

Coupling and Interaction between Regional Science and Technology Finance and High-quality Economic Development based on the Empirical Data of Anhui Province

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Abstract

This paper selects the panel data of 16 prefecture level cities in Anhui Province from 2010 to 2019, uses the entropy method to calculate science and technology finance and high-quality economic development, and uses the coupling coordination model and PVAR model to measure the coupling and interaction relationship between them. The research shows that science and technology finance and high-quality economic development in Anhui Province is developing steadily and well. The coupling and coordination degree of local level cities is developing to a higher level, but more than half of prefecture level cities are still in the stage of low coupling and coordination. There is no significant promotion between science and technology finance and high-quality economic development. In the long run, high-quality economic development can promote science and technology finance, which has positive feedback on high-quality economic development.

Keywords

Regional Science and Technology Finance; High Quality Economic Development; Coupling Coordination; PVAR Model.

1. Introduction

Science and technology is an important driving force for the development of modern productive forces, and finance is the financial support for the revitalization of the real economy. As the product of the organic integration of science and technology and finance, science and technology finance is not only an important measure for China to implement the innovation and development strategy, but also an inevitable choice to promote the upgrading of industrial structure and realize green and low-carbon development. Innovation driven high-quality development is an important starting point for accelerating the transformation of the mode of economic development. Innovation and development cannot be separated from adequate financial support, which requires the organic integration of science and technology and finance. Therefore, helping science and technology finance to provide driving force for high-quality economic development is an urgent problem to be solved in the new development stage. With the implementation and promotion of national and provincial policies on science and technology finance, the integration of science and technology finance in Anhui Province has become closer, and the development of science and technology finance has achieved certain results. In 2019, the R&D expenditure of Anhui Province was 75.4 billion yuan, an increase of 59.03 billion yuan over 2010. Science and technology expenditure accounted for 5.11% of fiscal expenditure, and the operating revenue of high-tech industry was 1308.02 billion yuan. However, due to the late start in the field of science and technology finance in Anhui Province, the evolution process of science and technology finance system is relatively backward, and there are still many problems in the development process. For example, in the process of the

development of science and technology finance in Anhui Province, the participation of financial institutions is still low and the amount of deposits and loans fluctuates greatly, which is not only not conducive to the stability and sustainability of the development of science and technology finance, but also difficult to promote the unbalanced and insufficient problems encountered in the process of economic development in Anhui Province through science and technology finance.

2. Literature Review

Foreign scholars mostly focus on the interaction mechanism between finance and scientific and technological innovation. It can be traced back to Schumpeter, an American economist, who explained the relationship between entrepreneur innovation and financial capital in his book economic development theory. The book holds that the screening and supervision of loan applying enterprises by credit institutions when issuing credit funds is conducive to the development of innovative enterprises, so as to promote the sustainability and progress of innovation activities and finally realize the development of science and technology [1]. On this basis, foreign scholars focused on the research on the interaction between science and technology and finance, and finally formed a series of more mature research results. Hall (2016) believes that the uncertainty, risk and long investment cycle of enterprises' scientific and technological innovation activities determine that it is more difficult for them to obtain funds in the financial market. Enterprises often use internal financing for scientific and technological innovation activities [2]. Mudambi et al. (2017) found that the impact between finance and scientific and technological innovation and development is two-way, and the two promote each other [3]. O Sano (2016) concluded from the survey data of SME financing that the government plays an important role in SME financing through policy guidance and support [4]. Domestic scholars' research on science and technology finance mainly focuses on the connotation discrimination, development process, development system guarantee, science and technology and financial integration mechanism of science and technology finance. The representative scholars include Fang Hanting (2010) [5], Zhang Mingxi (2018) [6], Zhou Changfa (2011) [7], Hong Yinxing (2011) [8], etc. Some scholars also measure the development level and efficiency of science and technology finance. Xu Yuming et al. (2020) measured the development level of science and technology finance in various regions of China and found that science and technology finance has the characteristics of positive agglomeration [9]. Scholars mainly use DEA model to measure the development efficiency of science and technology finance. It is found that the increase of investment in science and technology finance is conducive to improve the utilization efficiency of provincial science and technology finance in China. At present, the overall development efficiency of science and technology finance in China is still low, and the efficiency value is greatly affected by environmental factors [10-11].

