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Research on the Measurement and Convergence Characteristics of High-Quality Development of the Financial Industry in Anhui Province

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Abstract

This paper studies the development status of the financial industry in Anhui Province by constructing a high-quality development index for the financial sector and examining its changing characteristics and convergence properties. Using the Entropy Weight TOPSIS method for data measurement and convergence model analysis, the study finds that the overall development of the financial industry in Anhui Province is on an upward trend, but there are significant disparities in development among regions. Only the financial development of Anhui Province as a whole supports the hypothesis of absolute β-convergence, while central Anhui supports the hypothesis of conditional β-convergence. Analyzing the reasons for the regional differences in financial development in Anhui Province provides a theoretical basis for promoting the quality of financial development in the province and offers new ideas for narrowing the regional disparities in financial industry development.

Keywords

High-Quality Development of the Financial Industry; Entropy Weight TOPSIS Method; Convergence Model.

1. Introduction

The 2023 Central Financial Work Conference explicitly proposed to "accelerate the building of a strong financial nation" and emphasized the need to "focus on five major areas: technology finance, green finance, inclusive finance, pension finance, and digital finance." Finance is not only a reflection of competitiveness among nations but also within regions. High-quality development cannot be achieved without the support of finance. Therefore, it is necessary to study the issues existing in the financial development process of Anhui Province, with the aim of identifying the root causes and promoting effective development of both the economy and financial industry in Anhui.

2. Literature Review

In terms of the quality of financial development, Shi Rongrong et al constructed an evaluation index system from five dimensions: financial industry scale, structure, efficiency, stability, and risk, using the entropy method to measure the quality of financial industry growth in 31 provinces (municipalities, autonomous regions) in China from 2003 to 2015. The study found that the eastern region had the highest quality of financial industry growth, followed by the western region, while the central region experienced a "central collapse" phenomenon. Moreover, there was a convergence trend in the quality of financial industry growth among different provinces in the east, while the gap between different provinces in the central and western regions was more pronounced[1]. Xu Zhangyong based on financial functional theory and financial sustainable development theory, defined the connotation of financial development quality and tentatively constructed a financial industry development quality

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evaluation system consisting of 43 secondary indicators across five dimensions: financial scale, financial structure, financial efficiency, financial function, and financial stability[2]. Liu Hairui and Cheng Chunlin believed that high-quality financial development should be reflected in the enhancement of a country or region's financial innovation capability, reduction in financial risk levels, improvement in financial coordination, decrease in financial exclusion, increase in financial efficiency, and enhancement of financial sustainable development capabilities[3]. Li Junling et al measured the level of high-quality financial development in 31 provinces (autonomous regions) in China's mainland from 2013 to 2017. The results showed that the average level of high-quality financial development in these regions had slightly improved over the past five years, with the level of financial self-development and financial support for economic innovation and development showing rapid improvement[4]. Each province and city had its own advantages and disadvantages in terms of high-quality financial development. Gao Yiming et al. conducted a multi-dimensional comprehensive evaluation of the development quality of China's financial industry. The study found that, at the efficiency level, the quality of financial industry development continued to improve, and output efficiency continued to rise, but input efficiency was relatively low. At the fairness level, regional differences in financial industry development gradually narrowed, and inclusive development began to emerge, but unbalanced and inadequate development remained the norm[5]. At the sustainability level, the stability of financial industry development overall improved. Huang Lingyun et al measured the quality of China's financial development and examined the characteristics of its spatiotemporal evolution. The study found that the overall quality of China's financial development continued to improve, with a gradient effect at the regional level. The overall difference across the country showed a significant improvement trend, and the quality of financial development also exhibited relatively stable spatial agglomeration characteristics of "low-high" or "low-low"[6].

Although there are numerous studies measuring the high-quality development of China's financial industry, such as those by Chen Jinghua or Chen Zixi through the lens of financial development quality, few papers have examined this topic from the perspectives of efficiency and at the municipal level[7-8]. Moreover, most existing studies only focus on the static attributes of data, neglecting the dynamic nature present within it. Additionally, some papers employ relatively subjective data processing methods that fail to reflect the true economic significance contained within the data, leading to potential issues of spurious regression. Therefore, it is imperative to comprehensively measure the data in a way that reflects its actual meaning.

