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The Development Path of Financial Promotion of Science and Technology Innovation in the Context of New Quality Productivity Development

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Abstract. Science and technology innovation is the kernel of developing new quality productivity, and finance has an important role in promoting science and technology innovation. Based on this, this paper studies the path of financial boosting of science and technology innovation, selects the national panel data from 2013 to 2022, adopts the entropy value method to determine the weight of each index and calculate the comprehensive value, and establishes the VAR model of financial input and science and technology innovation development. It is found that 35% of the changes in the development of science and technology innovation can be explained by financial inputs, and further puts forward suggestions to improve the breadth, depth and precision of financial services for science and technology innovation in four aspects: innovating the form of financial inputs, improving the matching precision between financial services and science and technology innovation needs, innovating the financial service system and optimizing the financial ecological environment, so as to provide reference and reference for the formation and development of the development of new-quality productivity.

Keywords: New Quality Productivity; Financial Investment; Science and Technology Innovation.

1. Introductory

In order to comply with the trend of the new technological revolution and industrial change, and to solve the problem that China's productive forces need to undergo a new change, General Secretary Xi Jinping emphasized during his visit to Heilongjiang in September 2023, "integrating scientific and technological innovation resources, leading the development of strategic emerging industries and future industries, and accelerating the formation of new-quality productive forces", and for the first time put forward the new concept of "new-quality productive forces", emphasizing its specific embodiment as an advanced productive force. For the first time, the new concept of "new quality productive forces" was put forward, emphasizing its concrete embodiment as advanced productive forces. Science and technology innovation, as the main external manifestation of the new quality productivity, can better represent its level of development. Therefore, in order to make the rapid development of the new quality productivity, the most important thing is to promote the level of scientific and technological innovation development. Financial investment is the main factor to promote the development of science and technology innovation. Based on this, this paper explores the relationship between finance and scientific and technological innovation, and explores the development path of finance to promote scientific and technological innovation in the context of new quality productivity, so as to promote the development of new quality productivity.

2. Overview of New Quality Productivity

The new quality of productive forces is, in general, the contemporary advanced productive forces that have been spawned by revolutionary technological breakthroughs, innovative allocation of factors of production, and transformation and upgrading of industrial structure, and it is a double upgrade of China's traditional productive forces in terms of both "newness" and "quality". General Secretary Xi Jinping emphasized in the eleventh collective study of the Political Bureau of the CPC Central

Committee that "scientific and technological innovation can give rise to new industries, new modes, and new kinetic energy, and is the core element for the development of new-quality productive forces. It is necessary to strengthen scientific and technological innovation, especially original and disruptive scientific and technological innovation." From this, it can be seen that the new quality of productive forces is an advanced productive force that takes scientific and technological innovation as its main form of expression and realizes the dual upgrading of "newness" and "quality".

Since the proposal of new quality productivity, many scholars in China have conducted research on it. **Xie Mei(2024)**0 Xie Mei pointed out that "new quality productivity is the advanced productivity quality with high-tech, high-efficiency and high-quality features in which innovation plays a leading role"; **Du Chuanzhong et al.(2024)** [2] Through the analysis of theoretical logic, historical logic and practical logic, it is concluded that "new quality productivity, as a systematic concept, is the total power of all production factors. Among them, science and technology are the most important factors". **Zhang Yifan et al. (2024**) [3] Through the classical theory combing and literature review, we construct the theoretical framework of science and technology finance to support the new quality productivity, and put forward that "science and technology finance is in the core position in the development of new quality productivity." Therefore, as the main expression of the development of new quality productivity, the most important thing is to improve the level of scientific and technological innovation in order to truly promote the development of new quality productivity.

3. Mechanisms of the Impact of Financial Inputs on the Development of Technological Innovation

3.1. Financial Inputs provide Financial Support Mechanisms

Financial inputs provide the necessary financial support for Technological Innovation. Scientific and technological innovation, including research and development, testing, production and other phases, often requires a large amount of capital investment, while financial institutions can provide a stable source of funds for scientific and technological innovation by absorbing social savings and transforming them into investment funds. It helps to alleviate the financial bottleneck of science and technology innovation and promote the smooth progress of science and technology innovation projects.

3.2. Financial Inputs Provide Risk Diversification Mechanisms

Science, technology and innovation are high-risk, and financial inputs can effectively diversify such risks. By means of investment portfolios and other means, financial institutions can spread risks across multiple projects or multiple fields and reduce the impact of the failure of a single project on the entire portfolio. In addition, financial institutions can make more accurate predictions and manage risks through technologies such as big data analysis, providing a more robust financial environment for science and technology innovation.