As for the research on the impact of science and technology finance on high-quality economic development, there is no relevant concept of science and technology finance abroad. Foreign scholars mainly focus on the practical model of the development of the relationship between financial development, scientific and technological progress and economic growth. Solow (1957) established a model of the relationship between capital accumulation and economic growth. In the model, capital mainly refers to the combination of Finance and science and technology. Through model derivation, it is found that the organic combination of Finance and technology is the source of economic growth [12]. Ang J B (2010) found that financial innovation promotes economic growth by promoting technological progress [13]. Domestic scholars mainly focus on the one-way impact of science and Technology Finance on high-quality economic development. Based on the analysis of the function of science and technology finance by Wang Shujuan and Gu Shen (2021), they systematically analyze the mechanism of science

and Technology Finance on the sub dimensional indicators under the new development concept and the comprehensive index of high-quality economic development. It is found that the high-quality development effect of science and technology finance in China presents decreasing gradient hierarchy in the eastern, the central and the west [14]. Li Zhiqiang and Xu Ningming (2020) proposed that science and technology finance can promote high-quality economic development by adjusting the economic structure and promoting the transformation and upgrading of industrial structure, and explore the relationship between science and technology finance and the quality of regional economic growth through Moran index [15]. Li Guanglong and fan Xianxian (2019) took the Yangtze River economic belt as the research object, and found that scientific and technological innovation has a significant effect on the middle and lower reaches, but has not yet formed a significant promotion trend for the upper reaches [16]. Based on the inter provincial panel data, Liu Wenli et al. (2014) studied the impact of China's science and technology finance on economic development from the East, central and West plates. The study found that science and technology finance had a significant positive impact on economic growth, but this positive relationship was significantly different among the three plates [17]. Few scholars have studied the interaction between science and technology finance and high-quality economic development [18].

To sum up, the existing literature is increasingly rich in theoretical and empirical research on the impact of science and technology finance on high-quality economic development, which lays a solid theoretical foundation for this paper. However, most of the literature focuses on the impact of science and technology finance on the development of economic quality, and the literature on the interaction between them, especially on the provincial level, is scarce. Based on this, on the basis of measuring the high-quality development level of science and technology finance and economy in Anhui Province, this paper further analyzes the current situation of coupling and coordinated development between them, and estimates the dynamic relationship between science and technology finance and high-quality economic development in Anhui Province combined with panel vector autoregressive (PVAR) model. In order to build a new pattern of coordinated development between science and technology finance and high-quality economic development in Anhui Province in the new development stage, in order to improve the comprehensive level of high-quality economic development of science and technology finance in Anhui Province, and comprehensively promote science and technology finance and high-quality economic development in Anhui Province and other areas with similar development status.

3. Mechanism Analysis

General studies believe that the new development concept with "innovation, coordination, green, openness and sharing" as the main content is highly unified with the concept of high-quality economic development, and high-quality economic development is the contemporary practice of the new development concept [14-15]. Based on the perspective of new development concept, this part clarifies the coupling and interaction mechanism between regional science and technology finance and high-quality economic development.

3.1. Technology and Finance Boost High-quality Economic Development

(1) Based on the perspective of innovative development. First, science and technology finance increases innovation financing to provide financial support for innovation subjects. Secondly, technology finance can reduce innovation risks and help prevent various potential risks in the process of innovation.

(2) Based on the perspective of coordinated development. First, increase income and stimulate consumption. The development of science, technology and finance will increase the demand for jobs and improve the income level and consumption demand of residents. Secondly, optimize

the industrial structure. Science and technology finance promotes the development of science and technology enterprises and their related enterprises and forces the reform of traditional enterprises.

(3) Based on the perspective of green development. First, provide financial and technical support. Science and technology finance provides financial and technical support for the development of green and low-carbon industries. Secondly, improve the efficiency of resource utilization. Traditional industries rely on science, technology and finance to develop into higher yield and higher value-added industries.

(4) Based on the perspective of open development. First, promote the adjustment of export structure. Science and technology finance promotes the expansion of technology export scale of technology innovation countries, and promotes the transformation of export structure from primary products to high-tech products. Secondly, expand the scale of direct investment between import and export sides. Science, technology and finance improve the national technological endowment and attract foreign investment. The high-tech endowment has obtained excess profits in the international market due to technological advantages.

(5) Based on the perspective of shared development. First, promote industrial diversification and create jobs. Science and technology finance is conducive to promoting the formation of new economic growth points and building broader employment space, providing material guarantee for promoting shared development. Secondly, reduce the inequality of secondary distribution of wealth. The resource allocation function of science and technology finance promotes more financial resources to flow to innovative real economic entities, and reduces the speculative risk caused by the excessive inclination of funds to the virtual economic system.

3.2. High-quality Economic Development Supports the Development of Science, Technology and Finance

The development of science, technology and finance needs a good material foundation, including the strong investment of capital, manpower, technology and other factors, and high-quality economic development can provide important support for the deep integration of science, technology and finance. First, high-quality economic development is conducive to institutional innovation and provides policy support for promoting the introduction of policies and regulations related to science and technology finance and supervising the healthy and stable development of science and technology finance. Secondly, innovative development is conducive to providing special technical and financial support for scientific and technological enterprises. Thirdly, green development will promote the development of science and technology finance to energy-saving and environmental protection enterprises. Open development, strengthen interregional interaction and exchanges, and promote science, technology and finance to a higher platform.

To sum up, science and technology finance is closely related to high-quality economic development. The two permeate and coordinate closely with each other to jointly expand the space for economic growth. Adhere to the core position of innovation, promote high-quality economic development, accelerate the deep integration of Finance and science and technology, and meet the new requirements and tasks of economic development put forward in the post epidemic era.

