs, so that its development has become an important driving force of economic growth. Financial development plays an important leading role in the economic growth. McKinnon and Show put forward the early financial development theory represented by "financial deepening theory" and "financial inhibition theory", which shows that financial development plays a leading role in economic growth. Subsequently, Schumpeter, Hicks and other scholars have successively expounded the importance of financial development in economic growth. Therefore, narrowing the gap in regional financial development is of great significance for coordinating the balanced development of regional economy. Nowadays, there is an obvious "dualization" feature in the development of regional finance in China. The eastern region has a high degree of financial marketization and perfect financial categories, leading other regions in terms of financial scale and efficiency. Due to the influence of geographical environment, resource endowment and other factors, most of the financial systems in underdeveloped areas are facing the development dilemma of "the dominance of the banking industry, the lack of vitality of the financial market and the lack of securities".Therefore, the main focus of this paper is to identify the convergence of China's overall, regional and provincial financial development based on the convergence hypothesis, and further explore the influencing factors of China's financial convergence process, so as to provide a perspective of financial convergence for explaining the imbalance of China's regional development, and also help to solve the imbalance of China's regional financial development.

The classic definition of financial development convergence is: the process that the financial development level of low-level economies catches up with and closes to high-level economies in the long run, that is, the process that the financial development gap of economies gradually narrows to zero. The financial convergence hypothesis began with goldsmith (1969). He believes that the essence of financial development is the change process and trend of financial structure (the organic combination of a country's existing financial instruments and financial institutions). With economic growth, a country's financial related ratio (a measure of financial development level) will tend to stabilize when it rises to a certain limit. This discovery has become an important source of the convergence hypothesis of financial development,

and also provides an important analytical basis and methodological reference for subsequent research.

The existing empirical research on financial convergence in the world is mainly carried out from two perspectives: the price of financial products and the financial system. The price convergence test of financial products follows the idea of "one price law", which aims to test the price convergence of financial products between different economies. Apergis (2014) tested the dynamic convergence characteristics of the international stock market and found that there are convergence characteristics of stock prices in individual industries, and the convergence characteristics of stock price volatility are more obvious than that of stock prices. The financial system convergence test is more common. It is based on Goldsmith's financial structure theory, which identifies the dynamic convergence characteristics of the fundamentals of the financial system of various economies, that is, the financial structure. Bruno (2012) analyzed the panel data of OECD countries from the perspective of asset allocation. The results showed that OECD did not have significant convergence characteristics in bonds and savings, but showed convergence characteristics in stocks and insurance products. He believes that compared with financial institutions, the convergence of financial markets is easier to achieve. Schmidt (2001) constructed a systematic analysis framework of the financial system from the perspective of supply and demand. By comparing the financial systems of Germany, France and Britain, he put forward the view that the financial system among countries will converge to the financial system dominated by the capital market.

In the measurement of financial convergence in China, Zhang (1994) first explored the existence of financial convergence. He pointed out that the characteristics of regional financial development differences and economic growth changes in China are the same, showing a "Williamson inverted U-shaped" change trend of "convergence → divergence → convergence". Since then, scholars have used a variety of methodologies and development indicators from different angles to study the convergence and convergence characteristics of China's financial development, but they have not reached a consistent conclusion.

Most of the relevant studies use three methods of "σ-convergence", "β-convergence" and "group convergence" to identify the convergence. Early identification methods of "σ-convergence" and "β-absolute convergence" are more common. By imitating goldsmith, scholars established a single indicator of China's "financial correlation ratio" and concluded that China's financial development showed absolute convergence characteristics (Lu, 2004; Sun, 2013).

However, some scholars have reached the opposite conclusion (Li Jing, 2008; long Chao, 2010). They believe that China's economic development strategy of "getting rich first and then getting rich" has particularity. The difference between the initial level of financial development and the economic policy environment in each region cannot be eliminated in the short term, and its financial development level should have different steady-state values. Absolute convergence focuses on the trend of narrowing the development gap, and cannot identify the situation of multiple steady states. In view of the phenomenon of "multiple steady state", the "group convergence" gives a reasonable explanation. The concept of "group convergence" was first proposed by galor (1996), which means that the economic growth of economies with the same initial level and similar structural characteristics will tend to converge in the long run, that is, showing the distribution characteristics of "convergence within the group and divergence outside the

