

# Digital Inclusive Finance and Regional Innovation Performance

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**Abstract:** Digital inclusive finance is a new industry generated by inclusive finance in the context of the development of big data and the Internet. The development of digital inclusive finance promotes regional innovation, while the optimization and upgrading of industrial structure and the development of financial agglomeration provide good external conditions for the development of digital inclusive finance and regional innovation. Based on panel data from 248 prefectures from 2011-2019, this paper examines the impact of digital inclusive finance on regional innovation and the moderating role of the advanced development of industrial structure and financial agglomeration in this promotion process at the prefecture level. The study finds that digital inclusive finance promotes regional innovation; in terms of the transmission mechanism of the effect, it is found that the advanced industrial structure and financial agglomeration can strengthen the promotion effect of digital inclusive finance on regional innovation. Therefore, the development of digital inclusive finance can be promoted in terms of industrial structure optimisation and attracting financial agglomeration to enhance China's regional innovation performance.

**Keywords:** Moderating effect, Digital inclusive finance, Regional innovation, Advanced industrial structure, Financial agglomeration.

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## 1. Introduction

As innovation is the first driving force of development, the factors that drive regional innovation have always been a hot topic of research for scholars. In recent years, with the integration of digital technology and inclusive finance, digital inclusive finance has become an increasingly important driver of regional innovation, and the link between digital inclusive finance development and regional innovation has become an important issue of concern for academics.

Since the rampant spread of the new crown epidemic across the globe so far in 2019, people's lives have been affected in ways that cannot be ignored, and the development of the economy has been hit hard as never before. Digital transformation and the application of new technologies have changed the way people work and live, the way financial institutions and businesses operate, and redefined the parameters of financial products and services [1]. The development of digitalisation in finance enables financial transactions to be carried out more easily and remotely, and various financial services can be enjoyed directly via the Internet, reducing the risk of epidemic spread associated with offline transactions, making digital development more adaptable to the development of the financial sector in the current situation. In the rapid development of digital technology today digital inclusive finance is also becoming more and more successful. The digital development of inclusive finance has lowered the threshold of people's access to finance, enabling more and more people to enjoy financial services and vigorously promoting the development of the financial industry. In this context, exploring the relationship between digital inclusive finance and regional innovation and promoting digital inclusive finance for regional innovation is an important issue for current academic research.

## 2. Research Design

### 2.1. Research hypothesis

In recent years, with the rapid development of the Internet industry, China's inclusive finance has also gradually transformed into digital development, and digital inclusive finance, as an important innovation product of the joint development of the Internet industry and the financial industry, has strongly promoted the structural reform of the financial supply side in China. Digital inclusive finance can leapfrog geographical constraints[2] and improve the symmetry of information to ease financing constraints and optimise resource allocation[3], providing SMEs with more convenient and efficient payment and clearing services, solving the problem of geographical constraints in the traditional financial model, providing better financial support for the innovative development of SMEs, and alleviating the problem of insufficient liquidity for the innovative development of SMEs. The problem of insufficient liquidity has thus promoted the innovative development of enterprises and improved the imbalance of regional innovation development in China.

Based on the above analysis, this paper proposes Hypothesis 1: The digital inclusive finance can promote regional innovation.

Digital inclusive finance lowers the credit threshold and provides better financial support for enterprises and entrepreneurs, while industrial restructuring, as a strong supporting force for the high-quality development of the national economy and an important way to enhance China's independent innovation, also influences the relationship between digital inclusive finance and regional innovation development to a certain extent. On the one hand, regions with a higher proportion of secondary and tertiary industries tend to have a higher return on capital investment and can more efficiently use the financial support brought to enterprises by digital inclusive finance, so the advanced

industrial structure can help strengthen the driving force of digital inclusive finance for the enhancement of regional innovation capacity. On the other hand, regional innovation mainly comes from the innovation output of high-tech enterprises and high-quality talents in the region, and the upgrading of industrial structure can attract more excellent enterprises and researchers to develop in the region, creating human and material resources for the enhancement of innovation capacity, thus making digital inclusive finance more effective in promoting regional innovation.

Based on the above analysis, this paper proposes Hypothesis 2: The advanced industrial structure plays a positive moderating role in the influence of digital inclusive finance on regional innovation.

Financial industry agglomeration refers to a special industrial spatial structure in which large financial institutions converge to a specific region and work closely with other large corporate institutions. The development of digital inclusive finance optimises the allocation of market resources, allowing more capital to be invested in innovation, thereby increasing innovation output. In capital markets, capital held in the hands of the public tends to be invested more inefficiently, while financial agglomeration leads to a number of large enterprises becoming the dominant force in holding the national economy, with more capital being held by a few large enterprises, enabling them to invest more efficiently and allowing more savings into investment, making the services of digital inclusive finance more efficient and better targeted, thus enhancing the role of digital inclusive finance in promoting regional innovation.

