How does Sci-tech Finance Affect the Structural Upgrading of China's Service Industry?

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Abstract. Combined with the rise of science and technology finance(sci-tech fin) in the current digital age, this paper selects panel data of 30 provinces and cities from 2011 to 2020 to build a two-way fixed effect model, and empirically analyzes the influence of fintech on the structural upgrading of Chinese service industry. The results show that sci-tech finance significantly positively pushes forward the structural upgrading of the service sector with regional heterogeneity, which is specifically manifested in the positive promoting effect on the central and western areas. Additionally, the level of financial regulation and government expenditure can enhance the influence of sci-tech finance on the service industry structure promoting. Based on this, the paper puts forward some policy suggestions on developing sci-tech finance and deepening the combination of technology finance and service industry.

Keywords: Sci-tech Finance; Industrial Structure Upgrading; Producer Services; Two-way Fixed Effect Model.

1. Introduction

Along with the modernization and digital pullulation of Chinese economy, the reform of industrial optimization brings forward new requirements for the high-quality pullulation of modern service industry system. Over recent years, China's service sector has expanded its size ceaselessly, the structure of the service sector has been continuously optimized, and bright spots of new growth drivers have emerged, with huge potential for development, according to a series of CPC reports. In July 2020, the 14th Five-Year Plan emphasized that it is imperative to accelerate the pullulation of modern service industry, promote the extension of producer services to specialization and higher end of the value chain, and accelerate the digitization of tertiary industry. It can be seen that the traditional tertiary industry has embarked on a new journey of accelerating transformation and deeply integrating with other industries. Nowadays, the digital process has become an irreversible process, and the deep fusion of digital econ and real econ has become a powerful actuator for the high-quality development of China's economy[7]. Digital economy empowerment is one of the important ways to transform and upgrade the service industry. It can not only improve the labor productivity, expand the business scope and function, but also realize the long-distance transportation across regions and countries. As one of the new forms of business in digital economy, sci-tech finance is exerting a strong influence on the contemporary social economy. The development of sci-tech fin plays a significant role in promoting the optimization of structure of industry and the rational distribution of market resources. Therefore, in the context of the combination of the two, it is of enormous theoretical significance and practical value to learn sci-tech finance for the upgrading of service industry.

2. Literature References

For the past few years, the research on sci-tech finance has attracted attention in the academic circle, and the current literature conclusions mainly focus on the following two aspects.

On the one hand, the pullulation of the financial sector is conducive to the industrial upgrading. Some scholars, who believe that the pullulation of green finance can optimize and upgrade the industrial structure(Nian and Dong, 2022; Wang and Li, 2022)[20][21]. In terms of carbon emissions, Yang et al. (2023)[23] believes that financial expansion is a significant impetus for the rise of carbon

emissions. However, Yan et al. (2022)[22] believe that high financial geographic density can reduce carbon emission intensity by accelerating industrial structure upgrading. Jiang et al. (2020)[19] reflects financial development by OFDI and believes that foreign investment has a positive impact on the structure of industry. In addition, some scholars point out that financial aggregation can indirectly improve the level of industrial structure through technological innovation (Wang and Zhao, 2020)[17]. In the context of the combination of fin, sci and tech, some scholars have proved through in-depth theoretical analysis that science and technology finance has significant and positive policy effects on the promotion of industrial structure (Zhang and Wang, 2023)[10], and such positive policy effects show an increasing trend over time (Hu and Liu, 2021)[16]. In terms of industrial coupling degree, some scholars have proved that the coupling degree between science and technology finance and industrial structure upgrading shows an upward trend (Feng et al. 2022)[15], further demonstrating that sci-tech fin has an enormous promoting effect on industrial structure upgrading, but such an effect has regional heterogeneity. Specifically, the promotion effect of the western region is stronger than that of the central and eastern areas (Bai et al. 2022)[13]. In terms of the influence path, some scholars have found that the influence of sci-tech financial input on industrial structure presents an "inverted U-shaped" nonlinear feature, proving that sci-tech fin input, which can affect the technical innovation and then to industrial structure upgrade (Gui et al. 2022)[14], and also promote the industrial structure by improving the level of entrepreneurial vitality (Bai et al. 2022)[13].