group". Therefore, some scholars are committed to the study of "group convergence" whose hypothetical conditions are closer to the reality of China. They test the convergence of China's traditional economic division regions, namely, the eastern, Western and central regions, but their conclusions on the convergence of each group are not consistent. Zhao (2006) found that the western region showed a short-term financial convergence trend after 1996, but there was an obvious polarization effect between the western region and the eastern and central regions; Wang (2019) considered dynamic changes and spatial factors and found that the financial scale and efficiency in the eastern and western regions showed convergence, but the financial development in the central region showed a certain divergence. In recent years, with the further study of financial convergence, scholars have made breakthroughs in the selection of indicators and the identification methods of convergence. Scholars represented by Li (2021) have considered the endogenous dynamic convergence characteristics of financial development and achieved a breakthrough from static cross-section regression to dynamic panel model. Hu (2018) and other scholars used the spatial measurement method to break the exogenous traditional regional setting and realize the automatic division of convergence groups.

All the above studies have measured the financial convergence in China, and with the progress of the method, the estimation accuracy has been further improved. However, no consistent conclusion has been reached, and there are mainly the following deficiencies: first, in the selection of indicators, China's financial industry covers a wide range, and the single indicator method is difficult to ensure the comprehensiveness of the measurement of China's financial development characteristics. However, it is difficult to form a clear convergence evaluation standard by selecting multiple indicators. Second, the existing research focuses on the judgment of the existence of convergence, and lacks the analysis of the implementation mechanism and path of convergence. Third, in the identification of group convergence, although spatial econometric analysis realizes the automatic division of regional financial convergence groups, the division basis only considers geographical factors, and cannot realize the endogenous division of convergence groups. In addition, the previous convergence identification methods are based on the assumption of convergence speed and path homogeneity. The situation of "convergence after transient divergence" with heterogeneous transition paths cannot be accurately identified, and it is easy to misjudge it as divergence. Lee (1997) developed a random Solow Swan growth model to test whether there is "β-convergence" in per capita income with data from 102 countries. When they relaxed the homogeneity assumption involved in the traditional cross-section and panel data estimation methods, they found that the "β-convergence" speed was significantly improved, but the estimation accuracy was significantly reduced. Blinder and Pesaran (1999) questioned the accuracy of "β-convergence". They found that when studying the transition path of an economy approaching its own stable state, "β-convergence" could not identify the random transition path.

Bliss (2000) believes that rejecting the "σ-convergence" hypothesis does not necessarily mean that the economy is not convergent. The existence of transitional divergence paths in the data may lead to the rejection of the null hypothesis of "σ-convergence". The heterogeneity hypothesis is more realistic, so it is necessary to take it into account in convergence identification.

In view of the above shortcomings, this paper makes the following improvements: first, on the basis of selecting multiple indicators, using time series principal component analysis (GPCA) to build a comprehensive index evaluation standard, so that the identification of convergence is more clear. Second, in terms of convergence measurement, Phillips (2007) proposed a nonlinear time-varying factor model to identify the convergence of provincial-level finance in China. The model breaks through the limitations of the homogeneity assumption of traditional identification methods, can accurately identify the phenomenon of "short-term divergence, long-term convergence", and can realize the endogenous division of convergence groups. Third, after judging the convergence, this paper uses the ordered probit model to analyze the influencing factors of regional financial convergence and its internal formation mechanism.

The structure of this paper is arranged as follows: the second part introduces the selection of measurement indicators of "financial development convergence"; The third part introduces the measurement methods and empirical results used in this paper; The fourth part is the conclusion and policy recommendations.

2   Index selection

There are two methods to measure the level of provincial financial development: multi index method and single index method. The single indicator method imitates the financial related ratio proposed by goldsmith, and uses the year-end loans of financial institutions as a proportion of GDP to measure the scale of financial assets at the provincial level (Zhang , 1994). However, this indicator focuses on the scale of the banking industry, lacks the explanatory power of the financial market, and is difficult to show the overall picture of provincial financial development. Therefore, the multi indicator measurement method is more comprehensive and effective. In order to overcome the lack of clear evaluation criteria in the multi index method, this paper constructs a comprehensive index through the time series global principal component analysis method, so as to accurately judge the convergence of provincial financial development level.