4. Index System Construction, Research Methods and Index Selection

4.1. Construction of Index System

4.1.1. Measurement Index System of Development Level of Science and Technology Finance

Referring to the practices of Zhou Detian and Feng Chaocai (2020) [18], Zhang Zhiruo and Gu Guofeng (2019) [21] and other scholars on the construction of the measurement index system of the level of science and technology finance, this paper constructs the index system from the four dimensions of science and technology financial resources, financing, input and output to calculate the comprehensive development index of science and technology finance. The specific index selection is shown in Table 1, and the weight of each index is measured by entropy method.

Table 1. Evaluation index system of the development level of science and technology finance

Target layer	Sub indicators	Measure index	Attribute
Development level of science and Technology Finance	Science and technology financial resources	Scientific and technological activity personnel	+
		Number of R&D institutions	+
	Technology Finance	Deposits of financial institutions / R&D expenditure	+
		Loans from financial institutions / R & D expenditure	+
	Financial investment in science and technology	Science and technology expenditure / local financial expenditure (%)	+
		R&D expenditure / GDP (%)	+
	Scientific and technological financial output	Number of scientific papers published (articles)	+
		Patent authorization (item)	+

4.1.2. Measurement Index System of High-quality Economic Development Level

As for the index system of high-quality economic development level, at present, the official has not given a unified measurement standard. This paper selects 24 indicators from the five development dimensions of innovation, coordination, green, openness and sharing to represent the high-quality development level of Anhui economy. The specific index composition is shown in Table 2, and the index weight is measured by entropy method.

Table 2. Evaluation index system of high-quality economic development level

Evaluation dimension	Sub indicators	Index measure	Atribute
Innovation-driven development	Innovation environment	GDP per capita	+
		Education Expenditure/Regional Fiscal Expenditure (%)	+
	Innovation investment	R&D personnel full-time equivalent	+
		R&D expenditure for industrial enterprises above designated size / regional GDP (%)	+
	Innovation output	Incremental Capital Output Ratio (ICOR) = Investment Rate / Regional GDP Growth Rate	-
		High-tech industry added value / GDP (%)	+
Coordinated development	Regional coordination	GDP per capita in each region / GDP per capita in Anhui Province	+
	Urban Rural Coordination	Urbanization rate (%)	+
	Industrial coordination	Tertiary Industry Gross Output/Regional GDP (%)	+
	Coordination of material civilization and spiritual civilization	Expenditure on Culture, Sports and Media/Regional Fiscal Expenditure (%)	+
Green development	Green input	Energy consumption per unit of GDP (tons of standard coal/10,000 yuan)	-
		Energy Conservation and Environmental Expenditure/Regional Fiscal Expenditure (%)	+
	Green environmental protection	Green coverage rate of built-up area (%)	+
		The proportion of days with air quality that is up to or better than Grade II is the proportion of the whole year (%)	+
		Municipal sewage treatment rate (%)	+
Development for global progress	Open environment	The number of foreign-invested enterprises (units) in different regions	+
	Degree of openness	Total Imports and Exports/Regional GDP (%)	+
		Actual Utilization of Foreign Investment/Region GDP (%)	+
		GDP by Loan/Region (%)	+
Development for the benefit of all	Public service supply	Number of beds in health facilities per 1,000 people (per 1,000 people)	+
		General public service expenditure/local fiscal expenditure (%)	+
		Rural public toilet penetration rate (%)	+
	People's quality of life	Per capita expenditure of domestic tourism by region	+
		Years of schooling per capita	+

4.2. Research Method

4.2.1. Entropy Method

After constructing a multi-level index system to measure science and technology finance and high-quality economic development, determining the weight of each index is the top priority for follow-up research. According to the research of Wang Shujuan and Gu Shen (2021) [13], considering that the subjective weighting method is greatly disturbed by human factors, this paper uses the entropy method to calculate science and technology finance and high-quality economic development in Anhui Province. The main operation steps are as follows:

(1) Standardized treatment of indicators.

$$x'_{ij} = \begin{cases} \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}, & x_{ij} \text{ is a positive indicator} \\ \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})}, & x_{ij} \text{ is a negative indicator} \end{cases} \quad (1)$$

(2) Determine the index weight.

$$y_{ij}^t = \frac{x'_{ij}}{\sum_{t=1}^T \sum_{i=1}^m (x'_{ij})} \quad (2)$$

(3) Calculate information entropy.

$$e_j = -\frac{1}{\ln(mr)} \sum_{t=1}^T \sum_{i=1}^m y_{ij}^t \ln y_{ij}^t, \text{ where } i = 1, 2, \dots, m; j = 1, 2, \dots, n. \quad (3)$$

(4) Utility value calculation.

$$g_j = 1 - e_j, j = 1, 2, \dots, n \quad (4)$$

(5) Calculate the weight of each index.