3.3. Financial Inputs Provide Information Guidance Mechanisms

In the process of investment decision-making, financial institutions will strictly screen and evaluate science and technology innovation projects, which will help guide the flow of resources to projects with more innovative potential and market prospects. The information advantage of financial institutions can help innovation subjects better understand market demand, technology development trend, etc., providing strong information support for science and technology innovation.

3.4. Financial Inputs Provide Incentives and Constraints

By providing financing support, financial inputs can incentivize innovation mainstays to increase R&D investment and promote the in-depth development of science and technology innovation. At the same time, financial institutions will also supervise the use of funds by innovative subjects to

ensure that the funds are used for scientific and technological innovation projects and to avoid misappropriation or misuse of funds, which in turn will help to guarantee the smooth progress of scientific and technological innovation.

4. Empirical Research

4.1. Model and Indicator Selection

4.1.1. Model Selection

In this paper, the VAR model, or vector autoregressive model, is used in conducting the regression analysis, which specifically means that in the study of the complex system of financial inputs affecting the level of scientific and technological development, the main representative variables of the two are predicted separately as a whole, so as to derive the relationship between them.[4] The general expression of the VAR model is

$$Y_t = C + \Phi_1 Y_{t-1} + ... + \Phi_t Y_{t-p} + \varepsilon_t, t = 2013,\ 2014,\ ..., 2022$$

where Yt is an n-dimensional vector time series, C is a constant vector of n dimensions, p is the lag order, and t is the sample size.

4.1.2. Selection of Indicators

Table 1. System of Indicators for Evaluating the level of Scientific and Technological Development

Level 1 indicators	Secondary indicators	Specific indicators
Innovative Inputs	Financial Investment	Investment in Research and Development
	Manpower Inputs	Research and Development Staff then full
	Facility Inputs	Investment in Scientific Research facilities and equipment
Innovation Outputs	Knowledge Outputs	Number of Scientific and Technological Achievements
		Number of Patent Applications
		Number of Patents Granted
		Scientific and Technical Papers included in major Foreign Search Tools
	Technology Transformation	Amount of Contracts Transacted in the Technology Market
		Number of Technology Market Contracts
Innovation Efficiency	Number of R&D	Number of R&D Topics
	ScienceTechnology and Innovation Index	Science, Technology and Innovation Index
Innovation Environment	Infrastructure Development	Cell phone penetration Rate Road Density
	Government Support	Share of S&T Expenditures
	Talent support	Average Number of Students Enrolled in high level education per 100,000 population

(1) This paper draws on **Peng Kunjie et al.(2024)**[5] and **Zhuying et al.(2016)**[6] the research system of Peng Kunjie et al. and select innovation input, innovation output, innovation efficiency and innovation environment as the first-level indicators of the evaluation system of the level of scientific and technological development, and the description of the specific indicators is shown in Table 1.

This Paper Selects Government Financial Allocation, Financial Institution Loan, Capital Market Financing and Risk Investment Indicators to construct the evaluation system of Financial Inputs.[7] The description of specific indicators is shown in Table 2.

Table 2. Financial Input Evaluation System

Level 1 Indicators	Specific Indicators
Loans from Government Agencies	State financial allocations for science and technology
Loans from Financial Institutions	Balance of loans from Financial Institutions at the end of the year
Capital Markets Financing	Domestic A-share Fundraising
Venture Capital	Internal Expenditure on R&D funding from other funds

(2) Sample Data Source: in order to ensure the authority and validity of the data, this paper selects the panel data of the relevant indicators nationwide from 2013 to 2022, which are all from China Statistical Yearbook, China High-tech Industry Statistical Yearbook, China Science and Technology Statistical Yearbook, and the website of the National Bureau of Statistics.

4.1.3. Indicator Measurement

In order to avoid subjective influence and make the results more objective, this paper adopts the entropy value method[4] to determine the weights and measure the synthesized value, and the measurement steps are as follows:

Step1: Constructing the Indicator Matrix

Assuming m years, n evaluation indicators, and Xij is the value corresponding to the jth indicator in the ith year (i=1, 2, ..., m; j=1, 2, ..., n), a matrix of indicators of order m*n can be generated.

$$X=(X_{ij})_{m\times n}=\begin{bmatrix} X11 & \cdots & X1n \\ \vdots & \ddots & \vdots \\ Xm1 & \cdots & Xmn \end{bmatrix}$$