2.1   Selection and calculation of indicators

Considering the complexity of the measurement of financial development level, this paper selects a variety of indicators from the three aspects of financial scale, financial efficiency and financial structure to establish a comprehensive evaluation index system of financial development level. The selected indicators cover China's stock market, bond market, insurance and bank, which can comprehensively show the overall picture of China's financial development. Drawing on the research of Levine et al. (2000) and domestic scholar Zhang Chengsi (2013), and considering the characteristics of China's provincial financial development, this paper selects the panel data of 30 provinces, municipalities directly under the central government and autonomous regions (considering the availability of data, the sample in this paper does not include Tibet, Hong Kong, Macao and Taiwan) from 2005 to 2018 as the sample data. The data comes from the "China Statistical Yearbook", "China Financial Statistical Yearbook", provincial statistical yearbooks over the years National Bureau of statistics and wind database. The selection and processing of corresponding variables are shown in Table 1.

Table 1 comprehensive evaluation index system of provincial financial development level

Primary index	Secondary index	explanation	object	direction
financial scale	Financial Value Added /GDP	The scale of the newly created value of the financial industry relative to GDP reflects the development scale of the financial industry	finance	positive
	Financial institutions lend at the end of the year /GDP	The scale of bank financial assets relative to GDP reflects the development level of the banking industry in each province	bank	positive
	The scale of the bond and securities issue /GDP	The primary market size of the securities market reflects the issuance size of securities in each province	scurity	positive
	Stock market value /GDP	The scale of the secondary market of the securities market reflects the stock circulation scale of each province.	scurity	positive
	Number of listed companies	The number of Listed Companies in each province complements the financing scale of the stock market in each province.	scurity	positive
	Safety depth	The scale of premium income relative to GDP reflects the development level of the insurance industry in each province and its position in the economy.	insurance	positive
	Safety density	The per capita premium income of each province reflects the popularity of insurance in each province and complements the depth of insurance。	insurance	positive
financial structure	Direct financing/indirect financing	The relative proportion of direct financing scale and brief introduction financing scale reflects the financing structure of each province.	—	positive
Financial efficiency	Loan-to-deposit ratio	The ratio of year-end loan balance to year-end deposit balance of financial institutions in all provinces reflects the efficiency of savings investment transformation from the perspective of indirect financing.	—	positive

2.2 Time series global principal component analysis

This paper uses GPCA (generalized principle component analysis) to construct comprehensive financial development indicators.

First, build a temporal stereoscopic data table G:

$$G = \begin{bmatrix} X^1 \\ X^2 \\ \vdots \\ X^T \end{bmatrix} = \left(x_{ij} \right)_{Tn \times m}, \quad X^t = \begin{bmatrix} x_{11}^t & x_{12}^t & \cdots & x_{1m}^t \\ x_{21}^t & x_{22}^t & \cdots & x_{2m}^t \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1}^t & x_{n2}^t & \cdots & x_{nm}^t \end{bmatrix}$$

Time series stereoscopic data table G is a three-dimensional data table composed of plane data table sorted by time. The flat data table at each time is composed of the same samples and indicators. That is $X^t = (x_{ij}^t)_{n \times m}$. x_{ij}^t is the index value of the j-th index of sample I at time ($i = 1, 2, 3, \cdots, n$; $j = 1, 2, 3, \cdots, m$; $t = 1, 2, 3, \cdots, T$). Therefore, there were T horizontal data tables in the year, which formed the $Tn \times m$ matrix in chronological order. Based on this, this paper constructs a 14×30×9.

Second, the dimensions of the indicators selected in this paper are different and need to be dimensioned. Standardization, as a commonly used method of dimensionless processing, may weaken the

difference in the degree of variation between indicators in the application of multi indicator panel data. Therefore, this paper refers to relevant literature (Liu, 2019) and adopts the range standardization method for processing.

Third, test the effectiveness of principal component analysis. Before the time series global principal component analysis, this paper first uses kmo test and Bartlett spherical test to test the effectiveness of this principal component analysis. Among them, KMO value is 0.668, which is greater than the critical value of 0.5. Bartlett's spherical test rejected the original hypothesis that the variables were not related. The above test results show that this paper is suitable for using global principal component analysis to construct comprehensive financial development indicators.

Fourth, extract the principal components. The extraction principle of global principal components is: select the principal components whose initial characteristic value is greater than 1. Therefore, this paper selects the first three principal components, with a cumulative contribution rate of 85.535%, indicating that the first three principal components can cover more than 85.535% of the original index information.