On the other hand, the impact assessment of sci-tech fin. In aspect of economic growth, some consider that sci-tech fin can significantly push forward the pullulation of real economy in a broad sense and has positive spatial spillover effect (Wang and Tao., 2023) [5]. Further on this basis, Gao and Li, (2023) proves that the pullulation of sci-tech fin can significantly promote the development of regional economy, among which, its influence path is to improve the level of innovation and narrow the urban-rural income gap[4]. In terms of related industries, some scholars, through theoretical analysis, believe that digital finance can produce synergistic effect with e-commerce, and improve the efficiency of e-commerce to help farmers by easing financing constraints (Zhou et al. 2023) [3]. Some believe that sci-tech fin can promote the high-quality pullulation of cultural industry by positively influencing innovation ability, coordination level, openness, sharing level and industrial benefits (Li, 2023)[1]. In terms of enterprises, some scholars believe that digital finance can promote technological innovation of enterprises by improving their level of risk-taking and reducing their reform costs (Zhang et al. 2023)[2]. From the perspective of factor input, some scholars prove that digital finance can promote the digital transformation of manufacturing enterprises through talent introduction and R&D input (Pan and Zhang, 2023)[8].

To sum up, most of the available literature studies the impact of financial pullulation on the tertiary industry, often ignoring the role of sci-tech fin on the high-quality development of the service industry. Compared with the existing literature, the contribution may lie in the aspects below: first, it directly calculates the impact by using the fintech index; The second is to further use government expenditure on sci and tech and government regulation as moderating variables and pay more attention to the role of the government in the influencing process. The findings of this paper provide new ideas for the high-quality pullulation of China's tertiary industry in the era of digital economy, and provide an instructive reference.

3. Research Design

3.1 Model Setting

In order to verify the influence of sci-tech fin on the structural upgrading of service sector, panel model (1) is set up in this paper on the basis of controlling population, transportation facilities, economic development, government intervention and trade factors.

$$Upgrade_{it} = \alpha_0 + \alpha_1 Sci - tech\ fin_{it} + \alpha_2 Control_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Among them, i represents the corresponding province or city, t indicates the year. $Upgrade_{it}$ indicates the Upgrade degree of service industry structure of i province or city in t year,

$Sci-tech\ fin_{it}$ represents the development level of sci-tech finance of i province or city in t year, $Control_{it}$ represents a series of Control variables, μ_i represents the individual fixed effect, λ_t is the time fixed effect, ε_{it} is the random disturbance term, α_0 is the constant term. α_1 is the total impact of the development of science and technology finance on the structural upgrading of the service industry, and is the core coefficient value of this paper. The sign expectation of α_1 is positive.

To test the moderating effect, panel models (2) (3) was established.

$$Upgrade_{it} = \alpha_0 + \alpha_1 Fintech_{it} + \alpha_2 Control_{it} + \alpha_3 Sci-tech\ fin \times LnFinreg_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$Upgrade_{it} = \alpha_0 + \alpha_1 Fintech_{it} + \alpha_2 Control_{it} + \alpha_4 Sci-tech\ fin \times LnTech_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

$LnFinreg_{it}$ represents the level of financial supervision of i province or city in t year, $LnTech_{it}$ represents the level of scientific and technological expenditure of i province or city in t year, $Sci-tech\ fin \times LnFinreg_{it}$ represents the interaction between the level of technological and financial development and the level of financial supervision. $Sci-tech\ fin \times LnTech_{it}$ represents the interaction term between the level of Fintech pullulation and the level of science and technology expenditure. Other variables are consistent with model (1).

