The Effect of Fintech on the Upgrading of Industrial Structure

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Abstract. It aims to explore the effect of FinTech development on industrial structure upgrading. With the help of Färe-Primont index method, the fintech development index of 30 provinces in China is measured from 2013 to 2022, and the fintech development index is introduced into the panel threshold regression model of industrial structure upgrading for empirical analysis. It is found that China's FinTech development index as a whole shows a fluctuating upward trend, but the difference between provinces is obvious. Fintech development has a significant positive effect on China's industrial structure upgrading, but there is a certain threshold effect. The results of the control variables show that the level of infrastructure and technological progress are important factors in promoting the upgrading of industrial structure, but the positive effects of variables such as urbanization and foreign direct investment are not significant. Accordingly, targeted suggestions are put forward from the dimensions of differentiated implementation of fintech development strategy, constructing a benign interaction mechanism between the two, and establishing fintech service institutions.

Keywords: fintech; industrial structure upgrading; panel threshold regression model.

1 Introduction

In today's digital era, fintech, as an innovative force, is profoundly reshaping the global financial landscape and industrial structure [1]. By combining advanced technologies, such as artificial intelligence, big data and blockchain, with traditional financial services, FinTech not only improves the efficiency and accessibility of financial services, but also provides new impetus and opportunities for the optimization and upgrading of industrial structure [2]. Upgrading of industrial structure, as a core variable in the economic difference between developing and developed countries, is also an essential requirement for the development of late-developing countries. The Chinese government

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has elevated the development of FinTech to the level of national strategy, and has been promoting the combination of finance and technology to better promote the optimization and upgrading of industrial structure [3]. Although China's FinTech has been developing smoothly for many years, there are still many problems such as low level of FinTech and unsound system, which has become an important obstacle to the optimization and upgrading of China's industrial structure. Therefore, it is of great practical significance to study how to make full use of FinTech to promote the upgrading of industrial structure and realize the transformation of China's industry into high-end [4].

2 Measurement and Evaluation of the Fintech Development Index

2.1 Evaluation System Construction of Financial Technology Development Index

The development of financial technology is a complex systematic project, and the construction of the evaluation index system is an important prerequisite for index measurement [5]. The measurement of the index is based on the selection of indicators from the perspective of input and output, so it is necessary to select representative indicators of input and output. In order to ensure the scientific, reasonable and feasible construction of the index system, in the process of selecting the indicators of financial science and technology development, it is necessary to take into account not only its innovative, developmental and profitable characteristics, but also the current situation of its development. Input indicators are selected as the ratio of scientific and technological personnel to the regional population, the ratio of scientific and technological R&D structure to the regional population, the ratio of government funds to internal R&D expenditures, and the ratio of R&D expenditures to GDP. The output aspect is reflected in the scientific and technological achievements and the transformation of scientific and technological achievements, and the output indicators are selected as the number of patents authorized and the technology market turnover as a proportion of R&D expenditure. The evaluation index system of financial science and technology development constructed by this research is shown in Table 1.

Table 1. FinTech Development Index Evaluation Indicator System

Selection of indicators	Evaluation indicators
Input indicators	Scientific and technological active persons/regional population
	Structure of R&D in science and technology/population of the region
	Government funds/internal R&D expenditures
	R&D expenditure/GDP
Output indicators	Number of patents granted/expenditure on R&D
	Technology market turnover/expenditure on R&D

Data sources: compiled by the author.

2.2 DEA Evaluation Method based on the Färe-Primont Index

The main purpose of this study is to study the impact effect of FinTech development on industrial structure upgrading based on measuring the FinTech development index of Chinese provinces, so it is necessary to form a comparable panel data, and the Färe-Primont index happens to satisfy these two requirements at the same time, i.e., the index weights are determined by the sample data self-processing as well as having the transferability feature of inter-period comparison [6]. In view of this, the DEA evaluation method based on the Färe-Primont index is chosen to measure the FinTech development index.

2.3 Characterising facts of the FinTech Development Index

Based on the above methodology, the fintech development index of Chinese provinces was measured from 2013 to 2022. In order to better show the development trend of fintech in China, representative years such as 2014, 2018 and 2022 in the study period are selected for key analysis. 2014 is the first year of China's comprehensive deepening reform, with a number of major reform initiatives. 2018 is the 40th anniversary of the reform and opening up, and the Chinese government has made a new deployment to deepen reform and opening up. In 2022, China's opinion on accelerating the construction of a national unified market was released, clearly accelerating the establishment of national unified market system rules. Table 2 shows the measured fintech development index of China's provinces in 2014, 2018 and 2022.