The potential marginal contributions of this paper are as follows: First, there are few academic papers that evaluate financial development within a single province, which refines the scope of financial development research. Moreover, this paper constructs an index from four dimensions: financial input, financial development, financial services to the real economy, and financial risk, using financial data from 16 cities in Anhui Province from 2008 to 2022 for measurement. The Entropy Weight TOPSIS method is comprehensively applied for measurement, and a convergence model is used to analyze the convergence characteristics of financial development in Anhui Province. Second, an analysis is conducted on the reasons for regional disparities in the development of the financial industry in Anhui Province. At the same time, it provides new insights for deepening the supply-side structural reform of the financial sector, promoting the improvement of scale, structure, and efficiency in the financial industry of Anhui Province, and narrowing the regional disparities in financial industry development.

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3. Construction and Analysis of the High-Quality Development Index for the Financial Industry in Anhui Province

Based on the principles of comprehensiveness, representativeness. comparability, and timeliness,This paper selects indicators from three aspects: financial industry input, intended output of the financial industry, and unintended output of the financial industry.

Table 1. Construction of the Indicator System for High-Quality Development of the Financial Industry

	Overall Indicator	Sub-Indicator	Measurement Indicator
High-Quality Development Composite Index of the Financial Industry in Anhui Province	**Degree of Financial Input**	Comprehensive Indicator	number of employees in the financial industry at the end of the year
			total wages of employees in the financial industry
			total assets of financial institutions at the end of the year
		Capital Scale	balance of various deposits
			balance of savings deposits
		Relative input in the banking industry	ratio of banking business outlets to total financial institution business outlets
			ratio of total banking assets to total financial industry assets
		Relative input in the securities industry	ratio of securities business outlets to total financial institution business outlets
			ratio of the total market value of listed companies at the end of the year to total financial industry assets
		Relative input in the insurance industry	ratio of insurance business outlets to total financial institution business outlets
			ratio of premium income to total financial industry assets
	Degree of Financial Development	Comprehensive Indicator	ratio of the change in financial industry value added to the change in GDP
		Financial Service Coverage	number of financial institution business outlets per 10,000 people
			ratio of securities and insurance business outlets to banking business outlets
		Financial Service Utilization Rate	ratio of per capita short-term loans obtained from banks to per capita GDP
		Fintech Development	number of fintech companies
	Degree of	Comprehensive	scale of social financing

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	Financial Services to the Real Economy	Indicator	ratio of financial industry value added to the sum of value added in the primary and secondary industries
		Degree of Banking Services	short-term loan balance
			medium and long-term loan balance
		Degree of Securities Industry Services	number of listed companies
			ratio of direct to indirect corporate financing
			securitization rate
		Degree of Insurance Industry Services	insurance company claims
			insurance penetration
			insurance density
	Financial Risk	Comprehensive Indicator	absolute value of the credit gap
		Banking Risk	absolute value of the difference between non-performing loan balance and its trend component
			absolute value of the difference between non-performing loan ratio and its trend component
			absolute value of the difference between loan-to-deposit ratio and its trend component
		Securities Industry Risk	absolute value of the difference between debt-to-asset ratio and its trend component
			absolute value of the difference between the volatility of the regional stock composite index and its trend component
		Insurance Industry Risk	absolute value of the difference between the insurance company's loss ratio and its trend component

3.1. Data and Indicator Explanation

The data in this paper are sourced from the China Statistical Yearbook, the China Banking and Insurance Regulatory Commission, statistical yearbooks of various prefecture-level cities, statistical bulletins on national economic and social development of various prefecture-level cities, the EPS Global Statistics Data Platform, the websites of the Shanghai Stock Exchange and Shenzhen Stock Exchange, and the Wind database, among others.

Due to the financial development situation in Anhui Province and the scarcity of asset data for the insurance and securities industries at the city level, the year-end assets of financial institutions in Table 1 are represented by the year-end assets of banking institutions. The banking financial institutions in the financial industry exclude the China Development Bank and

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policy banks, while non-deposit-taking financial institutions in the banking sector only include trust companies and financial asset management companies. Securities industry financial institutions solely comprise securities and funds, while insurance industry financial institutions encompass property, life, and reinsurance companies, excluding insurance intermediary companies engaged in businesses such as insurance brokerage, agency, and assessment. Narrow credit refers solely to the total credit obtained by the real economy from domestic banking financial institutions, and the credit funding gap is the ratio of narrow credit to GDP.