Based on the above analysis, this paper proposes Hypothesis 3: The financial agglomeration plays a positive moderating role in the influence of digital inclusive finance on regional innovation

## 2.2. Model construction

This paper focuses on the moderating role of advanced industrial structure and financial agglomeration in the impact of digital inclusive finance on regional innovation output. With reference to relevant literature, we select the level of economic development, financial scale, government support, foreign investment dependence and urbanisation level as control variables, and regression Model (1) was set as follows.

$$\text{inn}_{it} = \alpha_1 \text{index}_{it} + \beta X_{it} + a_0 + v_{it} + \lambda i + \varepsilon_{it} \quad (1)$$

In order to examine the influence of the advanced level of industrial structure and financial agglomeration on the innovation efficiency of digital inclusive finance, two interaction terms of the advanced level of industrial structure and the degree of financial digitization ( $\text{index}_{it} \times \text{wit}$ ) and the degree of financial agglomeration and the degree of financial digitization ( $\text{index}_{it} \times \text{fagg}_{it}$ ) were introduced in the basic econometric model, to test whether the impact of financial digitisation on regional innovation output changes under the effect of differentiated levels of industrial structural sophistication and financial agglomeration, and regression Model (2) and Model (3) was set as follows.

$$\text{inn}_{it} = \alpha_1 \text{index}_{it} + \alpha_2 (\text{index}_{it} \times \text{wit}) + \beta X_{it} + a_0 + v_{it} + \lambda i + \varepsilon_{it} \quad (2)$$

$$\text{inn}_{it} = \alpha_1 \text{index}_{it} + \alpha_2 (\text{index}_{it} \times \text{fagg}_{it}) + \beta X_{it} + a_0 + v_{it} + \lambda i + \varepsilon_{it} \quad (3)$$

## 3. Empirical Analysis

### 3.1. Data sources

This study uses panel data of 248 prefecture-level cities in China from 2011 to 2019 as the research sample. Data on the Digital Inclusive Finance Index are obtained from the Peking University Digital Inclusive Finance Index, while data on regional innovation performance, advanced industrial structure, financial agglomeration and related control variables are obtained from the China Statistical Yearbook.

### 3.2. Variable selection

The explanatory variable is regional innovation performance. Most scholars choose to use the number of regional patent applications granted as a measure of the degree of regional innovation. In this paper, considering the large difference in the size of the number of people between different regions, which also has a greater impact on innovation output, the number of patent applications granted per 10,000 people is chosen as a measure of regional innovation performance.

The core explanatory variable is digital inclusive finance. The indicators related to the degree of development of digital inclusive finance are selected from the "Peking University Digital Inclusive Finance Index" compiled by Peking University, which contains three level indicators: breadth of coverage, depth of use and degree of digitisation, and the total index is chosen as a measure of the degree of financial digitisation.

The moderating variables are the degree of advanced industrial structure and the degree of financial agglomeration. The index of advanced industrial structure is based on the method proposed by Fu (2010) [4], and the index of advanced industrial structure is calculated. The measure of financial agglomeration refers to Zhuang and Chu (2021)[5] and uses the method of locational entropy index to measure the degree of financial agglomeration, with the following formula.

$$\text{fagg}_{it} = \frac{F_{it}/F_t}{\text{Pop}_{it}/\text{Pop}_t} \quad (4)$$

(where:  $\text{Fagg}_{it}$  denotes the financial agglomeration in region  $i$  in year  $t$ ,  $F_{it}$  is the loan balance of financial institutions in region  $i$  in year  $t$ ,  $F_t$  is the loan balance of financial institutions nationwide in year  $t$ ,  $\text{Pop}_{it}$  is the population in region  $i$  in year  $t$ , and  $\text{Pop}_t$  is the total population in the country in year  $t$ )

The control variables are the level of economic development, financial size, government support, foreign investment dependence and urbanisation level. The logarithm of provincial GDP per capita, the share of loan balance of financial institutions in GDP, the share of science expenditure in government fiscal expenditure, the share of actual use of foreign direct investment in GDP and the proportion of urban household members in the total population of the region are used as indicators of the level of economic development, the scale of finance, government support, foreign investment dependence and urbanisation respectively.

