

Digital Inclusive Finance and Regional Innovation Output

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Abstract. This paper systematically sorts out the internal mechanism of the development of digital inclusive finance affecting regional innovation output, and uses the panel data of 31 provinces in mainland China from 2011 to 2020. From the provincial level, the individual fixed effect model and channel test are used to test the promotion effect of digital inclusive finance on the improvement of regional innovation output. The study found that the development of digital inclusive finance, its coverage, depth and degree of digitalization help to improve regional innovation capacity. The empirical results show that the development of digital inclusive finance is conducive to alleviating financing constraints and directly promoting regional innovation output; The analysis of intermediary mechanism shows that digital inclusive finance can increase external demand by promoting industrial upgrading, and then indirectly promote regional innovation output. This provides policy inspiration for relevant government departments to evaluate regional development conditions, expand the scope of financial services, and improve regional innovation systems and mechanisms.

Key words: digital inclusive finance; regional innovation; industrial upgrading.

1. Foreword

China is in a critical period of economic transformation. Technological innovation plays a vital role in promoting the process of high-quality economic development, and the financial market also has the function of promoting technological innovation to promote technology research and development and market promotion.

China's regional innovation capacity is closely related to financial support, but financial institutions have always had limited access to enterprises' needs for innovation financing. Meanwhile, innovation financing is characterized by high uncertainty, confidentiality of innovation information and difficult supervision. Innovation subjects are often faced with many problems in R & D and innovation, such as the high financing cost of small and medium-sized enterprises, the constraints of regional geographical conditions, and the phenomenon of information asymmetry in traditional finance, which reduce the utilization efficiency of funds.

In this regard, the use of digital inclusive finance can provide the possibility to solve innovative financing difficulties. With its advantages of high efficiency, low cost and wide coverage, digital inclusive finance has effectively promoted the transformation and upgrading of the economic development mode and stimulated the innovation vitality of economic entities. In this regard, the Chinese government hopes to alleviate the financial exclusion problem of vulnerable groups and economically underdeveloped areas through inclusive finance, and reverse the distorted allocation of financial resources.

Research shows that digital inclusive finance can effectively alleviate regional credit constraints and improve the level of regional innovation. So how does the digital financial inclusion affect the regional innovation output? What is the mechanism of action? In view of the above problems, this paper conducts theoretical discussion and empirical analysis, the purpose is to further study the relationship between the two, help the government and enterprises to provide reference, help China to implement innovation-driven strategy and promote high-quality economic development.

2. literature review

2.1 Development and innovation of digital inclusive finance

The development of digital inclusive finance enhances the availability of financial services and promotes innovative output. As China's financial system is in the stage of continuous improvement and development, compared with traditional finance, digital inclusive finance adheres to comprehensively providing effective financial services for low-income people, small, medium and micro enterprises, and underdeveloped areas. Secondly, with the assistance of big data, cloud computing, blockchain and other technologies, digital financial inclusion improves the efficiency of financial resource allocation and strengthens its risk management capabilities.

The existing literature generally believes that the development of digital inclusive finance is conducive to encouraging enterprises to innovate and easing financing constraints. In terms of regional innovation, Du Chuanzhong (2020) and others have empirically tested the regional innovation effect of digital finance development from the direct and indirect dimensions, and believed that the bank credit innovation incentive and residents' consumption expansion are the indirect transmission channels for the development of digital finance to promote regional innovation.

In terms of easing the financing constraints of enterprises, Ren Xiaoyi (2020) found that the development of digital inclusive finance can effectively expand the cash flow of enterprises and reduce their financial expenses and leverage ratio level. Xie Huali (2018) and other studies have concluded that only because the development of digital inclusive finance alleviates the constraints of enterprise finance can the innovation and entrepreneurial vitality of enterprises be effectively released. Wan Jiayu (2020) and other companies have empirically verified that the easing of corporate financing constraints has a significant intermediary effect in the process of promoting the development of digital inclusive finance and promoting corporate innovation. Tang Song (2020) and others believe that the development of digital inclusive finance will help solve the structural problems arising in the enterprise innovation activities, and encourage the innovation activities of enterprises by improving the financing problems of enterprises and improving the stability of their financial conditions.

2.2 Financial inclusion policies

Inclusive financial policy is an important task of financial supply-side structural reform. Relying on digital technology, inclusive finance has been developed rapidly. On the one hand, the coverage capacity of digital technology promotes digital inclusive finance to play a "universal" role. On the other hand, the low threshold of financial services can be lowered through the Internet at a low cost, so as to achieve the purpose of "benefit" and improve the financing difficulties of low-income groups and small and medium-sized enterprises. Song Xiaoling (2017) proved that the development of digital finance is beneficial to the help of Peking University and the narrowing of the gap between urban and rural areas. Yi Xingjian and Zhou Li (2018) combined the index with data from the Chinese family tracking survey, pointing out to the significant role of THE development of inclusive finance in promoting household consumption.