Furthermore, for absolute quantity indicators in the indicator system that involve price measurements, such as GDP and value added in the financial industry, they are deflated based on 2008 constant prices to eliminate the impact of price factors. For indicators in the following text that are denominated in US dollars, such as total import-export volume and foreign direct investment, they are converted using the average annual exchange rate of the RMB.

3.2. Measurement Method for High-Quality Development of the Financial Industry in Anhui Province

3.2.1. Measurement Description

To better measure the high-quality development level of the financial industry in the Yangtze River Delta region from 2008 to 2022 and eliminate the inconsistency in dimensions among different indicators, the entropy weight method is first used to calculate the weight of each evaluation indicator, and then the TOPSIS method is employed to calculate and rank the high-quality development index of the financial industry in the Yangtze River Delta region for each year. The steps of the entropy weight TOPSIS method are as follows: standardize the data; calculate the weight of each sub-indicator; obtain the weighted normalized matrix and determine the positive and negative ideal solutions; calculate the Euclidean distances; and calculate the relative closeness coefficients.

3.2.2. Measurement Model

$$c_{ij} = \frac{x_{ij} - min\left(x_j\right)}{max\left(x_j\right) - min\left(x_j\right)} \tag{1}$$

$$c_{ij} = \frac{x_{ij} - max\left(x_j\right)}{max\left(x_j\right) - min\left(x_j\right)} \tag{2}$$

$$C_{m\times n} = \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \tag{3}$$

$$s(c_{ij}) = -\sum_{i=1}^{m}\left(c_{ij}\, ln\, c_{ij}\right) \tag{4}$$

$$s_j = \frac{s\left(c_j\right)}{ln\, m} \tag{5}$$

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$$d_j = 1 - e_j \tag{6}$$

$$w_j = \frac{d_j}{\sum_{i=1}^{n} d_i} \tag{7}$$

$$V_{m\times n} = \left(v_{ij}\right)_{m\times n} \begin{bmatrix} w_1 c_{11} & w_2 c_{12} & \cdots & w_n c_{1n} \\ w_1 c_{21} & w_2 c_{22} & \cdots & w_n c_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ w_1 c_{m1} & w_2 c_{m2} & \cdots & w_n c_{mn} \end{bmatrix} \tag{8}$$

$$\begin{cases} v^{+} = max\left(v_{ij}\right) \\ v^{-} = min\left(v_{ij}\right) \end{cases} \quad i = 1, 2, \cdots m \tag{9}$$

$$\begin{cases} d_i^{+} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^{+}\right)} \\ d_i^{-} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^{-}\right)} \end{cases} \quad i = 1、2、\cdots m \tag{10}$$

$$\rho_i = \frac{d_i^{-}}{d_i^{+} + d_i^{-}} \quad i = 1, 2, \cdots m \tag{11}$$

$$\rho_i = \frac{\sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^{-}\right)}}{\sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^{+}\right)} + \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^{-}\right)}} \tag{12}$$

Where c_{ij} represents the standardized value of the data, x_{ij} represents the initial data of the i-th indicator for the j-th city, m represents the number of cities studied, and n represents the number of evaluation indicators (j=1,2,...,n; i=1,2,...,m).w_j is the weight, and ρ_i represents the closeness coefficient, which can reflect the performance of the evaluation object. Specifically, a larger ρ_i value indicates a higher level of high-quality development in the city's financial industry, and vice versa.

3.3. Measurement Results of the High-Quality Development Index for Finance

Using the Entropy Weight TOPSIS method to process the data, Figure 1 presents the high-quality development index for the finance industry in Anhui and its various regions. Figure 2 displays the sub-indices, which are obtained through the weighted average of the financial industry's value added across various prefecture-level cities.In this paper,wannan is the southern Anhui region, which includes Ma'anshan, Wuhu, Xuancheng, Tongling, Chizhou, and Huangshan; wanzhong is the central Anhui region,which includes Hefei, Chuzhou, Lu'an, and

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Anqing; wanbei is the northern Anhui region,which includes Huaibei, Bozhou, Suzhou, Bengbu, Fuyang, and Huainan.