Table 2. Measurement results and ranking of FinTech development index of China's provinces

Province	2014	2018	2022	Province	2014	2018	2022
Beijing	1.044	1.776	1.544	Henan	0.718	1.461	0.719
Tianjin	0.978	1.471	1.453	Hubei	0.585	1.007	1.080
Hebei	0.570	0.634	1.347	Hunan	0.337	0.755	0.415
Shanxi	0.226	0.326	0.178	Guangdong	1.060	1.994	1.478
Neimenggu	0.140	0.304	0.124	Guangxi	0.049	0.310	0.240
Liaoning	0.365	0.392	0.447	Hainan	0.104	0.213	0.203
Jilin	0.190	1.477	0.736	Chongqing	0.578	0.769	0.947
Heilongjiang	0.071	0.191	0.262	Sichuan	0.336	0.666	0.540
Shanghai	0.740	1.627	1.114	Guizhou	0.598	0.928	0.771
Jiangsu	0.773	1.053	1.144	Yunnan	0.212	0.279	0.228
Zhejiang	0.918	1.129	1.362	Shaanxi	0.676	1.000	1.148
Anhui	0.414	0.751	0.853	Gansu	0.286	0.437	0.355
Fujian	0.271	0.543	0.202	Qinghai	0.398	0.398	0.454
Jiangxi	0.263	0.560	0.451	Ningxia	0.193	0.508	0.383
Shandong	0.870	1.370	1.328	Xinjiang	0.285	0.454	0.320

Data sources: compiled and calculated by the author.

In terms of the overall trend, the fintech development indexes of the majority of provinces have shown an overall upward trend during this 10-year period, indicating that the overall development of fintech in China has been favourable. In particular, during the period from 2014 to 2018, the indexes of most provinces grew significantly, reflecting the rapid development of fintech during this period. Second, in terms of ranking changes, some provinces have experienced large fluctuations in their rankings. For example, Beijing has risen from second place in 2014 to first place in 2022, demonstrating its continued strong development in fintech. Shanghai, on the other hand, rose from seventh place in 2014 to third place in 2018, but then dropped to ninth place in 2022, indicating some volatility in its development. It is worth noting that Jilin Province suddenly jumped to the fourth place in 2018, but then fell back to the fourteenth place in 2022, and this large fluctuation is more due to the supportive policy stimulus for the development of fintech, but the effect of the policy is difficult to be sustained or the support is weakened, resulting in a rapid decline in the fintech index. Again, in terms of regional distribution, eastern coastal provinces such as Guangdong, Beijing, Zhejiang and Jiangsu have always remained at the forefront, showing that these regions have obvious advantages in fintech development. And central and western provinces such as Henan, Shaanxi and Guizhou are also gradually narrowing the gap with the eastern region, reflecting the regional balance potential of fintech development. Finally, in terms of changes in index values, 2018 is generally higher than 2014 and 2022, which may reflect that FinTech experienced a period of rapid development around 2018 and then entered a relatively stable development stage. Meanwhile, the decline in index values in some provinces in 2022 may be related to the impact of major infectious diseases. Overall, China's FinTech development is characterised by regional differentiation, obvious stage characteristics, and overall improvement but fluctuation. The Chinese government should pay close attention to the coordinated regional development in the future to promote the balanced development of fintech in various places, while also paying attention to preventing possible risks and fluctuations.

3 Empirical Analysis

3.1 Research Strategy

In order to deeply explore the influence effect of fintech development on industrial structure upgrading, the panel threshold model is used to analyse the relationship between the two, and the following econometric regression model is constructed based on the principle of Hansen model:

$$\ln Cyjg_{it} = \beta_0 + \beta_1 Fintech_{it} + \beta_2 X_{it} + \beta_3 I\left(Fintech_{it} \le r\right) + \beta_4 I\left(Fintech_{it} > r\right) + \varepsilon_{it} \tag{1}$$

Threshold variable: the threshold variable construction uses the Fintech Development Index (Fintech) based on the Färe-Primon index measure.

Explained variable: industrial structure upgrading index (Cyjg). In order to ensure the scientific validity of the industrial structure upgrading index, taking into account its

connotation and characteristics, and drawing on the common practice in the academic world, the industrial structure upgrading index is measured by multiplying the proportion of the output value of the three industries respectively by the corresponding weights, and its calculation formula is as follows:

$$Cyjg = \sum_{i=1}^{3} y_i * i = y_1 * 1 + y_2 * 2 + y_3 * 3 \tag{2}$$

In formula (2), y_i represents the proportion of the output value of the tertiary industry, i represents the corresponding weight value of the tertiary industry, and the value of the industrial structure upgrading index ranges from 1 to 3. The larger the value, the more advanced the industrial structure.