The contribution of this paper is:. At present, there is relatively little research on the impact of digital financial finance development on innovation output and its internal mechanism. Most of the literature discusses the promotion effect of digital financial finance development on enterprise innovation based on the mechanism path of alleviating micro enterprise financial constraints and internal financial behavior optimization. Based on this, this paper makes the result of theoretical analysis and empirical test that digital inclusive finance can directly promote regional innovation output through the indirect ways of easing financing constraints and promoting industrial upgrading.

3. Theoretical analysis and research hypotheses

This paper introduces the direct promotion effect of digital inclusive finance development on innovation output, and explains the indirect transmission pathway, including two main hypotheses in the empirical test of this paper.

3.1 The direct impact of the development of digital inclusive finance on regional innovation output

Digital inclusive finance can promote regional innovative development in many ways. With the help of government support, financial institutions and other institutions will fully apply digital technology in the financial system, thus forming the existing digital financial services. Dong Yufeng (2020) and other scholars have concluded that digital inclusive financial policies not only broaden the access to innovation input elements, but also can get rid of the limitations of geographical space, and thus improve the financial availability.

In addition, digital platforms have the ability to efficiently integrate market information, which not only greatly improves the efficiency of the use of capital elements, but also promotes interdisciplinary integration and innovation. In addition, the combination of finance and technology significantly reduces the threshold limit for research subjects to obtain financial services, which is conducive to reducing the borrowing costs in the initial stage of R & D and reducing the transaction costs in the R & D process. Therefore, this paper believes that digital inclusive finance can significantly improve the financing efficiency of innovation subjects and overcome the obstacles in innovation research and development to a certain extent. In summary, the hypothesis H1 of this paper is presented.

H1: The development of digital inclusive finance directly promotes regional innovation output due to easing financing constraints.

Indirect transmission mechanism of digital inclusive finance affecting regional innovation

Relying on the advantages of digital technology, digital inclusive finance provides diversified financial service products, alleviating liquidity constraints, making household payments and transactions more convenient, broadening investment channels and increasing residents' income. From the perspective of external demand, industrial upgrading will promote innovation subjects to increase technological innovation efforts, and thus affect the level of innovation.

From the perspective of micro individual, the phenomenon of domestic and foreign market expansion, increased market demand and the deepening of enterprise division of labor caused by industrial upgrading causes enterprises to improve technical services and organize training, so as to compete for market share and increase enterprise innovation activities.

From a macro perspective, industrial transformation and upgrading is also accompanied by inter-regional innovation cooperation and competition. In order to solve the common problems encountered in industrial upgrading, local governments will exert their respective advantages, conduct regional cooperation, and accelerate the diffusion of technical knowledge among regions. Meanwhile, local governments will encourage technology introduction and regional innovation competition to promote the improvement of regional innovation level. In addition, international trade is more closely and convenient driven by industrial transformation and upgrading, which promotes national independent innovation. On the one hand, industrial upgrading brings domestic products into the international market, integrates them into the international division of labor system, with more rapid transnational flow of technology, capital and other factors, and further innovation; on the other hand, under the influence of national trade barriers, the Import Congress imposes stricter restrictions on product technical level, safety performance and green level to protect the domestic industry and cope with higher export trade requirements, and improve the overall innovation capability.

Industrial upgrading promotes innovation activities, and at the same time, financial development is also affecting industrial upgrading. By stimulating the transformation of savings to investment, finance improves the efficiency of capital allocation, and promotes the shift of capital to efficient industries to further stimulate the development of efficient industries and promote industrial upgrading. With its broader coverage of financial services and smaller financing constraints, inclusive

finance optimizes the reallocation of funds among various industries and promotes industrial upgrading. Based on the above analyses, the proposed study hypothesis H2.

H2: The development of digital inclusive finance can generate external demand by promoting industrial upgrading, and then indirectly promote the improvement of regional innovation level.

4. Research Design

4.1 Variable setting

1. Interpreted variable.

The explained variable in this paper is the regional innovation output. The number of domestic patent applications is selected to measure the regional innovation output. In order to alleviate the fluctuation of data trend, it is log in the model. Although the number of patent granted is more direct than the number of applications, it has a clear time delay effect, and in the absence of effective lag processing, it is more accurate to measure knowledge output (Han Zhaozhou and Cheng Xuewei, 2020).

2. Core explanatory variables.

Digital Financial Inclusion Index (Index). This article uses compiled by guo prefecture level Beijing university digital pratt & Whitney financial index as the agent of urban digital pratt & Whitney financial development level, and select digital pratt & Whitney financial coverage breadth (coverage), use depth (usage) and digital support service degree (digiti) three subdimension index to examine the influence of digital pratt & Whitney financial dimension development on regional innovation.