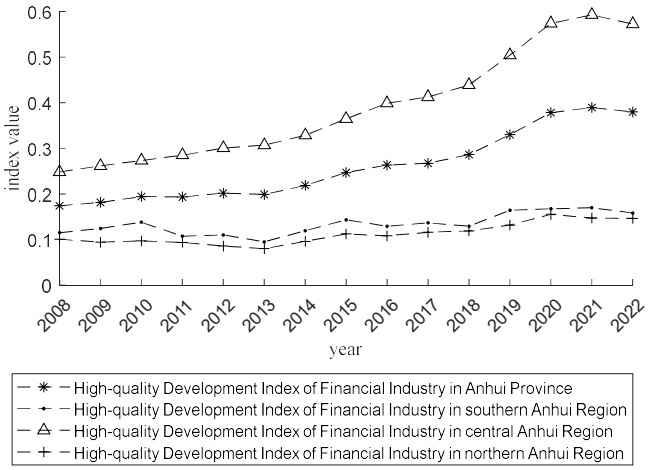

Figure 1. High-Quality Development Index of the Financial Industry in Anhui Province and Its Regions

The following two characteristics can be observed from Figure 1:

Firstly, the trend of the High-Quality Development Index of the Financial Industry in Anhui Province aligns with that of the Central Anhui region. However, the fluctuation amplitude of the development index in the Central Anhui region is relatively larger compared to the provincial index, particularly in 2019 and 2020. This suggests that the financial sector in the Central Anhui region is heavily influenced by the high level of financial development in Hefei, indicating a need for balanced development within this region.

Secondly, the financial sector in the Central Anhui region outperforms that of the Southern and Northern Anhui regions. Meanwhile, the development index of the financial industry in the Southern Anhui region is similar to that of the Northern Anhui region, indicating that the financial development level in the Central Anhui region is higher than that of the Southern and Northern regions, while the Southern region's financial development is comparable to that of the Northern region. This also reflects the inherent economic disparities between the Central and Northern Anhui regions, as well as the issue of unbalanced and uncoordinated development across different regions. Furthermore, it can be observed from Figure 1 that the trend of the financial industry development index in the Northern Anhui region is relatively stable compared to other regions.

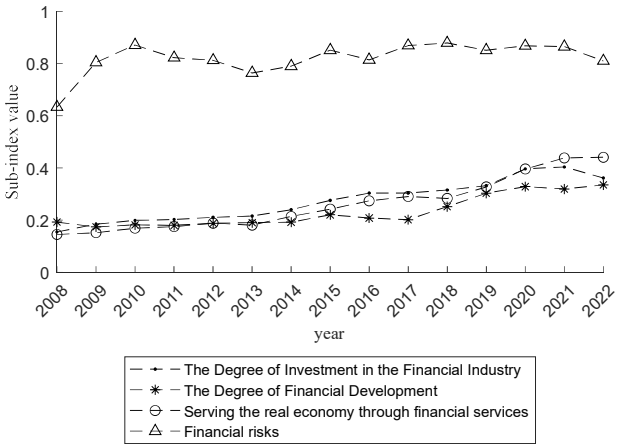

Figure 2. Trend of Sub-indices for High-Quality Development of the Financial Industry in Anhui Province

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From Figure 2, we can observe the changing characteristics of the sub-indices representing the development of Anhui's financial industry:

Firstly, the indices for Anhui's financial services to the real economy and financial development have generally shown a trend of annual growth. Analyzing the growth rates: The index for financial services to the real economy has seen the fastest increase, rising from 0.1447 in 2008 to 0.4408 in 2022, marking a 2.04-fold increase; whereas the growth in the financial development index has been relatively slower. Specifically: In 2008, the index for financial services to the real economy was lower than that for financial development, which was attributed to the obstruction of communication channels between governments, banks, and enterprises amidst the international financial crisis, as well as the increase in the financial risk index from 0.6334 in 2008 to 0.8044 in 2009; From 2014 to 2022, the index for financial services to the real economy consistently exceeded that for financial development, and the ratio of the two indices increased from 0.75 in 2008 to 1.32 in 2022. The growth in the index for financial services to the real economy benefited from relevant policies issued by government departments to support the development of the real economy.

Secondly, regarding the trend of financial risks, the financial risk index has remained at a relatively high level. The financial risk index rose from 0.6334 in 2008 to 0.871 in 2010, representing an increase of approximately 38%, and then declined to 0.8689 in 2017, a decrease of about 0.2%. From 2018 to 2022, the financial risk index fell from 0.8788 to 0.81. Between 2008 and 2022, Anhui's financial risks exhibited a fluctuating trend of initial increase, decrease, subsequent increase, and final decrease. During this period, the People's Bank of Anhui conducted dynamic monitoring and field research on financial risks, coordinated efforts to mitigate capital chain risks for small and medium-sized enterprises, and worked with multiple departments to actively resolve interconnected guarantee risks, ultimately ensuring that no systemic or regional financial risks occurred.