$$w_j = \frac{g_j}{\sum_{j=1}^n g_j} = \frac{1 - e_j}{n - \sum_{j=1}^n e_j} \quad (5)$$

4.2.2. Coupling Evaluation Model

(1) About the coupling model. Coupling model is used to describe the strength of the relationship between multiple elements. Based on the research of Zhu Jianhua and other scholars [22], this paper constructs the coupling degree model between science and technology finance and high-quality economic development in Anhui Province. The specific model forms are as follows:

$$C = \sqrt{\frac{D_1 D_2}{(D_1 + D_2)^2}} \quad (6)$$

Where, C represents the coupling degree between science and technology finance and high-quality economic development in Anhui Province, D1 represents the development level of science and technology finance, and D2 represents the high-quality economic development

level. C is in the range of 0 to 1. When $C = 0$, it indicates that there is a disordered and unstable state between the two; When $C = 1$, it indicates that the two are extremely coupled and present the most stable and orderly state. The closer the value is to 1, the more highly correlated the two. Referring to the existing research results, the coupling degree is divided into six categories, as shown in Table 3.

Table 3. Standards of coupling degree division

Coupling degree	Level of coupling phase
$0 < C \leq 0.3$	Very low coupling
$0.3 < C \leq 0.4$	Low coupling
$0.4 < C \leq 0.5$	Primary coupling
$0.5 < C \leq 0.6$	Moderate coupling
$0.6 < C \leq 0.7$	Highly coupling
$0.7 < C \leq 1$	Extremely high coupling

(2) About the coupling coordination model. Based on the analysis of the coupling mechanism of high-quality development level of science and technology finance and economy, the coordinated development of the two emphasizes endogeneity, integrity and comprehensiveness. The degree of coupling reflects the degree of mutual cooperation between the two, but it can not explain whether they are coordinated or not. Therefore, in the process of quantitative analysis of the interactive state of high-quality development level of science and technology finance and economy, this paper introduces the coupling coordination model to more objectively reflect the coordinated development level of the two. The formula is:

$$E = \sqrt{C \times D} \quad (7)$$

$$D = \alpha_1 D_1 + \alpha_2 D_2 \quad (8)$$

Where, E is the coupling co scheduling and D is the comprehensive coordination index of the two. α_1, α_2 . The parameters to be evaluated, because the contribution of high-quality development of science and technology finance and economy to their composite system is the same, so in this paper $\alpha_1 = \alpha_2 = 0.5$. Based on the research results of Zhu Jianhua et al. (2019) [22], this paper divides the level of coupling cooperative scheduling, as shown in Table 4.

Table 4. Criteria for division of coupling coordination degree

Coupling coordination degree	Level of coupling coordination
$0 < E \leq 0.3$	Very low coupling coordination
$0.3 < E \leq 0.4$	Low degree coupling coordination
$0.4 < E \leq 0.5$	Primary coupling coordination
$0.5 < E \leq 0.6$	Moderate coupling coordination
$0.6 < E \leq 0.8$	Highly coupled coordination
$0.8 < E \leq 1$	Extreme coupling coordination

4.2.3. PVAR Model

In order to analyze the interaction between variables, the panel vector autoregressive model is used to further model and analyze the internal economic logic between science and technology finance and high-quality economic development. Panel vector autoregressive model has the

advantages of effectively considering individual heterogeneity and clarifying the relationship between variables. Its benchmark model is set as:

$$y_{it} = \alpha_0 + \sum_{j=1}^p \beta_j y_{i,t-j} + f_i + d_t + \varepsilon_{it} \quad (9)$$

Where, y_{it} represents the endogenous variable of the model; α_0 and β_j are the parameters to be estimated; f_i and d_t is individual effect and time effect; ε_{it} represents random error.

4.3. Data Sources

The original data of this paper comes from the statistical bulletin of science and technology of Anhui Province, Anhui statistical yearbook and the statistical yearbooks of local cities from 2011 to 2020. Linear interpolation is used to complete the missing data.

5. Empirical Analysis

5.1. Comprehensive Evaluation of Science and Technology Finance and High-quality Development Level

Through the construction of the measurement index system of high-quality development of science, technology, finance and economy in Anhui Province, based on the calculation results of entropy method, the high-quality development level of science, technology, finance and economy in 16 prefecture level cities in Anhui Province is obtained by linear weighted summation method (Table 5) [23]. The calculation results show that the high-quality development of science, technology, finance and economy in Anhui Province mainly has the following characteristics:

(1) In the development of science, technology and finance. First, the overall development level of science and technology finance in Anhui has improved. From 2010 to 2019, the development level of science and technology finance in Anhui province increased from 0.1392 in 2010 to 0.1632 in 2019, showing an overall upward trend, with an average annual growth rate of 1.78%. This is closely related to Anhui Province actively implementing national policies, paying attention to the integrated development of science, technology and finance, and creating a high-quality basic environment for "Inclusive Finance" and "mass entrepreneurship and innovation". Second, there is still a large gap in the development level of science, technology and finance in Anhui Province between local cities. As the capital city of Anhui Province, the development level of science, technology and finance in Hefei is much higher than that in other cities in Anhui. In 2019, the ratio of the comprehensive level index of science, technology and finance development between Hefei (0.7523) in the first place and Chizhou (0.0588) in the last place was 12.81:1, which shows that there is still a long way to go to narrow the differences in science, technology and finance development among cities in Anhui.