3.2 Variable and Data Description

3.2.1 Upgrading the Structure of the Service Sector

Academic circles believe that producer service industry is the main component in the global service industry at the present stage, and its increasing proportion can represent the optimization of the tertiary industry structure (Dai et al. 2023)[9]. From the perspective of producer service industry, this paper takes Yuan and Xia, (2022)[12] as reference. The ratio of productive service sector employees to tertiary industry employees (PS) and high-end service sector employees to tertiary industry employees (HS) were used as indicators to measure the structural upgrading of service industry.

3.2.2 Sci-tech Finance

The PKU-DFIIC, compiled by PKU Digital Finance Research Center ae well as Ant Technology Group, is selected to measure the pullulation of technology finance. The index covers the data of all provinces from 2011 to 2020, which has strong authenticity and reliability.

3.2.3 Control Variables

Mainly selects control variables from five sides: population, traffic facility level, economic development level, government intervention degree and economic opening level. Specifically, the number of populations is measured by population density (natural logarithm), the level of transportation facilities is expressed by the proportion of railway and highway mileage in the area of the province (natural logarithm), the level of economic development is reflected by per capita GDP (natural logarithm), the proportion of government intervention in GDP measured by fiscal expenditure, the level of economic openness is expressed by the proportion of Exim volume in GDP.

3.2.4 Adjust Variables

Referring to relevant literature of Zhang et al. (2022)[11], this paper selects sci-tech expenditure and financial regulation as moderating variables. Specifically, the proportion of science and technology expenditure in fiscal expenditure is used to measure the level of science and technology expenditure, and the proportion of financial regulation and other affairs expenditure in fiscal expenditure represents the level of financial regulation.

3.2.5 Data Sources

Select panel data of 30 provinces (2010-2020) as research samples. All data are from the PKU-DFIIC and China Macroeconomic database over the years

Table 1. Descriptive statistical results of main variables

Variable representation		obs	Mean	Maximum value	Minimum value	Standard diviation
Explained variable						
PS	Upgrading the structure of service industry I : Proportion of employees in producer service industry in tertiary industry (%)	300	0.28	0.53	0.17	0.07
HS	Upgrading the structure of service industry II : Proportion of employees in high-end service industry in tertiary industry (%)	300	0.19	0.44	0.11	0.06
Core explanatory variable						
Sci-tech fin	Development level of sci-tech finance, aggregate index	300	217.25	431.93	18.33	96.81
Explanatory variable						
Breadth	Coverage of digital finance	300	198.01	397.00	1.96	96.17
Depth	Depth of use of sci-tech fin	300	212.04	488.68	6.76	97.94
Digi	The digitalization degree of sci-tech fin	300	290.24	462.23	7.58	117.45
Control variable						
LnPOP	Population, population density (person/square kilometer), natural logarithm	300	470.87	3949.21	7.86	706.59
LnRoad	The proportion of railway and highway mileage in the area of the province (km/km^2), natural logarithm	300	9738.53	22227.18	120.05	5195.34
LnAgdp	Level of economic development, per capita GDP (yuan), natural logarithm	300	56385.68	164889.00	16413	27260.95
Gov	Degree of government intervention, proportion of fiscal expenditure to GDP (%)	300	25.05	64.30	11.03	10.33
Open	Level of economic openness, proportion of import and export trade in GDP (%)	300	26.65	154.82	0.76	29.58
Adjust variable						
LnTech	Proportion of expenditure on science and technology in government expenditure (%)	300	2.09	6.76	0.39	1.46
LnFinreg	Level of financial regulation, proportion of expenditure on financial regulation in government expenditure (%)	300	13.66	161.07	0.07	20.04
Instrumental variable						
Internet	Internet Development Indicators, Internet broadband access ports (per 10,000)	300	2034.22	8653.20	62.00	1692.45

4. Empirical Results and Analysis

4.1 Analysis of Benchmark Results

Table 2 reports the stepwise regression results of the influence of technology finance on the structural upgrading of the service industry. In column (1), only core explanatory variables are added, and it is found that the regression coefficient of the influence of sci-tech fin on the structural improvement of the serv industry is significantly positive. By gradually adding other explanatory variables. The value of the regression coefficient fluctuates somewhat, but is still pos, which preliminarily proves that sci-tech fin has a pos role in pushing forward the structural upgrading of the tertiary industry.