Table 2 Determination of the number of principal components

component	Initial eigenvalue			Extract the sum of squares of loads		
	total	Variance percentage	accumulate %	total	Variance percentage	accumulate %
1	2.047	40.932	40.932	2.047	40.932	40.932
2	1.222	24.438	65.370	1.222	24.438	65.370
3	1.008	20.166	85.535	1.008	20.166	85.535
4	0.669	13.370	98.906			
5	0.055	1.094	100.000			

Table 3 Component score coefficient matrix

Original indicators	component		
	1	2	3
Financial institutions lend at the end of the year /GDP (ZX_1)	0.268	-0.017	-0.264
Loan-to-deposit ratio (ZX_2)	0.180	0.083	-0.003
Direct financing/indirect financing (ZX_3)	0.196	-0.054	0.536
Stock market value /GDP (ZX_4)	0.217	-0.059	-0.319
Safety depth (ZX_5)	0.026	0.584	-0.011
Safety density (ZX_6)	0.008	0.260	0.074
Financial Value Added/GDP (ZX_7)	0.272	-0.016	-0.254
Number of listed companies (ZX_8)	0.026	0.527	0.032
The scale of the bond and securities issue/GDP (ZX_9)	0.223	-0.061	0.464

Fifth, build a comprehensive financial development index. Table 3 shows the global principal component matrix after rotation. According to table 3, the three principal components, F_1, F_2 and, F_3

cover all the indicators, representing the development of banking, insurance and securities markets respectively. The first principal component mainly explains ZX_1, ZX_2 and ZX_7. The second principal component mainly explains ZX_5, ZX_6 and ZX_8. The third principal component mainly explains ZX_3, ZX_4 and ZX_9. The scoring formulas are as follows:

$$F_1 = 0.268ZX_1 + 0.180ZX_2 + 0.196ZX_3 + 0.217ZX_4 + 0.026ZX_5 + 0.008ZX_6 + 0.272ZX_7 + 0.026ZX_8 + 0.223ZX_9$$

$$F_2 = -0.017ZX_1 + 0.083ZX_2 - 0.054ZX_3 - 0.059ZX_4 + 0.584ZX_5 + 0.260ZX_6 - 0.016ZX_7 + 0.527ZX_8 - 0.061ZX_9$$

$$F_3 = -0.264ZX_1 - 0.003ZX_2 + 0.536ZX_3 - 0.319ZX_4 - 0.011ZX_5 + 0.074ZX_6 - 0.254ZX_7 + 0.032ZX_8 + 0.464ZX_9$$

From this, combined with the cumulative weight of each principal component in Table 2, the specific calculation formula of the comprehensive index of the financial development level of each province in China can be obtained:

$$FD = \frac{40.932\%}{65.370\%} F_1 + \frac{65.370\% - 40.932\%}{85.535\%} F_2 + \frac{85.535\% - 65.370\%}{85.535\%} F_3 \tag{1}$$

According to formula (1), the annual comprehensive financial development level index of all provinces and cities from 2005 to 2018 can be calculated. Thus, the only evaluation standard of the provincial financial development level is formed, which is ready for the further identification of provincial financial convergence.

3 Model construction and empirical test

This chapter selects the nonlinear time-varying factor model established by Phillips and sul (2007) to identify the convergence of China's provincial financial development, and explains its convergence mechanism on this basis.

3.1 Construction of nonlinear time-varying factor model

The nonlinear time-varying factor model follows the idea of "convergence", and aims to identify the convergence of samples through testing. If the sample does not have global convergence, we can further realize the endogenous division of convergent groups through the convergent group endogenous identification algorithm proposed by Phillips and sul (2007). This model has the following advantages: first, it breaks through the limitation of the homogeneity assumption of the traditional convergence model and can identify the excessive divergence path of individuals in the convergence process. Second, the model has no stability requirements for the sample data. The convergence test is equivalent to the asymptotic cointegration test and will not be affected by the small sample problem. Third, the model can not only identify the global convergence of the sample, but also endogenously divide the convergence groups in the

sample in the case of global divergence. Furthermore, the model can recognize the unique equilibrium steady state proposed by Solow (1956) and the multiple steady state of group convergence proposed by galor (1996).

In convergence recognition, the measured index can be divided into two parts: the common factors of convergence and the heterogeneous factors of divergence. Therefore, the logarithmic form (FD_{it}) of financial development level can be roughly expressed by formula (2):

$$FD_{it} = g_{it} + a_{it} \tag{2}$$

a_{it} is a stability factor extracted from the financial development level of the sample individuals, and represents a common factor that remains stable over time. It refers to the change factors in the financial development level of the sample individuals, and represents the heterogeneity factors that affect individuals to deviate from the common trend over time. In order to better measure the heterogeneity factors, this paper deforms formula (2) and separates it from the common factors to obtain a nonlinear time-varying factor model:

$$FD_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it} \mu_t \tag{3}$$

Formula (2) divides the financial development level (FD_{it}) into two parts: common factor (μ_t) and time-varying dynamic factor (δ_{it}). Among them, μ_t is only affected by the passage of time and does not include individual differences, which represents the common change trend in the financial development level of all regions. δ_{it} is a heterogeneity factor that changes with time, and represents the heterogeneity transition path of each region.