(2) In terms of high-quality economic development. First, from the development level of high-quality economic development. The provincial average rose from 0.2343 in 2010 to 0.3305 in 2019, with an average annual growth rate of 3.90%. In 2019, among the 16 prefecture level cities, the high-quality economic development level of Hefei, Wuhu, Tongling, Ma'anshan, Huangshan and Bengbu was higher than the average level of Anhui, of which southern Anhui accounted for 2 / 3. It can be seen that most areas in southern Anhui are in an advantageous position in the high-quality economic development with good geographical position, rich research and experimental development personnel and relatively complete science, technology and education policies. Central Anhui and Northern Anhui should pay attention to narrowing the high-quality economic development gap within and between regions. Second, from the perspective of the growth rate of high-quality economic development level. Hefei, Wuhu,

Chuzhou, Ma'anshan, Fuyang and Bengbu have a large increase in high-quality economic development, which may be related to the above regions adhering to the concept of innovative development and promoting the transformation and upgrading of traditional industries to high-tech industries.

Table 5. Calculation results of high-quality development level of science, technology, finance and economy in various cities of Anhui Province from 2010 to 2019

Region	Development level of science and Technology Finance				High quality economic development level			
	2010	2014	2019	Mean value	2010	2014	2019	Mean value
Hefei	0.3576	0.5020	0.7523	0.5503	0.4498	0.5614	0.7143	0.5734
Huaibei	0.0854	0.0987	0.0727	0.0787	0.1914	0.2856	0.2628	0.2467
Bozhou	0.1230	0.1804	0.0732	0.1017	0.1289	0.1387	0.2208	0.1521
Suzhou	0.2169	0.1343	0.0749	0.1133	0.1225	0.1602	0.1994	0.1572
Bengbu	0.1020	0.1345	0.1852	0.1469	0.2320	0.2890	0.3334	0.2886
Fuyang	0.1198	0.1093	0.1172	0.1052	0.0930	0.1264	0.1995	0.1363
Huainan	0.1809	0.1084	0.0846	0.1179	0.1866	0.2554	0.2336	0.2154
Chuzhou	0.0902	0.1114	0.1665	0.1241	0.1933	0.2678	0.3187	0.2568
Lu'an	0.1509	0.1137	0.0932	0.1041	0.1506	0.1785	0.2424	0.1921
Ma'anshan	0.0715	0.1087	0.1875	0.1315	0.3193	0.3987	0.4260	0.3605
Wuhu	0.1540	0.2376	0.2768	0.2403	0.3519	0.4306	0.5007	0.4221
Xuancheng	0.0863	0.0913	0.1264	0.0969	0.2288	0.2817	0.3153	0.2651
Tongling	0.0601	0.1048	0.1415	0.1024	0.4256	0.5200	0.4225	0.4109
Chizhou	0.2253	0.1041	0.0588	0.0938	0.2038	0.2760	0.3038	0.2529
Anqing	0.1081	0.1103	0.1192	0.1051	0.1969	0.2410	0.2694	0.2310
Huangshan	0.0948	0.0891	0.0806	0.0801	0.2740	0.3773	0.3246	0.3131
Mean value	0.1392	0.1462	0.1632	—	0.2343	0.2993	0.3305	—

Note: due to space limitation, only the calculation results and average values of 2010, 2014 and 2019 are listed here.

5.2. Analysis on the Coupling and Coordination between Science and Technology Finance and High-quality Economic Development

Based on the calculation results of entropy method, the high-quality development index of science, technology, finance and economy is obtained. On this basis, the coupling degree (c) and coupling coordination (E) of the high-quality development index of science, technology, finance and economy in Anhui Province are calculated by using the coupling coordination model. The calculation results are shown in Table 6. According to the classification standard of coupling value, Ma'anshan and Tongling were in the low coupling stage in 2010, and the other cities were in the primary coupling stage. However, there is still a gap among cities in specific degree, among which the coupling degree of Lu'an and Huainan is higher, reaching or approaching 0.5.

In 2019, except Chizhou and Huangshan are in the low coupling stage, other cities are in the primary coupling stage, and Hefei has the highest coupling value, reaching 0.4998.