Specifically, the reason why the level of economic opening is inconspicuous may be that the government's strict regulation on the service industry has immeasurably increased the cross-border transaction cost of the service industry, to some extent inhibited its opening to the outside world, and thus failed to promote the structural upgrading of the service industry. Per capita GDP also has no positive effect. From 2011 to 2020, GDP mainly consists of the secondary and the tertiary industry, and the linkage effect between industries is not obvious[18], which may be one of the reasons.

Table 2. Regression of the benchmark model

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Sci-tech fin	0.032*** (2.62)	0.044*** (3.57)	0.044*** (3.57)	0.056*** (4.27)	0.055*** (4.19)	0.037*** (2.69)
LnHR		-11.536*** (-3.34)	-11.312*** (-3.25)	-7.707** (-2.07)	-7.922** (-2.12)	-11.284*** (-3.03)
LnRoad			-0.237 (-0.58)	-0.265 (-0.66)	-0.300 (-0.74)	-0.178 (-0.45)
LnAgdp				-2.601** (-2.55)	-3.107** (-2.32)	-3.325** (-2.56)
Gov					-0.033 (-0.59)	-0.067 (-1.22)
Open						-0.047*** (-4.04)
Time effect	√	√	√	√	√	√
Regional effect	√	√	√	√	√	√
Constant term	24.63*** (44.59)	86.843*** (4.66)	87.727*** (4.69)	95.208*** (5.08)	102.781*** (4.51)	125.380*** (5.49)
R^2	0.523	0.543	0.543	0.554	0.555	0.582
Obs	300	300	300	300	300	300

Note: * means p<0.1, ** means p<0.05, *** means p<0.01.

4.2 Heterogeneity Analysis

4.2.1 Influence Difference of Different Dimensions of Sc-tech Finance

In order to investigate whether different dimensions of sci-tech fin have different influences on the structural upgrading of the serv sector, this paper selects four indicators, which are coverage breadth (Breadth), use depth (Depth) and digitization degree (Digi) respectively. In this paper, each explanatory variable is returned separately and control variables are added. Columns (1) to (4) of Table 3 report the results. Except the coefficient of the coverage breadth of sci-tech finance is significantly negative, other explanatory variables are significantly positive. Among them, the depth of use passes the significance test of 1%, while the degree of digitization passes the significance test of 5%, indicating that both have a positive impact on the structural upgrading of the serv sector, and the depth of use has a more prominent promoting effect than the degree of digitization. The reason may be that the measurement of the depth of use focuses on people's actual application level of sci-tech finance, such as usage, frequency of use, degree of use, etc., while the degree of digitalization measures the facilitation and affordability of sci-tech fin services. The embodiment of the degree of digitalization needs to go through a series of intermediate transformation processes to reflect the effect of promoting the structural upgrading of the service industry. However, the reason why the sign of coverage breadth of sci-tech finance is neg may be that the reach and popularity range of Chinese sci-tech financial services and products are relatively narrow, which has not been able to effectively break through the regional restrictions. Therefore, the coverage breadth of sci-tech fin has not shown a pos effect on the structural upgrading of the serv indus.

4.2.2 The Influence Difference of Different Geographical Locations

To investigate the heterogeneity of the influence caused by different geographical locations. According to the geographical location of different cities, the samples are divided into eastern regions and central and western areas. According to the regression results, sci-tech finance has a significant pos impact on the upgrading of serv indus structure in the central and western provinces, but has no

significant impact on the eastern region. Compared with the eastern region where the service industry has developed at a high level, the central and western regions have a larger space for the development of the serv indus, thus, the pos result will be exhibited in the central and western regions, while for the eastern region, sci-tech finance does not show an obvious "icing on the cake" effect[6].