The financial development convergence of the sample depends on the change of δ_{it} . If δ_{it} no longer changes with the change of time, it indicates that the financial development of the sample converges to a certain steady-state level. Therefore, in order to better measure δ_{it} , we will first express δ_{it} in the form of semi parametric model:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t) t^\alpha} \tag{4}$$

δ_i is an individual non time varying parameter; ξ_{it} is independent and identically distributed on the cross section and is weakly correlated with t ; σ_i Is the heterogeneity scale parameter; $L(t)$ is a slowly changing time-varying function similar to $\log(t)$, and when $t \to \infty$; $L(t) \to \infty$. α represents the convergence rate of δ_{it} , and, when $\alpha > 0$ and $t \to \infty$, $\delta_{it} \to \delta_i$ exists. The quotation of t^α and $L(t)$ is used to ensure that convergence is true for any $\alpha > 0$.

Therefore, when δ_{it} converges to δ_i , δ_{it} no longer has individual time-varying characteristics, that is, the change of individual financial development level of the sample no longer has the characteristics of heterogeneity, but is only affected by common factors, and the sample finally converges to a certain steady state. Therefore, the original assumption of convergence is:

$$H_0 : \delta_{it} = \delta_t \ 且 \ \alpha > 0$$

The alternative assumption of convergence H_1 is: for $\forall i$, there is $\delta_{it} = \delta_t$ $\alpha < 0$ or $\delta_{it} \neq \delta_t$, and α is any value. Under the original assumption, the transition period allowed by the model includes the possibility of cross-sectional heterogeneity $\delta_{it} \neq \delta_{jt}$ and even transition divergence, but the final sample will converge to the same steady-state level. Alternative hypothesis means that at least one sample does not converge to the overall level, including the possibility of divergence and group convergence. Therefore, the advantage of nonlinear time-varying factor model over other models is that it can identify the special situation of "short-term transition divergence, long-term convergence", and can also detect the existence of group convergence.

3.2　Convergent group endogenous identification

According to the $\log t$ regression based cluster convergence clustering algorithm introduced above, this section identifies the convergent clusters in the sample. Table 4 shows the specific process of the identification algorithm, and table 6 shows the final results of the obtained group members.

<div align="center">Table 4 Results of clustering algorithm based on $\log t$ regression</div>

Group	Number	Member	$t_{\hat{\gamma}}$
Group 1	5	Beijing、Guangdong、Shanghai、Jiangsu、Zhejiang	2.06
Group 2	4	Tianjin、Shandong、Fujian、Sichuan	3.08
Group 3	10	Henan、Chongqing、Liaoning、Hebei、Hunan、Hainan、Shaanxi、Shanxi、Xinjiang、Hubei	2.98
Group 4	11	Guizhou、Yunnan、Jilin、Inner Mongolia、Guangxi、Jiangxi、Anhui、Heilongjiang、Ningxia、Qinghai、Gansu	2.12

This paper obtains four groups (as shown in Table 6): group 1 is composed of five members, including the core group (Beijing, Shanghai, Jiangsu, Zhejiang) and the group member Guangdong; Group 2 consists of four members, including the core group (Tianjin and Shandong) and group members (Fujian and Sichuan); Group 3 is composed of core groups (Liaoning, Hunan, Hubei, Henan) and group members (Shaanxi, Chongqing, Hebei, Xinjiang, Shanxi, Hainan), including 10 provinces and urban areas; Group 4 is composed of core groups (Jiangxi and Guizhou) and group members (Yunnan, Jilin, Inner Mongolia, Guangxi, Anhui, Heilongjiang, Ningxia, Qinghai and Gansu), including 11 provinces and urban areas.

The financial development level of 30 provinces and cities in China finally converged to four different steady states. In order to show the evolution of financial convergence of each group in more detail, figure 1 shows the transition path of each group, that is, the transition path of (see formula 5). It reflects the change trend and range of the average financial development level of each group relative to the national average level over time. If the value of convergence group is greater than 1, it indicates that the financial development level of the group is higher than the national average level; On the contrary, it is lower than the national average.