Step2: Normalize the Indicator Matrix

In order to ensure that the indicators are comparable with each other, it is necessary to eliminate the influence of the scale of the data, so standardization is applied to the evaluation indicators. The standardization formula is:

Positive normalization: $Xij=\frac{Xi-Xmin}{Xmax-Xmin}$; Negative normalization: $Xij=\frac{Xmax-Xi}{Xmax-Xmin}$

Step3: Find the Specific Gravity P Value

The formula is: $P_{ij}=\frac{X_{ij}^{'}}{\sum_{i=1}^{m}X_{ij}^{'}}$

Step4:Calculate e-entropy Value

The formula is: $e_j=-k.\sum_{i=1}^{m}[P_{ij}\times\ln(P_{ij})],k=\frac{1}{ln(n)}$

Step5: Determine the Weight of the jth Indicator

Calculated as: $W_j = d_j \Big/ \sum_{j=1}^{n} d_j$, where dj is the redundancy of the information entropy of the indicator

Step6: Calculate the Composite Value for each year by Applying the linear Weighting Method

The formula is: $T_{score} = \sum_{j=1}^{n} (W_j \times X_{ij})$

4.2. Empirical Analysis

The results obtained by measuring the synthesized values using the entropy method are shown in Table 3.

Table 3. STI Development Index IT and Financial Input Level Index FI (in %)

Vintages	STI Development Index (%)	Financial Input Level Index (%)
2013	5.83	0.00
2014	5.33	7.87
2015	8.72	18.41
2016	18.74	33.90
2017	29.28	40.21
2018	45.19	53.70
2019	62.25	67.07
2020	71.11	77.05
2021	90.96	94.57
2022	100.00	65.10

4.2.1. Stability Tests

Considering that the statistical data utilized in this paper are time series data, most of which are non-stationary variables, it is very easy to appear the phenomenon of "pseudo-regression" when they are directly included in the VAR model. In order to avoid this phenomenon, this paper on the level of development of science and technology innovation indicators (LNIT) and financial investment indicators (LNFI) to carry out a time series of smoothness test, the use of ADF unit root test method test. According to the results of the test in Table 4, it can be concluded that the P-value of the original variable series of financial input and scientific and technological innovation development is less than 0.05, which indicates that these variables are smooth and pass the smoothness test at the 5% significant level.

Table 4. ADF unit root test results

Variant	ADF Test Value	5% Threshold	P-Value	Test Results
LNFI	-5.080714	-3.320969	0.0056	smoothly
LNIT	-4.683290	-3.320969	0.0089	smoothly

4.2.2. Optimal Lag Order Determination

To establish an effective VAR model, the first and crucial step is to determine the optimal lag order. In this paper, the optimal lag order of the model is determined by using the integrated statistics index,

according to the minimum value criterion of AIC and SC, and the test results are shown in Table 5, which determines that the optimal lag order is 1, so it is necessary to establish a VAR (1) model.

Table 5. VAR lag order test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1.359546	NA	0.008987	0.959870	0.944416	0.768859
1	16.83416	20.79281*	0.000175*	-3.095474*	-3.141837*	-3.668509
2	19.98246	1.799029	0.000409	-2.852132	-2.929403	-3.807190*

Note: * indicates the number of steps under this item.

4.2.3. Cointegration Tests

The unit root smoothness test concludes that the variable series are all single-integrated smooth series of the same order, which can be further tested for cointegration using the Johansen test to observe whether there is a long-run equilibrium relationship between these variable series. The test results are shown in Table 6.

Table 6. Cointegration Test Results

Original Hypothesis	Eigenvalue (math.)	Trace Statistic	5% Threshold	P-Value
None*	0.897781	29.19097	15.49471	0.0003
At Most 1*	0.745443	10.94585	3.841466	0.0009

From the above table, the trace statistic test shows that the P-value at 5% significance level implies that there are 2 cointegrating relationships and hence there is a long run equilibrium relationship between the time series.

4.2.4. VAR Model Stability Test

After the VAR model is constructed, the stability of the VAR model can be further judged by the AR root plot. If the mode of all AR unit roots is less than 1, this means that all eigenvalues are within the unit circle, which indicates that the model has stability; if there is an eigenroot outside the unit circle, the opposite is true. As can be seen from Figure 1, all the eigenroot values are within the unit circle, which indicates that the constructed VAR model is stable.