4. Convergence Model Analysis

Beta convergence refers to the phenomenon where regions with lower financial development quality catch up with those with higher quality at a faster growth rate over time, narrowing the gap between them and ultimately achieving a state of dynamic equilibrium. Beta convergence is divided into two models based on whether control variables are included in the model: one is the absolute beta convergence model, which does not include control variables and instead uses a logarithmic measurement model of financial development quality growth rate and financial development quality; the other is the conditional beta convergence model, which incorporates control variables.

$$ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta \, ln \, y_{i,t-1} + \mu_{it} \tag{13}$$

$$ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta \, ln \, y_{i,t-1} + \nu x_{it} + \mu_{it} \tag{14}$$

Where y represents the high-quality development index of the financial industry, $\ln(y_{i,t}/y_{i,t-1})$ denotes the growth rate of the high-quality development level of the financial industry in region i in year t, x_{it} represents the control variables, and μ_{it} represents the random disturbance term.

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Table 2. The results of the absolute beta convergence test for various regions in Anhui Province.

area	Anhui province	wannan	wanzhong	wanbei
Model type	Individual fixed effects SDM model	Random effects SDM model	dual fixed effects SDM model	Random effects SDM model
Hausman test	64.66*** (0.000)	-	67.14*** (0.000)	0.36 (0.547)
LM spatial Error	9.616*** (0.002)	5.341** (0.021)	7.464*** (0.006)	2.611 (0.106)
Robust LM spatial Error	0.825 (0.364)	3.041* (0.081)	5.346** (0.021)	0.177 (0.674)
LM spatial Lag	9.477*** (0.002)	3.661* (0.056)	6.744*** (0.009)	3.344* (0.067)
Robust LM spatial Lag	0.687 (0.407)	1.362 (0.243)	4.626** (0.031)	0.910 (0.340)
LR test(ind)	55.32*** (0.000)	-	43.84*** (0.000)	-
LR test(time)	68.15*** (0.000)	-	39.79*** (0.000)	-
Main	-7.16*** (0.000)	-3.69*** (0.000)	-6.23*** (0.000)	-5.53*** (0.000)
Wx	4.06*** (0.000)	-9.36** (0.035)	0.16 (0.875)	3.47*** (0.001)
rho value	4.50*** (0.000)	2.68*** (0.007)	-3.41*** (0.001)	2.23** (0.026)
Convergence speed	0.019	0.031	0.011	0.017
Half-life of convergence	37.29	22.35	61.02	40.36

Note:*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively..The values below the statistics in the Hausman test and Robust LM test results are the corresponding P-values for those statistics. For the β and rho values, the values below the z-statistics are the corresponding P-values. A dash (-) indicates that the value is not available.The same applies to the table below.

Table 2 presents the results of absolute β-convergence for high-quality financial development in Anhui Province and its various regions. The table indicates that Anhui Province, southern Anhui, central Anhui, and northern Anhui all passed the LM test. However, southern Anhui and northern Anhui failed the Hausman test, leading to the selection of the Spatial Durbin Model (SDM) with random effects. The rho values for financial development in Anhui Province and southern Anhui are significant at the 5% level, and the coefficient Main is significantly negative at the 1% level, indicating a clear trend of spatial absolute β-convergence in financial development in these areas. In contrast, while the rho value for financial development in northern Anhui is significant at the 5% level, the coefficient Main is significantly negative at the 1% level, suggesting that the trend of spatial absolute β-convergence in financial development

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in northern Anhui is either not evident or absent. For central Anhui, the P-value of the rho value is 0.001, which is less than the 1% significance level, but the negative rho value indicates that there is no trend of absolute β-convergence in financial development in this region.