As shown by the relative transfer path in Figure 1, the convergence path of the four groups was

relatively flat from 2005 to 2018. The financial development gap between group 1 and other groups is large, but the gap has gradually narrowed in recent years. At present, the financial development level of group 1 is much higher than the average level, almost twice the average level; Group 2 and group 3 have been fluctuating at the average level; Group 4 is below average. However, since 2015, although the convergence path of each group has fluctuated, it generally shows a trend of slow convergence. The government has continuously increased its support for the financial development of the central and western regions, and the financial growth rate of the central and western regions has been accelerating to catch up with the development pace of the eastern region.
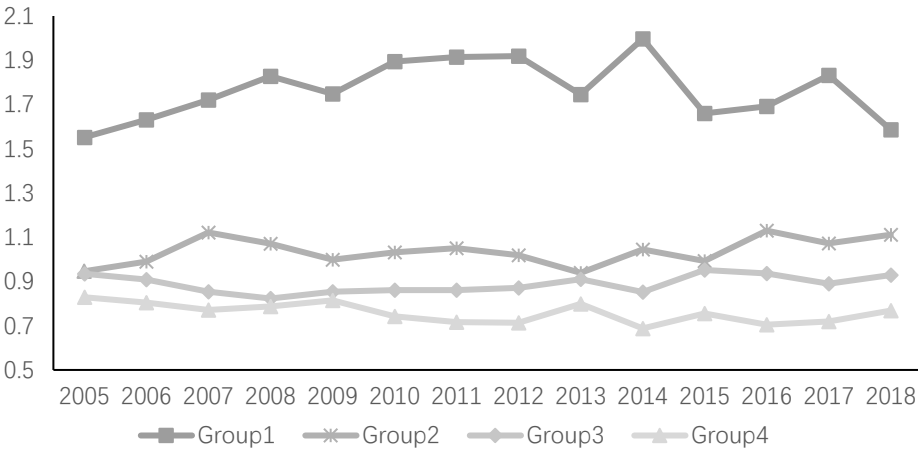

Figure 1 relative transfer path of convergence group

From the relative transfer path of convergent groups, it can be seen that the financial level in eastern China is much higher than that in other regions, and the financial polarization phenomenon of "developed in the East, less developed in the middle, West and northeast" still exists, but the financial gap between groups has a narrowing trend in recent years. In combination with the results shown in Table 1 and figure 1, the distribution of convergence groups in China is analyzed below.

The distribution of financial groups in China has three characteristics: first, the four convergence groups in China's financial development show a "pyramid" distribution pattern of "few members of high-level groups and more members of low-level groups". There are 21 provinces and cities whose financial development converges to a lower steady-state level (Group 3 and group 4), accounting for about of the country. And concentrated in the central, Western and northeastern regions; Almost all the provinces and cities that converge to a higher level come from the eastern region. Second, the development gap between convergence groups is large. The financial development level of group 1 is much higher than that of other groups, almost twice that of group 2 (see Figure 1), which shows that the financial polarization phenomenon of "developed east, underdeveloped middle, West and northeast" in China is still very prominent. Third, although the traditional four region division method can not accurately identify financial convergence groups, it is still reflected in the formation of groups. Most of the members of group 1 and group 2 come from the eastern region, while the provinces and cities in the other three regions belong to group 3 and group 4.