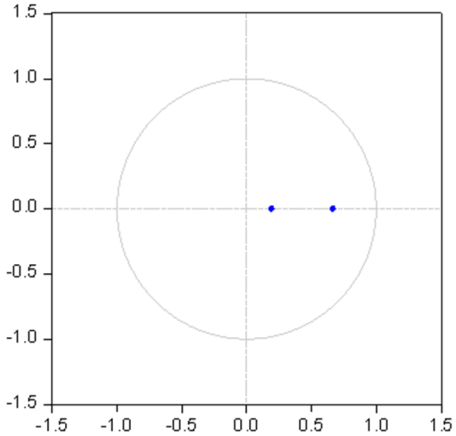

Fig 1. Smoothness test of VAR (1) model

4.2.5. Granger Causality Tests

In this paper, the Granger causality test can be used to find out whether there is a causal relationship between IT and FI, and the results of the test are shown in Table 7, which indicates that financial investment is the main reason for enhancing the level of STI development.

Table 7. Granger Causality Test

Original Hypothesis	Statistic	P-Value
Granger reasons why LNFI is not LNIT	7.440042	0.0064
Reasons why LNT is not LNFI's Granger	0.057814	0.8100

4.2.6. Impulse Response

The impulse response function analysis method is highly intuitive, and the impact effect between the variables can be observed from the graph of the impulse response function. Fig. 2 Impulse response results of the impact of financial investment on the development of science and technology innovation. From the figure, it can be seen that financial inputs have positive impacts on the development of science and technology innovation from the first period to the tenth period, in which the degree of impacts from the first period to the second period shows a linear increase, and reaches the maximum value of positive impacts in the second period, and the maximum degree of impacts at this time is close to 0.08, which indicates that the financial inputs always have a positive impact on the development of science and technology innovation, no matter it is short-term or long-term development.

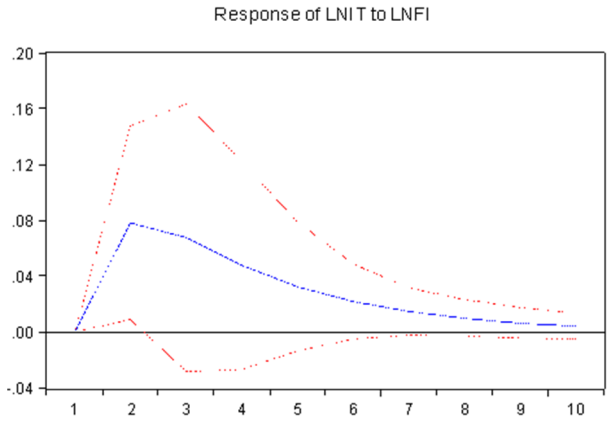

Fig 2. The role of Financial Inputs in shocks to STI development

4.2.7. Variance Decomposition

Table 8. Results of Variance Decomposition

Period	S.E.	LNIT	LNFI
1	0.083418	100.0000	0.000000
2	0.152537	73.78296	26.21704
3	0.183411	68.36350	31.63650
4	0.196796	66.56833	33.43167
5	0.202644	65.86986	34.13014
6	0.205224	65.57757	34.42243
7	0.206370	65.45091	34.54909
8	0.206880	65.39510	34.60490
9	0.207108	65.37032	34.62968
10	0.207210	65.35927	34.94073

The variance decomposition is used to analyze the contribution of structural shocks affecting the endogenous variables of a given time series in order to explain the relative importance of each

perturbation on the endogenous variables of the VAR model, and the results of the decomposition are shown by Table 8.

As can be seen from Table 8, the degree of influence of financial inputs on STI development in the long run increases period by period and stabilizes at 35%. This indicates that about 35% of the changes in STI development can be explained by financial inputs. Taken together, the variance decomposition shows that financial inputs have a large degree of influence on STI development, which indicates that the increase of financial inputs will have a large positive influence on STI development.

5. Conclusion and Recommendations

5.1. Conclusion

Using a combination of theoretical analysis and empirical analysis, this paper explores the important role of financial inputs in the development process of the level of science and technology innovation by establishing a VAR model, and draws the following conclusions: (1) Financial inputs provide strong support and guarantee for the development of science and technology innovation through the mechanisms of financial support, risk diversification, information guidance, incentive constraints and so on. (2) Granger causality test shows that financial investment is the main reason for boosting the development of science and technology innovation. (3) The impulse response function image shows that financial investment will always have a positive impact on the development of science and technology innovation in both short-term and long-term development. In summary, our government must fully recognize the important role of financial support in the process of improving the level of scientific and technological innovation development, and continuously improve the financial investment to better serve the development of new quality productivity.