Table 3. The results of conditional beta convergence test for various regions in Anhui Province

Area	Anhui province	wannan	wanzhong	wanbei
Model type	dual fixed effects SDM model	Random effects SEM model	dual fixed effects SDM model	Random effects SEM model
Hausman test	70.79*** (0.000)	-	27.57*** (0.000)	-
LM spatial Error	6.215** (0.013)	2.988* (0.084)	7.805*** (0.005)	1.771 (0.183)
Robust LM spatial Error	0.192 (0.661)	1.544 (0.214)	5.990** (0.014)	3.185* (0.074)
LM spatial Lag	6.683** (0.01)	1.958 (0.162)	6.151** (0.013)	0.703 (0.402)
Robust LM spatial Lag	0.660 (0.417)	0.513 (0.474)	4.337** (0.037)	2.118 (0.146)
LR test(ind)	54.23*** (0.000)	35.64*** (0.000)	42.78** (0.037)	38.54*** (0.000)
LR test(time)	64.76*** (0.000)	11.52*** (0.000)	13.46** (0.037)	8.61* (0.072)
Main	-7.22*** (0.000)	-6.16*** (0.000)	-4.77*** (0.000)	-4.29*** (0.000)
Wx	-1.74* (0.081)	-	1.91* (0.056)	-
rho value or lambda value	-1.66* (0.097)	-0.99* (0.051)	2.28** (0.023)	1.55 (0.120)
Convergence speed	0.021	0.034	0.016	0.016
Half-life of convergence	33.52	20.24	42.73	43.13

Given the lack of a clear absolute convergence trend in central and northern Anhui, we analyze the convergence rates of Anhui Province and southern Anhui. The convergence rates for the quality of financial development in Anhui Province and southern Anhui are 0.019 and 0.031,

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respectively. This suggests significant disparities in the quality of financial development across various regions in Anhui Province, with southern Anhui's convergence rate being approximately twice that of the province. Reducing the differences in financial development among cities within the province is essential for improving and balancing the overall level of financial development in Anhui Province.

Table 3 displays the empirical results of conditional β-convergence for high-quality financial development in Anhui Province and its regions. It reveals that Anhui Province uses the SDM with dual fixed effects, while southern and northern Anhui both adopt the Spatial Error Model (SEM) with random effects. The coefficient Main is significantly negative at the 1% level, and the rho value for northern Anhui is not significant, indicating that financial development in northern Anhui does not exhibit spatial conditional β-convergence characteristics, further suggesting a trend towards absolute β-convergence. Meanwhile, the rho values for financial development in Anhui Province and southern Anhui are significantly negative, indicating that these areas do not exhibit conditional β-convergence trends. Although the rho value and β coefficient for financial development in central Anhui are significant at the 1% level, the positive rho value suggests that these control variables influence the spatial convergence characteristics of financial development quality in Anhui Province and southern Anhui, leading to spatial convergence trends under absolute convergence but not under conditional convergence.

This study selects technology expenditure, education expenditure, urbanization level, and total retail sales of consumer goods as control variables for conditional β-convergence. When conducting conditional β-convergence tests for each region, it was found that only central Anhui exhibits club convergence characteristics. Anhui Province and southern Anhui, influenced by control variables, do not show spatial convergence trends under conditional convergence, and northern Anhui does not exhibit any convergence characteristics. The empirical research concludes that these control variables are essential factors for the rapid development of the financial industry. Increased foreign investment and greater policy support from government departments are necessary to reduce the disparities in the quality of financial development across various regions in Anhui Province.

5. Conclusion

The analysis is conducted based on the results of the convergence model. Qualitatively, the results of sigma convergence indicate that the coefficient of variation in Anhui Province and the central region of Anhui (wanzhong) shows a significant downward trend, while the decrease is smaller in the southern (wannan) and northern (wanbei) regions of Anhui. This suggests that only Anhui Province and wanzhong support the sigma convergence hypothesis. Quantitatively, the results of beta absolute convergence show that the estimated coefficients of beta absolute convergence for Anhui Province and the three regions are significantly negative at the 1% level, supporting the beta absolute convergence hypothesis. The rho values further indicate a positive correlation between the quality of financial development and space in Anhui Province, wannan, and wanzhong, while there is no correlation in wanbei. The results of beta conditional convergence also quantitatively show that the estimated coefficients of beta conditional convergence for Anhui Province and the three regions are significantly negative at the 1% level, supporting the beta conditional convergence hypothesis. In terms of rho values, there is a positive correlation between the quality of financial development and space in wanzhong, while there is a negative correlation in Anhui Province and wannan, due to the spatial characteristics affecting the quality of financial development among the control variables.

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