3. Control variables.

To avoid other unrelated factors affecting the causality to be verified in this paper, the following four control variables were added to the regression model:

(1) human capital. Measure it with the proportion of the number of ordinary college students in the total population.

(2) infrastructure. Measure with the urban per capita road area.

(3) Urbanization rate. The ratio of the urban population to the total regional population at the end of the year is expressed. Towns gather more knowledge and resources, and have the ability to allocate resources more effectively. The relationship between urbanization degree and regional industrial upgrading is the main driving force for the contemporary society to promote the improvement of economic level.

(4) Science and education investment. The proportion of the sum of urban science and education expenditure in the fiscal budget expenditure is expressed.

4. Mediator variable.

According to the previous theoretical analysis, industrial upgrading was selected as the intermediary variable to test the indirect impact of digital inclusive finance on regional innovation. Among them, the industrial upgrading of the ratio of secondary and tertiary industries to regional GDP. The industrial structure has an important impact on the innovation output capacity. For example, the provinces with a high proportion of the secondary and tertiary industries will theoretically have a broader innovation space compared with the provinces dominated by the primary industry.

(2) Model setting

In order to effectively explore the impact of digital inclusive finance on regional innovation level, the following model is constructed by referring to Xie Huali et al. (2018):

$$\ln \text{patent}_{it} = \alpha_0 + \alpha_1 \ln \text{Index}_{it} + \alpha_2 X_{it} + u_i + \varepsilon_{it} \quad (1)$$

Among them, patent_{it} represents the level of region i in t , and the core explanatory variable Index_{it} The digital financial inclusion index (including the total index, breadth of coverage, depth of use, and digitalization), representing region i in year t , is treated logarithmically for both variables.

XitRepresents the other control variables, uiFor the individual fixed effects, εitFor the random perturbation term.

Referring to the intermediary effect test procedure proposed by Wen Zhonglin and Ye Baojuan (2014), the following model is constructed for the mechanism of digital inclusive finance affecting regional innovation output:

$$M_{it} = \beta_0 + \beta_1 \ln \text{Index}_{it} + \beta_2 X_{it} + u_i + \varepsilon_{it} \quad (2)$$

$$\ln \text{patent}_{it} = \alpha_0 + \alpha_1 \ln \text{Index}_{it} + \alpha_2 X_{it} + u_i + \varepsilon_{it} \quad (3)$$

Among them, Mit represents the intermediary variable, and industrial upgrading (M1) is selected as the intermediary variable according to the above research hypothesis; α and β are the estimated coefficient; the other variables have the same meaning as the model (1).

4.2 Data source and a descriptive statistical analysis

The above data indicators mainly come from the China Statistical Yearbook, and the digital financial inclusion index is provided by the Financial Research Center of Peking University.

In addition, based on data availability and comparability, 2011-2020 was used as the research period. Meanwhile, to ensure the consistency of statistical data caliber and data quality, 31 provinces, municipalities and autonomous regions in mainland China except Hong Kong, Macao and Taiwan were selected as the research samples. Table 1 presents the descriptive statistical results of the main variables.

Table 1. Descriptive statistics of the variables

Variable	Obs	Mean	Std.Dev.	Min	Max
patent	310	10.587	1.528	6.596	13.295
Index	310	5.070	0.670	2.910	5.930
coverage	310	1.964	0.955	0.135	3.621
usage	310	2.111	0.982	0.068	4.887
digiti	310	2.902	1.165	0.333	4.392
M1	310	0.902	0.052	0.742	0.997
hc	310	1.071	1.061	0.205	4.680
infrastructure	310	0.004	0.004	0.001	0.023
urb	310	0.582	0.128	0.332	0.891
education	310	0.215	0.038	0.130	0.295

5. Empirical inspection and analysis

5.1 Base-point regression results

Before the multiple regression analysis, the Hausman test shows that the fixed-effect model estimates are more consistent with the sample characteristics of this paper. Table 2 is based on the linear regression results of model 1, (1) (2) (3) as digital pratt & Whitney financial three composition index and control variables corresponding value and significance, respectively reported the coverage of digital pratt & Whitney financial breadth (c overage), use depth (usage), digital degree (digiti) level dimension indicators on regional innovation output.

The results of Table 2 show that the direct effect of digital inclusive finance development in promoting the improvement of regional innovation output is significant at the 1% level, indicating that the development of digital inclusive finance has an obvious direct impact on regional innovation output, that is, the hypothesis 1 of this paper is established. The statistical results of the control variables are briefly explained for the regression results of column (1). Human capital, infrastructure, urbanization rate and science and education investment have a significant positive effect on the improvement of regional innovation output, which is in line with the previous theoretical expectations.