Industrial structure upgrading is affected and constrained by multiple factors, based on the existing research results, the control variables are selected as infrastructure level (Infr), urbanisation (Ur), economic development (GDP), human capital (Hr), foreign direct investment (Fdi) and technological progress (Tech).

Infrastructure level (Infr), where higher levels of infrastructure improve factor mobility and reduce transaction costs, as measured by the number of road miles per square kilometre in each region.

Urbanisation (Ur), an increase in the level of urbanisation will promote the development of modern industries and the upgrading of the industrial structure. Therefore, it is measured here as the proportion of urban population in the regional population.

Economic development (GDP), an increase in the level of economic development will promote the clustering of innovation resources, as measured by the total GDP of each region.

Human capital (Hr), the agglomeration of high-quality talent can improve the level of technology and innovation management efficiency, the proportion of the number of people at each stage of education level multiplied by the corresponding weight to measure the level of human capital in the region, the regional illiteracy, primary school, junior high school, higher vocational, post-secondary and above the level of education were assigned a value of 0, 6, 9, 12, 16, respectively.

Foreign direct investment (Fdi), FDI can increase the regional capital stock and also promote the upgrading of industrial structure through technological spillovers, so the amount of FDI is directly chosen to measure it.

Technological progress (Tech), which is difficult to measure, was chosen to be measured by the R&D investment intensity of each province.

3.2 Estimated Results

To reduce the heteroscedasticity of the empirical analysis, the above six control variables were logarithmically processed. A threshold test was conducted on the panel threshold regression model using the bootstrap method 2,000 times, and the results are shown in Table 3. The results show that the residual sum of squares achieved a minimum value when the threshold value was 0.246. This indicates a possible threshold value. At this time, the LM value was 8.690, and the null hypothesis was rejected at the

1% significance level, that is, it was considered that there was a threshold value. At this point, the other threshold values will be searched for as a known threshold value, and it is found that the minimum residual sum of squares occurs when the threshold value is 1.314. At this time, the LM statistic value is 4.561, and the null hypothesis is rejected at the 5% significance level. Then the third threshold value is searched for. At this time, the first threshold value changes, and the LM statistic also rejects the existence of the third threshold value. Therefore, the final threshold values are 0.246 and 1.314.

Table 3. Threshold effect test for FinTech development index

threshold variable	original hypothesis	alternative hypothesis	LM value	P-value	reach a verdict
Fintech	no threshold	A threshold value	8.690	0.005	Rejection of the original hypothesis
	A threshold value	Two thresholds	4.561	0.036	Rejection of the original hypothesis

Data sources: compiled and calculated by the author.

The results of the panel threshold regression are shown in Table 4, and it can be found that, first of all, the development of financial technology has a significant effect on the upgrading of industrial structure, and with the continuous improvement of the index of the development of financial technology, its role in promoting the upgrading of industrial structure is even greater, and therefore it can be considered that the development of financial technology is an important driving force to promote the upgrading of industrial structure. This is mainly due to the following three aspects, firstly, the development of financial technology promotes the innovation and optimisation of financial services, improves financial efficiency and reduces financial costs. This provides important financial support for the optimisation and upgrading of industrial structure. Second, financial technology applications such as big data and artificial intelligence can deeply analyse the business situation of enterprises and provide them with accurate financial services, which improves the pertinence and adaptability of financial services and helps upgrade the industrial structure. Thirdly, the development of fintech has broadened financing channels, especially for SME innovation to provide a new way of financing and promote the optimisation of industrial structure. Secondly, there is a certain threshold effect of the role of fintech development on industrial structure upgrading. When the fintech development index is lower than 0.246, the coefficient of its effect on industrial structure upgrading is only 0.138, which is relatively limited. However, when the fintech development index exceeds 1.314, the coefficient of its effect on industrial structure upgrading rapidly rises to 1.362, that is to say, when the fintech development index is low, the application of fintech is still relatively limited, and the promotion effect on industrial structure upgrading is relatively small. However, as the level of fintech continues to improve, its impact on industrial structure upgrading is also increasing. When the FinTech development index exceeds 1.314, FinTech plays a more important role in improving financial efficiency, optimising financial services, broadening financing channels, etc., which in turn has a significant role in promoting industrial structure upgrading. In summary, industrial structure upgrading is an important driving force for China's transformation to high-end manufacturing, and the

level of FinTech development has a significant role in China's industrial structure upgrading. Of course, the development of financial technology is also one of the important reasons for the significant differences in the status quo of regional industrial structure, and the regions with higher financial technology development index can effectively attract the development of all the required innovative factors, which will lead to the transformation of regional industrial structure to high-end, and also exacerbate the inter-regional differences to a certain extent.