Judging from the internal composition of each group, group 1 members are developed provinces and municipalities directly under the central government in the eastern coast, and all of them come from the three major urban agglomerations of "Beijing Tianjin Hebei", "Guangdong Hong Kong Macao" and "Yangtze River Delta" with the most developed financial industry. Among them, there are three provinces and cities from the "Yangtze River Delta" urban agglomeration, indicating that the "Yangtze River Delta" urban agglomeration has the strongest financial development momentum among the three urban agglomerations. Member 1 of the group is ahead of other provinces and cities in the improvement of financial market categories, financial resource endowment, degree of financial marketization, scale of financial institutions and operation efficiency, and its financial development level is far higher than that of other provinces and cities in China. Tianjin, Shandong and Fujian of group 2 also have certain financial strength within the radiation range of the three major urban agglomerations due to their inherent geographical advantages. However, on the whole, there is still a wide gap between group 2 and group 1. The financial development level of group 1 is almost twice that of group 2 (see Figure 1),. The main reason for the large gap between the two groups is the financial market. The financing scale of the primary market and the secondary market of the securities of the first member of the group are 5.57 times and 4.25 times of the national average respectively. This shows that the provinces and cities with the highest degree of financial marketization in China are highly concentrated in group 1. However, most of the financial systems in other provinces and cities in China have the common problems of "one dominant bank", insufficient development of securities, futures and fund industries, and unbalanced financial structure. As a relatively developed province in the western region, Sichuan Province is also the only province outside the eastern region to join the group 2. Due to the support of financial related policies in the national "western development" strategy, Sichuan Province has developed well in the overall scale of the financial industry and the scale of the insurance industry in recent years, with a rapid growth rate. Its insurance depth is even the same as that of Shanghai. However, its securities industry foundation is relatively weak, its financial structure is still dominated by indirect financing, and its ability to convert deposits into investment is limited, and its financial efficiency needs to be improved. The composition of group 3 is relatively complex, covering four regions: East, West, middle and northeast. Among them, there are four provinces and cities in the central region, accounting for nearly half of the total members. The weakness of financial development in central provinces such as Hubei, Hunan, Anhui, Henan and Shanxi lies in the slow growth of financing scale and narrow financing channels. The central region relies too much on banks for financing and the securities market is underdeveloped, which makes it difficult to solve the loan problem, especially the loan problem of small and medium-sized enterprises. It is worth noting that Chongqing, Xinjiang and Shaanxi in the southwest region are also located in group 3. The contribution of the state's financial preferential policies to the rapid financial development of the western region cannot be ignored. However, the financial support of the state to the west is mostly reflected in the realization of loan policies through the channels of large state-owned banks, while the financial vitality of the western region itself is insufficient, and there are few small and medium-sized financial institutions and local financial organizations. Therefore, although the scale of bank loans in Xinjiang and Shaanxi grows rapidly, their performance in the financial market and

insurance industry needs to be improved. As an eastern province, Hebei Province is also facing the common problem of financial development in the central and Western Regions: insufficient development of financial markets. In addition, it faces the problems of strict financial supervision and limited development of the capital market. Hainan Province and Liaoning Province also have problems such as narrow financial channels, relatively weak market players, and the lack of some financial market categories. Most of the members of group 4 come from the western and northeast regions. Due to geography, resources, policies and other reasons, the financial development of the four members of the group is lower than the national median level. Ningxia, Qinghai, Gansu and other western provinces have a weak financial foundation. Although they have the key support of national financial policies, they are still below the national average. The four members of the group generally have the shortcomings of unreasonable financial structure, few types of financial products and services, and mismatches between financial supervision and development needs, so their financial development level is not high.

3.3 Analysis on the formation mechanism of convergence group

This section will explore the formation mechanism of the above convergence groups, draw lessons from the research of bartkowska and Riedl (2012), and use the ordered probit model to analyze the classification conditions and specific action mechanism of the groups in detail.

$$\mathrm{y}_{it} = \beta X_{it} + \varepsilon_{it}$$

Among them, y_{it} represents the group rating score of provinces and cities at time, and represents the group ownership of provinces and cities. In this paper, the value of group member 1 is assigned as 1, the value of group member 2 is assigned as 2, and so on, that is, the value of each group member is consistent with its group serial number, and the value of group members with higher financial development level is smaller; On the contrary, the larger. Is the parameter to be estimated, which is a random disturbance term. It refers to the set of factors that affect the ownership of provincial and municipal groups. Referring to relevant literature, this paper selects three influencing factors as explanatory variables: per capita real GDP level (GDPc), trade openness (OP) and foreign direct investment (FDI) from the perspectives of economic growth, product market opening and capital market opening. The per capita real GDP level is measured by the logarithm of the gross national product of each province and city; Trade openness is measured by "the ratio of total import and export to regional GDP"; Foreign direct investment is expressed by "foreign investment amount / regional GDP". In order to eliminate the influence of dimension, all values are standardized in this paper. Table 5 shows the estimated results of parameters and the marginal effects of various influencing factors on each group.

First, establish the basic model as follows:

Table 5 The result of Ordered Probit model

Varible	β	Marginal effect			
		Group1	Group 2	Group 3	Group 4

GDPc	-0.2528[***]	0.0612[***]	0.0204[***]	0.0126[***]	-0.0943[***]
OP	-2.0272[***]	0.1314[***]	0.1562[***]	0.3010[***]	-0.5887[***]
FDI	-0.8008[***]	0.1582[***]	0.0558[***]	0.0400[***]	-0.2540[***]

Observing the estimation results in Table 7, it is found that the values of the three variables of per capita real GDP level, trade openness and foreign direct investment are all negative, which indicates that the transfer effect of these three variables on the transfer of provinces and urban areas to high-level groups is significantly positive, that is, for each unit of per capita real GDP level in each province and urban area, the possibility of the province and urban area belonging to a group with a smaller serial number is higher, in other words, The more likely it is to transfer to a group with a higher level of financial development. Similarly, trade openness and foreign direct investment can also bring the same transfer effect. From the perspective of marginal effect, if the per capita real GDP level increases, the possibility of provinces and cities in group 1, group 2 and group 3 increases significantly, but the possibility of being in group 4 decreases significantly. By analogy, trade openness and foreign direct investment also have the same marginal effect.