**Table 1.** Comparison of variables

Variable type	Variable Name	Variable Symbols	Variable Definition
Core explanatory variables	Digital Inclusive Finance Index	index	From "Peking University Digital Inclusion Index"
Explained variables	Regional Innovation Performance	inn	Number of patent applications granted per 10,000 people
Moderating variables	Level of industrial structure sophistication	w	Calculated
	Financial agglomeration	fagg	$\frac{F_{it}/F_t}{Pop_{it}/Pop_t}$
Variable type	Level of Economic Development	pgdp	Logarithm of GDP per capita in each city
	Scale of Finance	loan	Loan balance of financial institutions/GDP
	Government Support	gov	Science expenditure/ Government fiscal expenditure
	Dependence on Foreign Investment	fdi	Actual use of foreign direct investment/GDP
	Level of Urbanization	urb	Persons in urban households / Total regional population

## 4. Empirical Results and Analysis

### 4.1. Model testing

The results of the F-test showed that the model passed the test at the 1% significance level, and the LSDV test showed that most of the individual dummy variables were significant, rejecting the original hypothesis that "all individual dummy variables are zero", i.e. that there is an individual effect and therefore no individual effect should be selected. The results of the LM test showed that the original hypothesis of "no individual random effects" was strongly rejected at the 1% significance level, i.e. the hypothesis of "random effects" and "mixed regression" was rejected. The results of the LM test

showed that the original hypothesis of "no individual random effect" was strongly rejected at the 1% significance level, i.e. the "random effect" should be chosen between "random effect" and "mixed regression". The Hausman test was used to test whether the random effects model or the fixed effects model was chosen, and the results showed that the original hypothesis was strongly rejected at the 1% significance level, so the fixed effects model should be chosen. Finally, the model was tested for the presence of time effects, and the results showed that the original hypothesis of "no time effects" was strongly rejected, so the model should include time effects, so the two-way fixed effects model was finally chosen for the empirical analysis.

**Table 3.** Tests of model effects

Types of model tests	Fixed and mixed effects	Random and mixed effects	Random versus fixed effects	Individual versus two-way fixed effects
Test method	F-test, LSDV test	LM test	Hausman test	Time effect tests
Statistical value	33.60	4120.71	242.87	9.87
P-value	0.0000	0.0000	0.0000	0.0000

### 4.2. Empirical analysis

The results are shown in Table 4, with regressions (1) to (3) for the prefecture-level city data. The regression results (1) show that without the inclusion of moderating variables and their interaction terms in the model, the regression coefficients of the Digital Inclusive Finance Index are positive and all significant at the 1% level, indicating that the degree of financial digitisation has a significant contribution to the degree of regional innovation over the sample period. The regression results (2) include the interaction terms of the advanced industrial structure and the advanced industrial structure and the digital inclusive finance index in the model, and the regression results show that the regression coefficients of the core explanatory variables and the

interaction terms are positive and all statistically significant at the 1% level, indicating that the promotion effect of digital inclusive finance on regional innovation increases with the increase in the level of advanced industrial structure. regression results (3) include the regression coefficients of the financial agglomeration and the interaction term between financial agglomeration and the digital inclusion index were included in the model, and the regression results showed that the regression coefficients of both the core explanatory variables and the interaction term were positive, and the coefficients of both the core explanatory variables and the interaction term were statistically significant at the 1% level, indicating that the promotion effect of digital inclusion finance on regional innovation would increase with the increase in the level of financial agglomeration.

**Table 4.** Regression results

	(1) inn	(2) inn	(3) inn
index	0.347*** (9.72)	0.162*** (4.55)	0.126*** (3.81)
w		-14.816*** (-6.19)	
indexw		0.114*** (13.91)	
fagg			-0.275 (-1.04)
indexfagg			0.043*** (22.47)
_cons	34.476** (2.44)	95.469*** (4.89)	0.840 (0.07)
Variable controlled	Yes	Yes	Yes
Area controlled	Yes	Yes	Yes
Year controlled	Yes	Yes	Yes
N	2232	2232	2232
adj. R2	0.186	0.281	0.357

t statistics in parentheses

\* p &lt; 0.1, \*\* p &lt; 0.05, \*\*\* p &lt; 0.01

### 4.3. Robustness test

In order to prove the robustness of the experimental results, this paper chooses the method of replacing the explanatory and explanatory variables for robustness testing, replacing the explanatory variable of regional innovation degree with the weighted number of patent applications granted with weights of 0.5, 0.3 and 0.2 for invention patents, utility model patents and design patents respectively, and replacing the explanatory variables of digital financial inclusion index with digital financial inclusion. The explanatory variables were replaced with the breadth of coverage index, the depth of digital financial use index and the digitalization of financial inclusion index, respectively. The empirical results are shown

in Table 5. Regression results (1) and (2) are the results of the robustness test after replacing the explanatory variables with the weighted number of patent applications granted, from which it can be seen that the main effects and interaction effects are significant at the 1% significance level. From the regression results, we can see that the signs of the interaction coefficients are consistent with those in the previous section and are all significant at the 1% level of significance, which is generally consistent with the previous section. Overall, the results of the robustness tests show that the regression results are generally consistent with the previous study, indicating that the conclusions obtained in the previous paper are reliable.