Table 3. Results of heterogeneity analysis

Variable	(1)	(2)	(3)	(4)	Eastern	Central and western
Sci-tech fin	0.037*** (2.69)				-0.012 (-0.39)	0.038** (2.10)
Breadth		-0.039* (-1.84)				
Depth			0.026*** (3.76)			
Digi				0.011** (2.43)		
LnHR	-11.284*** (-3.03)	-8.847* (-2.26)	-10.443*** (-2.84)	-10.012*** (-2.67)	-4.230 (-0.44)	-24.082*** (-6.31)
LnRoad	-0.178 (-0.45)	-0.198 (-0.49)	-0.209 (-0.53)	-0.197 (-0.49)	2.034 (0.59)	-0.253 (-0.77)
LnAgdp	-3.325** (-2.56)	-1.570 (-1.10)	-2.536** (-2.01)	-2.906** (-2.26)	-4.372 (-1.62)	1.316 (0.76)
Gov	-0.067 (-1.22)	-0.075 (-1.36)	-0.049 (-0.90)	-0.067 (-1.21)	-0.096 (-0.77)	-0.021 (-0.36)
Open	-0.047*** (-4.04)	-0.055*** (-5.00)	-0.039*** (-3.27)	-0.050*** (-4.44)	-0.044** (-2.34)	0.088*** (2.73)
Time effect	√	√	√	√	√	√
Regional effect	√	√	√	√	√	√
Constant term	125.380*** (5.49)	97.204*** (3.77)	112.364*** (5.00)	115.301*** (5.05)	91.206* (1.80)	127.518*** (5.30)
R2	0.582	0.576	0.592	0.580	0.730	0.590
Obs	300	300	300	300	110	190

Note: * means p<0.1, ** means p<0.05, *** means p<0.01.

4.3 Analysis of Regression Results of Adjustment Effect

Table 4. Regression results of adjustment effect

Variable	(1)	(2)
Sci-tech fin	-0.032* (-1.93)	0.025* (1.79)
Sci-tech fin * LnFinreg		0.001*** (3.07)
Sci-tech fin * LnTech	0.005*** (6.43)	
LnHR	-13.278*** (-3.82)	-10.255*** (-2.78)
LnRoad	-0.223 (-0.60)	-0.099 (-0.25)
LnAgdp	-4.510*** (-3.69)	-3.025** (-2.36)
Gov	-0.087* (-1.71)	-0.080 (-1.48)
Open	-0.028** (-2.53)	-0.046*** (-3.97)
Time effect	√	√
Region effect	√	√
Constant term	150.868*** (6.99)	116.572*** (5.15)
R^2	0.640	0.597
Obs	300	300

Note: * means p<0.1, ** means p<0.05, *** means p<0.01.

According to the regression results, the both interaction term coefficient are significantly pos, indicating that both the financial supervision and the sci-tech expenditure significantly strengthen the above effect.

4.4 Robustness Test

4.4.1 Instrumental Variable Method

To alleviate the endogenous problems mentioned above, instrumental variable method is used to carry out two-stage least squares estimation. Referring to Yang et al. (2023)[6], the internet broadband access port (internet) is selected to measure the degree of pullulation of the Internet and taken as an instrumental variable. The regression results with the development level of sci-tech finance as the core explanatory variable are shown in Column (1) in Table 5 below. The coefficient of development level of sci-tech fin is significantly pos, indicating that the conclusion still has good robustness after considering the endogeneity problem.