Table 6. Coupling degree value and coupling coordination degree value of high-quality development of science, technology, finance and economy in various cities of Anhui Province

Region	2010		2019	
	Coupling degree(C)	Coupling coordination degree(E)	Coupling degree(C)	Coupling coordination degree(E)
Hefei	0.4967	0.4478	0.4998	0.6054
Huaibei	0.4619	0.2528	0.4119	0.2629
Bozhou	0.4999	0.2509	0.4325	0.2522
Suzhou	0.4803	0.2855	0.4456	0.2472
Bengbu	0.4606	0.2774	0.4791	0.3525
Fuyang	0.4960	0.2297	0.4828	0.2765
Huainan	0.4999	0.3031	0.4417	0.2651
Chuzhou	0.4658	0.2570	0.4747	0.3394
Lu'an	0.5000	0.2745	0.4479	0.2741
Ma'anshan	0.3867	0.2749	0.4607	0.3759
Wuhu	0.4601	0.3412	0.4788	0.4314
Xuancheng	0.4460	0.2651	0.4520	0.3159
Tongling	0.3294	0.2828	0.4335	0.3496
Chizhou	0.4994	0.3273	0.3685	0.2585
Anqing	0.4784	0.2701	0.4612	0.2993
Huangshan	0.4370	0.2839	0.3992	0.2844

Note: due to space reasons, only the coupling degree value and coupling coordination degree value of high-quality development of science, technology, finance and economy of various cities in Anhui Province in 2010 and 2019 are shown here.

Based on this, this paper further investigates the coupling and coordination relationship between science and technology finance and high-quality economic development in Anhui Province. From the perspective of time dimension, the degree of coupling and coordination between science and technology finance and high-quality economic development in Anhui Province has been continuously improved, but more than half of prefecture level cities are still in the stage of very low coupling and coordination. Except that the coupling coordination degree of Chizhou and Huainan decreased, the coupling coordination degree of other prefecture level cities increased. From the spatial dimension, the value of coupling coordination degree in Northern Anhui is lower than that in southern Anhui and central Anhui. This shows that for Anhui Province, the higher the level of economic development, the better the coupling and coordination between science and technology finance and high-quality economic development. The number of prefecture level cities in the stage of extremely low coupling coordination is decreasing. Among them, no prefecture level city reached the level of moderate coupling

coordination in 2010, while Hefei was in the stage of moderate coupling coordination in 2019. It can be seen that with the passage of time, more and more prefecture level cities are evolving towards a more harmonious and higher level. However, the difference of coupling coordination degree between local cities is also gradually expanding. Most prefecture level cities in Anhui Province are still in the stage of extremely low coupling and coordination between science and technology finance index and high-quality economic development index.

5.3. The Interactive Relationship between Science and Technology Finance and High-quality Economic Development

In order to further investigate the dynamic relationship between science and technology finance and high-quality economic development in Anhui Province, this paper uses panel vector autoregressive (PVAR) model for empirical analysis. In order to weaken the influence of heteroscedasticity on various variables, we take logarithms for the technology finance index and the high-quality economic development index respectively, and record them as *lnstf* and *lnhqed* respectively. In order to avoid estimation errors caused by heteroscedasticity or autocorrelation of random disturbance terms, this paper uses the Stata panel vector autoregressive program PVAR2 written by Lian Yujun's improved love I [24], and uses a more effective panel generalized moment estimation (GMM) method to estimate the model parameters [25], so as to obtain the short-term interaction coefficient between science, technology, finance and high-quality economic development in Anhui Province. At the same time, impulse response function analysis is carried out to observe the impact on itself and other variables in the future under the impact of high-quality development of science, technology, finance or economy. In the process of empirical analysis of this part of the model, the data calculation and processing, model setting and test all passed stata16 0 software completed. The specific analysis results are as follows:

5.3.1. Stationary Test

Before the PVAR estimation of the model, in order to avoid the occurrence of pseudo regression, the stability of the sequence should be tested. In this paper, LLC and IPS test methods are used to test the stationarity of science and Technology Finance (*lnstf*) and high-quality economic development (*lnhqed*) series (Table 7). The results show that *lnstf* and *lnhqed* sequences are stable.

Table 7. Results of unit root test

Sequence	Inspection method	Inspection results
lnstf	LLC	-8.4186(0.0000)***
	IPS	-3.4575(0.0003)***
lnhqed	LLC	-6.7950(0.0000)***
	IPS	-2.7102(0.0034)***

Note: the P values of LLC and IPS tests are in parentheses, ***, **, * respectively represent the significance levels of $P \leq 0.01$, $P \leq 0.05$ and $P \leq 0.1$.

5.3.2. PVAR Model Estimation

Firstly, determine the lag order, and judge the samples in Anhui Province according to AIC, BIC and HQIC criteria. The results show that the best lag period is 1 period. Use Lian Yujun's PVAR2 program for estimation [25], so as to explore the interaction mode between science and technology finance and high-quality economic development in Anhui Province (Table 8). The moment estimation results show that the impact coefficient of high-quality economic development lagging behind one period on science and technology finance is 0.1018. Through the 10% significance level test, it shows that high-quality economic development has a significant positive impact on science and technology finance. For the high-quality economic

development, the high-quality economic development lagging behind the first stage has a significant impact on it, and the impact coefficient is as high as 0.8182, while the regression coefficient of science and technology finance fails to pass the 10% significance level test, which indicates that the high-quality economic development of Anhui Province is obviously dependent on time. In short, there is a significant promotion between high-quality economic development and science, technology and finance.