**Table 5.** Robustness test results

	(1) inn c	(2) inn c	(3) inn	(4) inn	(5) inn	(6) inn	(7) inn	(8) inn
index	0.056*** (5.47)	0.047*** (4.95)	0.078** (2.18)	0.014 (0.42)	0.089*** (4.08)	0.078*** (3.80)	0.024*** (2.95)	0.015* (1.82)
w	-4.750*** (-6.90)		-15.213*** (-6.29)		-14.805*** (-6.17)		-16.942*** (-7.11)	
index×w	0.038*** (16.16)		0.121*** (14.46)		0.117*** (14.90)		0.100*** (15.86)	
fagg		-0.058 (-0.77)		-0.447* (-1.67)		0.089 (0.34)		-0.407 (-1.51)
index×fagg		0.014*** (25.18)		0.046*** (22.41)		0.044*** (24.08)		0.029*** (22.11)
_cons	31.632*** (5.63)	1.720 (0.48)	90.009*** (4.50)	-10.085 (-0.78)	95.016*** (4.88)	1.749 (0.14)	104.919*** (5.41)	4.316 (0.34)
Variable controlled	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area controlled	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year controlled	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2232	2232	2232	2232	2232	2232	2232	2232
adj. R2	0.340	0.418	0.268	0.336	0.279	0.364	0.277	0.329

t statistics in parentheses

\* p &lt; 0.1, \*\* p &lt; 0.05, \*\*\* p &lt; 0.01

## 5. Conclusions and Recommendations

This paper investigates the moderating effect of advanced industrial structure and financial agglomeration in the impact of digital inclusive finance on regional innovation at the prefecture-level city level, using data from 228 prefecture-level cities in China from 2011-2019 to construct a two-way fixed-effects model for regression analysis, and the main conclusions obtained are: (1) Digital inclusive finance development has a significant moderating effect on regional innovation. (2) The degree of advanced industrial structure has a significant and reinforcing moderating effect on the role of digital inclusive finance in promoting regional innovation. The enhancement of the level of digital inclusive finance is carried by the degree of advanced industrial structure, and regions with a higher degree of advanced industrial structure have more positive externalities of digital inclusive finance spilling over and a more obvious role in promoting regional innovation. (3) Financial agglomeration has a significant reinforcing moderating effect on the role of digital inclusive finance in promoting regional innovation. This indicates that the development of financial agglomeration can enhance the support of the digital inclusive financial system for innovative enterprises and improve the allocation efficiency of financial resources through the leverage driving effect and positive signaling guidance, thus strengthening the role of digital inclusive finance in promoting the level of regional innovation.

Based on the analysis results derived from this paper, this paper suggests the following insights: (1) Further promote the coordinated development of digital inclusive finance and give full play to its positive promotional role for regional innovation. In recent years, China's digital inclusive finance has developed rapidly, but there is still a problem of uneven development. Regions with developed financial industries should give full play to their own advantages, so that digital inclusive finance development can better support the innovative development of enterprises and promote the enhancement of regional innovation capacity, while regions with relatively backward financial industries should attach importance to the development of digital inclusive finance and encourage digital inclusive finance to better provide financing services for small, medium and micro enterprises (1) To solve the problem of capital needs for enterprise development, realise the joint development of the financial industry and the real industry, and promote regional innovation in a concerted manner. (2) Scientifically promote the advanced development of industrial structure, and give full play to the positive regulatory role of the advanced

development of industrial structure in promoting regional innovation through digital inclusive finance. Compared with the primary industry, the secondary and tertiary industries have higher capital utilization rates, and the development of secondary and tertiary industries can enhance the return rate of digital inclusive finance. Therefore, we should accelerate the process of transformation of the advanced industrial structure, increase employment and industrial support, broaden regional innovation channels, and provide a good external environment for the development of digital inclusive finance. (3) Promote the agglomeration of the financial industry and give full play to the positive regulating effect of financial agglomeration on digital inclusive finance for regional innovation. Make use of the market's own regulatory role to bring into play the inclusive nature of digital inclusive finance and provide richer and better quality financial services for the long-tail population. At the same time, local governments should also play a guiding role to attract financial industry agglomeration and expand the scale of financial services through policy measures such as interest subsidies, subsidies and incentives, and for regions with high financial agglomeration, they should encourage the financial industry to transform into digitalization and improve the efficiency of financial industry services.

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