5.2. Recommendations

Finance is committed to the level of scientific and technological innovation and the common development of new quality productivity, at present, China has established a relatively complete financial policy system, a variety of financial instruments have a certain scale of development[8] On this basis, this paper, through the conclusion of the study, accordingly puts forward the following policy recommendations:

5.2.1. Increased Government Guidance and Innovative Forms of Financial Inputs

In order to better solve the problem of financial investment in the process of technological innovation development, firstly, the government should strengthen the key position of financial investment and financing, introduce relevant policies to encourage and guide financial institutions to increase investment in scientific and technological innovation ; secondly, innovate the form of financial investment, such as adopting preferential tax policies and financial subsidies to reduce the cost and risk of financial institutions supporting scientific and technological innovation; set up scientific and technological innovation special funds to provide loans for projects and enterprises with significant innovation potential; vigorously develop the bond market to support more science and technology-oriented enterprises to obtain sustainable medium- and long-term financing through issuing bonds. Secondly, innovative forms of financial input, such as tax incentives and financial subsidies, to reduce the cost and risk of financial institutions to support scientific and technological innovation; the establishment of a special fund for scientific and technological innovation, to provide loans for projects and enterprises with significant innovation potential; and vigorously develop the bond market, to support more science and technology-based enterprises to obtain sustained medium- and long-term financing through the issuance of bonds, to help promote the level of scientific and technological innovation and development.

5.2.2. Enhancing Matching Accuracy to Achieve Full Financial Coverage

First of all need to improve the development of science and technology innovation evaluation system. It is necessary to pay more attention to the effective evaluation of scientific and technological innovation ability, scientific and technological achievements transformation potential, etc. Secondly, it is necessary to innovate financial products and services. For the different needs of science and technology innovation enterprises, develop customized financial products and services, such as intellectual property pledge loans, science and technology insurance, etc.; the use of financial science and technology means to improve the level of intelligence and personalization of financial services, reduce the cost of financing and improve the efficiency of financing; and lastly, to cultivate financial talents and improve financial literacy. Only with sufficient professionals with high financial literacy can financial institutions better understand and assess the risk and value of science and technology innovation, and take more precise and differentiated measures.

5.2.3. Innovative Financial Services Systems to strengthen Risk Management and Control

In supporting science and technology innovation, finance is prone to various risks. How to strengthen the management and control of these risks and create a sustainable profit model is the first problem to be solved. First, through continuous reform and innovation, we should build a financial service system that can better promote the development of science and technology-based enterprises. For example, market risks can be reduced through phased investment and setting milestones; credit enhancement measures such as guarantees and insurance can be taken to reduce credit risks; and liquidity risks can be reduced through financial institutions' rational planning of capital utilization to ensure sufficient financial support capacity in the process of science and technology innovation. Secondly, a perfect risk assessment and management mechanism should be established to strictly screen and assess the science and technology innovation projects to ensure the safety and effectiveness of financial input. Finally, a third-party risk assessment organization can be introduced to provide financial institutions with independent and objective risk assessment opinions to help them better control risks.

5.2.4. Optimize the Financial Ecological Environment and Enhance the Atmosphere of Financial Assistance for the Development of Technological Innovation

A good financial ecosystem plays an important role in promoting the development of science and technology innovation. Firstly, strengthen the construction of financial infrastructure, including the construction of credit system and the development of credit agencies, so as to improve the efficiency and convenience of financial services; secondly, strengthen the construction of information database of technological enterprises, promote the docking cooperation between financial institutions and science and technology innovation enterprises, establish long-term and stable cooperation relationship, guide financial resources to support key science and technology innovation fields with more precision, and promote the in-depth fusion of financial resources and scientific and technological resources, so as to smooth the "science and technology-industry-financial environment". Finally, it will further improve supporting policies such as intellectual property pledge financing, expand the scope of online registration of intellectual property pledges by banking financial institutions, and enhance the convenience of enterprise financing.

6. Conclusion

Science and technology innovation is the kernel of the development of new quality productivity, and finance has an important role in promoting science and technology innovation.This paper combines theoretical analysis and empirical analysis to construct a VAR model and concludes that financial investment is the main reason for promoting the development of scientific and technological innovation, so it is necessary to pay attention to improving the level of financial investment and put forward the following four aspects: innovating the form of financial inputs, improving the precision of matching the demand for financial services and scientific and technological innovation, innovating

the financial service system and optimizing the financial ecological environment. Relevant ideas and suggestions. Looking to the future, it is still necessary to improve the breadth, depth and precision of financial investment in science and technology innovation, so as to better serve the development of new quality productive forces and contribute to the promotion of high-quality economic development.

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