Table 8. Estimation results of PVAR model

Variable	h_lnstf		h_lnhqed	
	SYS_GMM	z	SYS_GMM	z
L1.h_lnstf	0.6816***	7.03	-0.0373	-1.08
L1.h_lnhqed	0.1018	0.83	0.8182***	21.96

Note: * * *, * * and * represent the significance levels of 1%, 5% and 10% respectively; Lt. represents lag order t, h _ represents the variable processed by forward mean difference.

5.3.3. Impulse Response Analysis

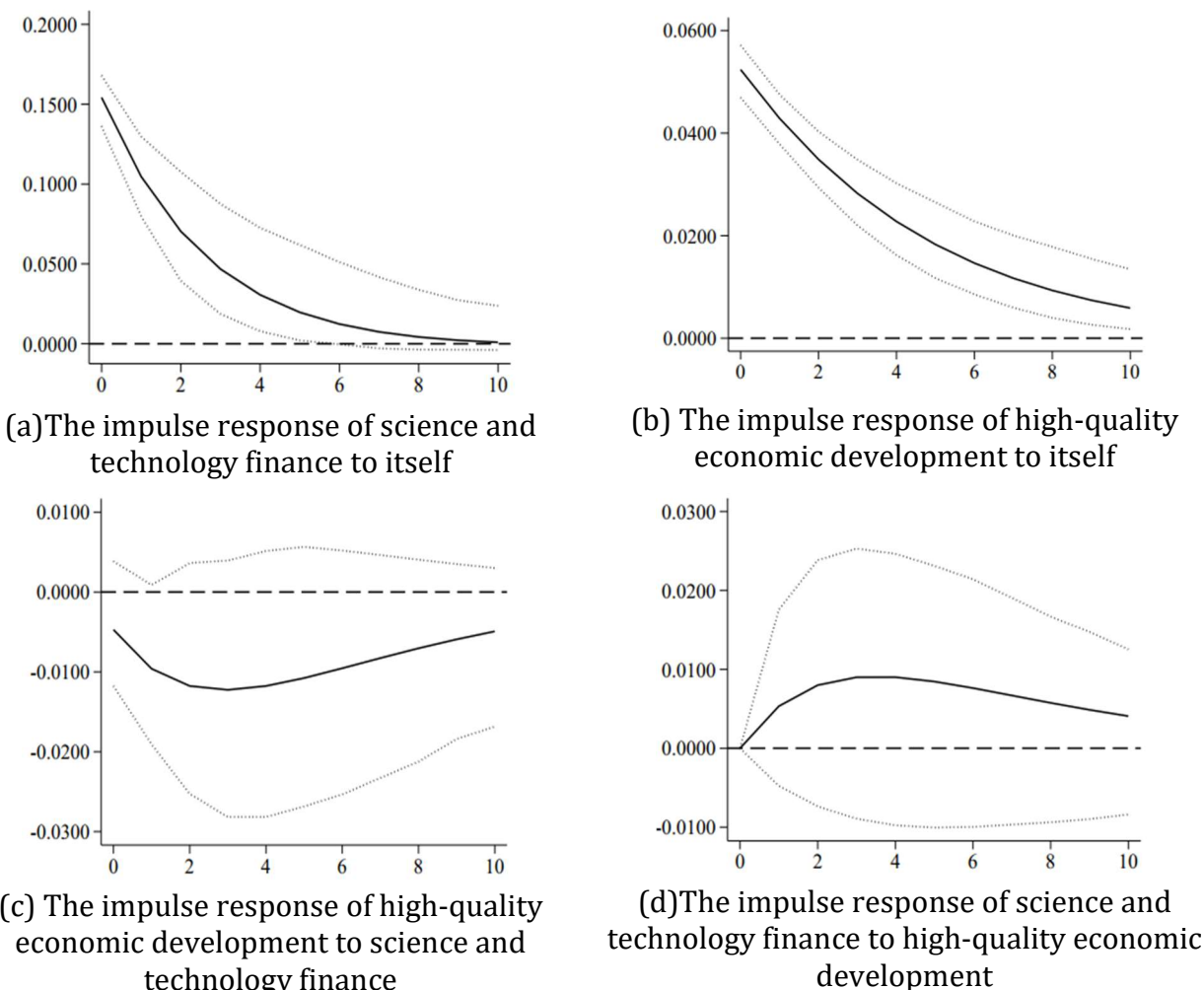


Figure 1. Impulse response analysis of high-quality development of science and technology finance and economy