In terms of control variables, the level of infrastructure and technological progress are the main factors in the upgrading of China's industrial structure, and they have a positive driving effect on China's industrial structure upgrading at the significant level of 1%. The coefficient of their respective effects is 1.307 and 2.104. For the level of infrastructure, this may be due to the fact that a higher degree of infrastructure perfection will contribute to the 'spatial spillover effect' and 'Thiebaut selection'. Technological progress helps enhance China's capacity for independent innovation, so as to better serve industrial structure upgrading. Urbanisation and foreign direct investment have no significant effect on industrial structure upgrading, with effect coefficients of 0.503 and 1.325 respectively. The development of urbanisation can promote industrial structure upgrading by consuming excess capacity, promoting industrial agglomeration, and improving resource utilisation efficiency. However, China's current urbanisation development relies more on the driving force of resource factors, which has prevented it from contributing its due strength. The contribution of foreign direct investment to the upgrading of China's industrial structure is not significant, which shows that China's industries themselves have accelerated their move towards cutting-edge technology by climbing up the value chain, narrowing the internal and external technology gaps, and thus gradually reducing their dependence on foreign direct investment.

Table 4. Panel threshold regression parameter estimates

variant	Parameter estimates	T-statistic
ln(Infr)	1.307***	6.596
ln(Ur)	0.503	1.135
ln(GDP)	0.763**	2.546
ln(Hr)	0.561**	1.993
ln(Fdi)	1.325	1.247
ln(Tech)	2.104***	5.372
$Fintech_1$	0.138	1.609
$Fintech_2$	0.574	3.458
$Fintech_3$	1.362	2.763

Note: *, **, *** indicate significant at the 10%, 5% and 1% levels, respectively.

Data sources: compiled and calculated by the author.

4 Conclusions

On the basis of combing relevant theoretical analyses and researches of existing scholars, we measured the fintech development index of 30 provinces in China from 2013 to 2022 with the help of the Färe-Primont index method, and then introduced the fintech development index into the equilibrium model of industrial structure upgrading, and set up a panel threshold regression model to analyse the impact of fintech development on industrial structure upgrading. The effect of FinTech development on industrial structure upgrading is analysed. The study finds that China's fintech development index as a whole shows a fluctuating upward trend, but there are significant differences between provinces. Fintech development has a significant positive effect on the upgrading of China's industrial structure, but there is a certain threshold effect on the effect of Fintech development. When the index of FinTech development exceeds 1.314, its role coefficient on industrial structure upgrading rapidly rises to 1.362, and its influence is significantly enhanced. Infrastructure level, technological progress, economic development, human capital and other important factors to promote industrial structure upgrading, urbanisation, foreign direct investment due to the stage of development factors do not show a significant positive effect. Accordingly, the following countermeasures are recommended based on the findings of the study:

Promoting differentiated fintech development strategies. There are significant differences in the development of financial technology among regions in China, and the adoption of non-discriminatory financial technology policies will, to a certain extent, lead to inefficient resource allocation and even exacerbate the disparity in the level of industrial structure between provinces and cities. In the economic context of the new era, the development of targeted and coordinated financial technology development strategy is particularly important. According to the characteristics of China's significant regional differences, it is necessary to rationally arrange the allocation of resources in each region. In regions where high-tech industries and service industries are concentrated, it is appropriate to continue to increase the input of scientific research and financial resources; while in regions with a high proportion of traditional industries, the input of resources is biased in favour of the real needs of the region.

Constructing a benign interaction mechanism between financial science and technology and the upgrading of industrial structure. In order to ensure the coordinated and steady development of all regions, the core lies in the optimisation and upgrading of industrial structure, so the efficient development of fintech based on science and technology and finance is particularly important. At present, the focus is on building a macro system environment for the coordinated development of fintech and industrial structure upgrading, and strengthening the support of policy banks for inter-regional fintech development. From the perspective of policy-based finance, commercial finance is weak in supporting the economic development and industrial structure of the more backward regions. Therefore, it has become a necessity to enhance the development of financial science and technology with the help of policy-based finance, so as to effectively promote the upgrading of industrial structure in the more backward regions.

Establishing policy-oriented fintech institutions for science, technology and innovation-based enterprises. Fintech institutions not only have economies of scale in information collection, but also have unique advantages in project feasibility assessment. Thus, they can effectively reduce the cost of information search and processing, and make the screening and mining of project investment value more scientific. As an important member of the transformation of scientific and technological achievements, most of the science and technology innovative enterprises have the problem of capital shortage. Considering the significant differences between the development of financial science and technology and the upgrading of industrial structure in various regions of China, we have established a science and technology policy bank based on the science and technology innovative enterprises in a specific region, which is committed to carrying out the financial services with the science and technology innovative enterprises as the service object.

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