The results show that in China, economic growth has played a significant positive role in improving the level of financial development. The demand for finance varies at different stages of economic development. With the continuous growth of the economy (that is, the improvement of the per capita real GDP level), finance also develops a higher-level structure, stage and level. Most of the members of group 1 and group 2 benefit from the reform and opening up, have a good foundation for economic development, and private enterprises are more active, which puts forward more demands for finance. Therefore, its financial market categories are also more perfect, and the types of financial products are more comprehensive. Compared with the "bank dominated" financial structure in the central and western regions, its degree of financial marketization and financing efficiency are higher. Most of the members of group 3 are provinces and cities that are more developed in the central, Western and northeast regions and are supported by national policies, and their economic level is more developed in their regions. In contrast, most of the members of group 4 are economically underdeveloped provinces and urban areas in the central, Western and northeastern regions. They are generally facing the problems of insufficient driving force for sustainable economic development, such as technological innovation and backward industrial structure, labor and capital outflows, so their financial development level is also relatively backward.

Opening up has an impact on a country's financial development by breaking the balance between supply and demand of financial development under closed conditions. Opening to the outside world includes product market opening and capital market opening. Product market opening is trade opening. It can indirectly stimulate financial development through economic growth channels, and also directly promote external financing demand, so as to increase the degree of financial deepening. As a typical export-oriented country, China has a strong demand for external financing, which has played a positive role in promoting China's financial development. In addition, the opening of trade has also brought a series of risks, which has promoted the development of financial institutions such as the insurance industry and the

innovation of new financial products. The mechanism of capital market opening on financial development is more intuitive. China's capital market is mostly opened to the outside world in the form of direct financing, that is, foreign direct investment. This is conducive to optimizing the financial structure dominated by indirect financing for a long time and improving the efficiency of the financial system. Relying on its geographical advantages, the eastern region of China has a high degree of openness compared with the central, Western and northeast regions. This is consistent with the distribution characteristics of financial groups, which can explain the formation mechanism of financial groups in China.

4   Conclusions and policy recommendations

Based on the nonlinear factor time-varying model, this paper identifies the convergence of financial development in 30 provinces and cities in China from 2005 to 2018, and draws the following conclusions: first, different from the traditional convergence identification method, on the premise of allowing the existence of heterogeneous convergence transition path, China's financial development does not have the characteristics of national convergence. Second, China's financial development shows a trend of group convergence. However, there is no convergence phenomenon in the traditional four economic regions of East, central, West and Northeast China. In this paper, four convergent groups are obtained through the group endogenous identification algorithm, which shows that China's financial development converges to four different steady-state levels. Third, the distribution of convergent groups presents a pyramid like distribution pattern of "few high-level group members and more low-level group members", and there is a financial polarization phenomenon of "developed east, underdeveloped middle, West and northeast". However, with the evolution process, the gap between groups has gradually narrowed. Fourth, the formation mechanism of convergence groups is comprehensively affected by economic level, opening-up and other factors, and the higher the economic level and opening-up degree of provinces and cities, the greater the probability of belonging to convergence groups with high financial level.

Based on the above convergence research conclusions, this paper puts forward the following three suggestions: first, in order to achieve the coordinated development of regional finance, we should take the division of four convergence groups as a reference, and provide differentiated financial, fiscal and tax policy support on the basis of clarifying the development ideas of each group, especially for the provinces and cities in the central, Western and northeast regions, improve regional capital markets and trading places, and speed up the development of financial markets, Optimize the current financial structure of "banks are dominant and the financial market is underdeveloped". Second, the group should strengthen financial cooperation, promote financial innovation, and build a financial development pattern in which competition and cooperation coexist within the group, so as to achieve regional financial development. Third, this paper finds that economic growth, the opening of product markets and capital markets have played a significant positive role in financial development. Therefore, we should speed up the opening-up of less developed provinces and cities, promote the development of trade and accelerate the introduction of investment, and coordinate the common development of economy and finance among regions.

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