In order to intuitively reflect the response mechanism of high-quality development of science, technology, finance and economy in Anhui Province, 200 Monte Carlo simulations are carried out in this paper, and the time is set to 0-10 periods to obtain the impulse response diagrams of the two systems (Figure 1). Among them, figure (a), figure (b), figure (c) and figure (d)

respectively show the impulse responses of science and technology finance to itself, high-quality economic development to itself, high-quality economic development to science and technology finance and science and technology finance to high-quality economic development. All four show a convergence trend, indicating that the PVAR model is stable. In terms of the impact of high-quality development of science, technology, finance and economy on itself, when impacted by itself, the impact on the current period reaches the maximum, and then the impact gradually decreases, but it still maintains a continuous positive impact, indicating that the high-quality development of science, technology, finance and economy in Anhui province depends on its own development. As can be seen from figure (c), the feedback of science and technology finance impacted by a standard deviation of high-quality economic development has maintained a negative effect during the investigation period, reached the maximum in the third period, and then the negative force is gradually weakening. In the long run, high-quality economic development promotes the development of science, technology and finance; Figure (d) shows that when high-quality economic development is impacted by science and technology finance, the response value continues to be positive before phase 3, and gradually weakens after reaching the maximum in phase 3, until it tends to zero and is basically stable. This shows that high-quality economic development in Anhui Province will promote the development of science and technology finance, which is basically consistent with the above GMM estimation results, and further shows the interactive relationship between science and technology finance and high-quality economic development.

6. Conclusions and Suggestions

6.1. Conclusions

(1) During the sample investigation period, the overall development level of science and technology finance in Anhui Province showed a fluctuating upward trend. With the passage of time, the regional differences in the development level of science and technology finance gradually appear. Hefei, Wuhu, Bengbu and Maanshan have a high level of scientific and technological financial development, while Xuancheng, Chizhou, Huangshan and Huaibei are in a backward position. The overall high-quality economic development level of Anhui Province shows a significant upward trend, but the gap between prefecture level cities is also further widening. Hefei, Wuhu, Tongling, Ma'anshan, Huangshan and Bengbu have high-quality economic development. On the whole, the high-quality development level of Southern Anhui is in the leading position, followed by central Anhui, and Northern Anhui is at a low level.

(2) In terms of time, from 2010 to 2019, the coupling and coordination average value of high-quality index of science, technology, finance and economy in Anhui province increased from 0.2890 in 2010 to 0.3244 in 2019, which is in a stage of steady progress. From the perspective of space, there are great differences in the coupling degree and coupling coordination degree of local cities. In 2010, more than half of the prefecture level cities in the province were in the stage of extremely low coupling and coordination. With the improvement of the ecological environment and operation efficiency of science and technology finance, the coordinated development level of science and technology finance and economy has improved. In 2019, more and more prefecture level cities reached the standard of low coupling and coordination, but the differences between regions have become more and more significant. Generally speaking, the coupling and coordination level between science and technology finance and high-quality economic development in Anhui Province has not reached a high level, and there is still a lot of room for improvement.

(3) In terms of the interactive relationship between the two, the interactive relationship between science and technology finance and high-quality economic development in Anhui province needs to be strengthened. At this stage, there is a strong self enhancement mechanism

in the high-quality development of science, technology, finance and economy in Anhui Province. There is no significant promotion between science and technology finance and high-quality economic development. In the long run, high-quality economic development can promote the development of science and technology finance. Science and technology finance has positive feedback on high-quality economic development, but the effect is not obvious.

6.2. Suggestions

(1) Pay attention to the development efficiency of science, technology and finance and improve the high-quality development level of economy. While paying attention to the development of science, technology and finance, all regions of Anhui Province should pay attention to the transformation efficiency of scientific, technological and financial achievements, reasonably allocate funds to serve the field of science and technology, and reduce redundant investment. Further deepen the structural reform of the financial supply side, promote the establishment of a financial system and mechanism suitable for the high-quality economic development of Anhui Province, and then promote the high-quality economic development level to a new level.

(2) Enhance regional relevance and give play to the driving role of the growth pole. According to the results of the coupling coordination model, the coupling coordination degree of high-quality development of science, technology, finance and economy in most prefecture level cities in Anhui Province is still in the low coupling stage. It is urgent to strengthen the regional coordination and correlation between them. With reference to some policies on the transformation of scientific and technological achievements implemented in Hefei, give full play to the radiation and driving role of Hefei, promote Wuhu and other cities to become new growth poles, strengthen the policy support for science, technology and finance in Northern Anhui, improve the local service level of science, technology and finance, and help form a spatial layout of coordination and cooperation between science, technology and finance in Anhui Province.

(3) We will improve the science, technology and financial support system and stimulate the vitality of financial development. According to the estimation results of panel vector autoregressive model, the interaction between science and technology finance and high-quality economic development in Anhui Province is not significant. At this stage, we need to improve the level of modern financial service industry, establish a risk mitigation mechanism for science and technology finance business, and create a good environment for the development of science and technology finance; Accelerate the conversion efficiency of scientific and technological financial achievements and promote them to better serve peer-to-peer enterprises; Build a more effective inclusive financial service system, promote it to serve all social strata and groups with financial service needs, and promote the economic development of Anhui Province with higher quality.

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