4.4.2 Change the Sample Size

To mitigate the influence of outliers, samples that are more consistent with the purpose of the study are selected and robustness test is conducted by changing the sample size. Sample data from four municipalities, including Beijing, Shanghai, Tianjin and Chongqing, are excluded. The results are consistent with the previous ones, that is, sci-tech finance significantly push forward the upgrading of the serv indus, indicating that the results still have good robustness and reliability after considering the sample selection.

4.4.3 Replace the Measure of the Explained Variable

Table 5. Robustness test results

Variable	2SLS	Change the sample size	Replace the explained variable
Sci-tech fin	0.261***	0.048***	0.041***
	(2.71)	(3.45)	(3.06)
LnHR	-13.490**	-15.328***	-10.644***
	(-2.34)	(-4.42)	(-2.91)
LnRoad	-0.321	-0.035	-0.263
	(-0.82)	(-0.10)	(-0.67)
LnAgdp	-7.063***	-0.519	-3.881***
	(-3.28)	(-0.40)	(-3.04)
Gov	0.064	0.028	-0.075
	(0.59)	(0.53)	(-1.38)
Open	0.018	-0.094***	-0.081***
	(0.47)	(-5.32)	(-7.05)
Time effect	√	√	√
Region effect	√	√	√
Constant term	198.780***	109.339***	120.511***
	(4.64)	(5.08)	(5.38)
Cragg-	11.578	-	-
R^2	0.939	0.59	0.675
Obs	300	260	300

Note: * means p<0.1, ** means p<0.05, *** means p<0.01.

This paper makes a reasonable replacement, using the proportion of high-end serv indus employees in the tertiary indus to measure the upgrading of the serv indus structure, and verifies the classification of different service industries. There is no significant difference with the results of the previous reference regression, which proves the robustness of the regression results in this paper. This paper makes a reasonable replacement of the proportion of producer services, uses the proportion of high-end service industry employees in the tertiary industry to measure the structural upgrading of the service industry, and verifies the classification of different service industries. The regression results

are shown in column (3) of Table 5, and there is no significant difference with the results of the previous reference regression.

5. Conclusion and Suggestions

According to the results of the model, the following conclusions are drawn: First, sci-tech finance have significantly positively promoted the serv indus structure upgrade. The use depth and digitization degree of sci-tech finance have a positive effect on the structural upgrading of service industry. Secondly, the influence has regional heterogeneity, that is, has a significant pos effect on CWR. Third, the level of government expenditure on sci and tech and financial supervision have significantly strengthened the role of sci-tech fin in promoting the structural upgrade of the serv sector.

Based on the above, this paper puts forward suggestions as follows:

First, attach importance to the development of sci-tech fin, strengthen innovation in sci-tech finance, deepen the integration of sci-tech fin with the service industry, and give full play to the role of sci-tech finance in upgrading the structure of the service industry. The government should increase the input of sci-tech expenditure, improve the level of financial supervision, ensure the quality development conditions of sci-tech fin, and promote sci-tech finance to become a strong support for the pullulation of the service industry. Second, we should improve the infrastructure of sci-tech fin and optimize its development links. Horizontally, improve accessibility and popularity, actively respond to the demand for financial services, especially in remote areas, and reduce regional barriers; Vertically, the depth of people's use of sci-tech fin should be strengthened, so that people can see the convenience and benefit of sci-tech finance, and the degree, frequency and activity of people's use of digital financial services should be improved. Thirdly, considering the regional heterogeneity of the influence of sci-tech finance, it is inevitable to formulate corresponding financial development and service industry development strategies according to local conditions. For the eastern region, which has reached a high level of service development, it is necessary to strengthen internal supervision and give full play to the "icing on the cake" role of sci-tech finance. For the CWR with large development space, local governments should enhance the strength of sci-tech finance, pay attention to the innovation and development of sci-tech fin, correctly guide sci-tech finance to become the new leading force for the pullulation of the service industry, and make full use of its features such as expanding service boundaries, improving service efficiency and simplifying service processes to further stimulate the growth of local service industry.

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