Table 2. Basic model regression results

VARIABLES	(1) patent	(2) patent	(3) patent
coverage	0.334*** (6.462)		
usage		0.392*** (7.890)	
digiti			0.211*** (5.260)
hc	-0.600*** (-8.399)	-0.581*** (-8.121)	-0.604*** (-8.396)
infrastructure	21.25 (0.921)	12.40 (0.555)	35.82 (1.560)
urb	6.094*** (11.33)	5.674*** (10.15)	7.074*** (14.72)
education	15.04*** (11.99)	14.17*** (11.80)	16.47*** (12.67)
Constant	3.695*** (8.408)	3.975*** (9.114)	2.800*** (6.402)
Individual fixed	fixed	fixed	fixed
Time fixed	unset	unset	unset
N	31	31	31
Observations	310	310	310
R-squared	0.804	0.817	0.797

Note: The values in parentheses are estimated, and the t-value of the coefficient, *, ** and ***, is significant at the statistical levels of 10%, 5% and 1%, respectively.

5.2 The indirect effect mechanism of digital inclusive finance on the improvement of regional innovation output

Table 3. Estimation results of the indirect effects of digital financial inclusion development and regional innovation output improvement

VARIABLES	(1) patent	(2) M1	(3) patent
M1			8.083*** (6.609)
index	0.334*** (6.462)	-0.00696*** (-2.645)	0.390*** (8.371)
hc	-0.600*** (-8.399)	0.00276 (0.552)	-0.622*** (-12.64)
infrastructure	21.25 (0.921)	6.142*** (4.963)	-28.41 (-1.516)
urb	6.094*** (11.33)	0.372*** (11.52)	3.087*** (4.818)
education	15.04*** (11.99)	0.589*** (6.780)	10.28*** (8.392)
Constant	3.695***	0.542***	-0.682
Individual fixed	fixed	fixed	fixed
Time fixed	unset	unset	unset
N	31	31	31
Observations	310	310	310
R-squared	0.804	0.492	0.843

Note: The values in parentheses are estimated, and the t-value of the coefficient, *, ** and ***, is significant at the statistical levels of 10%, 5% and 1%, respectively.

The intermediary effect model is further used to test whether the path of digital inclusive finance promoting regional innovation output through industrial upgrading is established. The specific estimation results are shown in Table 3.

The coefficient of digital financial inclusion in column (2) is positive and significant, indicating that digital financial inclusion has a significant driving effect on industrial upgrading; the coefficient of industrial upgrading in column (3) is significantly positive, indicating that industrial upgrading promotes regional innovation output; the coefficient of digital financial inclusion in column (2) and industrial upgrading in column (3) are significant, indicating that the intermediary effect of regional innovation output is significant. Since the coefficient of digital financial inclusion in column (2) also passed the test at the significance level of 1%, this indicates that there is a partial mediation effect. Thus, the path that digital inclusive finance promotes regional innovation output through industrial upgrading is established, and the intermediary effect accounts for 0.5906%.

6. Conclusion and revelation

This paper theoretically explains the mechanism of the development of digital inclusive finance affecting regional innovation, and empirically tests the impact of the development of digital inclusive finance on regional innovation in China based on the data of 31 provinces in China in 2011 from 201 to 2020. Conclusion shows that: First, the development of digital inclusive finance is conducive to promoting regional innovation capacity. Second, it is found that on the one hand, the development of digital inclusive finance promotes the regional innovation capacity by improving the regional credit resource allocation, and promotes the increase of regional innovation and output by promoting industrial upgrading.

Based on the above conclusions, the following policy implications can be obtained:

Firstly, with the help of various social forces, the publicity and popularization and education of financial knowledge and digital technology should be strengthened, so as to improve the financial knowledge and literacy of the financial service audience. Connect the own development needs of financial services demanders with the development goals of digital inclusive finance more effectively, so as to obtain satisfactory and suitable financial services.

Secondly, all regions should implement differentiated digital inclusive financial development strategies according to the actual situation. We will promote equal allocation of financial resources, improve the adaptability of the financial system to the real economy, and promote high-quality development of the real economy.

In order to strengthen the role of digital inclusive finance in promoting regional innovation in eastern China, the government should encourage the development of high-level digital inclusive finance and pay attention to the guiding role of digital inclusive finance in industrial upgrading; On the other hand, use low economic advantages to narrow the regional gap, and at the same time, create more and stronger innovation subjects and indirectly improve the local innovation level.

Thirdly, governments at all levels should encourage and guide the further deep integration of digital technology and financial business, strengthen the construction of credit investigation system, strengthen the construction of information infrastructure, and strive to break down digital barriers and information "islands", so as to lay a solid foundation for regional innovation-driven development. We will pay attention to the integrity and coordination of the development of digital inclusive finance to further promote regional innovation output and help China's innovation-driven strategy.

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