



# Research on the Impact of Digital Finance Development on Regional Innovation Level

## — Empirical Analysis based on Panel Data From 31 Provinces in China

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### Abstract

Based on the panel data of 31 provinces in China from 2011 to 2020, this paper studies the development status and characteristics of digital finance in China by using descriptive statistics and analysis of variance; And use the regression model to test and analyze the relationship between digital finance and the level of regional technological innovation. Empirical research shows that the overall development trend of digital finance in China is good. Digital finance and its decomposition index (coverage, use depth and digitization degree) have an incentive effect on the level of regional innovation, but their positive incentive effects are different; In terms of transmission path, the development of digital finance is affected by both internal and external factors, and the influencing factors are more extensive. The research of this paper is not only conducive to the relevant government decision-making departments to better improve the scientific and technological innovation system and mechanism, improve the efficiency of financial services, and formulate more efficient financial supervision schemes in the initial stage of the 14th five year plan, but also has a certain enlightening effect on enterprises to make good use of digital finance as a tool to realize technological take-off, transformation and breakthrough, integrate various resources and promote growth. (Abstract)

**Keywords**-Digital finance; regional innovation; human capital; financial supervision; R &D intensity

### 1. INTRODUCTION

In March 2020, the Standing Committee of the Political Bureau of the CPC Central Committee proposed to speed up the construction of new infrastructure, such as 5G networks and data centers, and continue to firmly grasp the new development concept. The proposal of this policy provides important historical opportunities for the development of digital finance.

In the new development concept, innovation is an important engine to promote development and is at the core of development which steady rise needs the support of financial resources. However, due to technological innovation is a kind of high risk, long cycle and uncertain economic activities. And under the background of weak independent innovation consciousness, weak regional

overall innovation ability, excessive reliance on technology introduction, and lack of vitality and vitality in regional innovation, how to solve the regional innovation activity financing channels and financing scale lag problem is particularly important. Considering the current booming trend of digital finance, this paper studies whether digital finance can help the regional innovation level, and considers the relevant incentive path and influencing factors, and finally draws the conclusion.

The innovation of this article is mainly reflected in the following aspects: First, different from the previous literature that studied the impact of traditional financial models such as capital markets and commercial banks on technological innovation. This article, following closely on the hot spots of the times and starting with the new

financial model of digital finance, explores the role of financial development on regional innovation and verifies the possible path of digital finance affecting regional innovation, which provides a data supplement for the development of high-quality digital finance in China; Second, when analyzing the current characteristics of China's digital finance, this paper divides it into east-west dimensions and finds a new way, which is innovative to a certain extent; Third, this paper has some inspiration in the selection of internal and external factors that influence digital finance and expands the literature in the field of digital finance.

## 2. LITERATURE REVIEW

Innovation is an important engine for promoting development. However, the development of innovation in various regions in China is currently unbalanced and uncoordinated. At present, the academic circle has conducted a lot of research on the regional differences of innovation, and believes that the main reasons for this innovation difference are the economic development level, geographical location, the allocation of innovation environmental resources (Jiixin Xu, 2021)<sup>[1]</sup>, and the government fund subsidies (Zhen Gao, 2021)<sup>[2]</sup>. Digital finance has developed rapidly in the past decade and has become another important driving force for economic development. Thanks to the digital Inclusive inclusion Index of Peking University, the academic community has conducted a lot of research on digital finance. Yulan Zhu studied the development status of inclusive finance in China, then found that the overall level of digital finance in China was on the rise and the level and convergence characteristics of digital finance in eastern, central and western regions are different (Yulan Zhu, 2020)<sup>[3]</sup>. The level of digital finance and innovation shows a regional imbalance, so is there a connection between digital finance and innovation drive?

Scholars have studied the effect of digital finance on innovation incentive and the study involves two main aspects. On the one hand, how digital finance affects the urban-rural income gap (Luhao You, 2021)<sup>[4]</sup>, drives entrepreneurship, industrial upgrading (Wenjin Tang, Shuang Li, Yunqing Tao, 2019)<sup>[5]</sup>, etc. On the other hand, digital finance affects the generating effect, action mechanism and influencing factors of innovation incentive. With the background of "double cycle", Jiixin Liu and Sha Li analyzed the internal mechanism of digital financial development affecting regional innovation from the aspects of supply and demand (Jiixin Liu, Sha Li, 2021)<sup>[6]</sup>. Liang Zhang et al. analyzed the impact of digital finance on regional innovation gap, and proposed the "Matthew effect" of digital finance (Liang Zhang, Guangping Xiang, Yongfan Ma, 2021)<sup>[7]</sup>. Yuanfei Xiao et al. proved the spatial negative effect of the development of digital finance, further proving that digital finance will become an advantage of

regional innovation ability (Xiao Yuanfei, and Muli, 2021)<sup>[8]</sup>. Wanteng Zheng et al. examined the incentive effect of financial development level on regional innovation (Wanteng Zheng, Hongyan Zhao, Hong Fan, 2021)<sup>[9]</sup>. After literature study, We find that the existing literature research on how digital finance promotes regional innovation is not deep enough. Digital finance can not only directly promote regional innovation, but also indirectly stimulate regional innovation through various factors. In view of this, we study the incentive effect of digital finance itself on regional innovation and its indirect role on regional innovation through internal and external factors.

## 3. RESEARCH DESIGN

### 3.1. Research hypothesis

Hypothesis 1: The development of digital finance promotes regional innovation

Hypothesis 2: The breadth of digital finance coverage affects regional innovation and development

Hypothesis 3: The depth of the use of digital finance affects regional innovation and development

Hypothesis 4: Digital degree of digital finance affects regional innovation and development

Hypothesis 5: The development of digital finance requires the combination of internal factors and external factors

### 3.2. Data source description

In this paper, the panel data from 31 Chinese provinces from 2011 to 2017 are selected for analysis. The invention authorization patent application data comes from the State Intellectual Property Office. The data of digital finance development general index and sub-index are both derived from the report of *Peking University Digital Inclusive Finance Index*. The proportion of internal R & D expenditure in GDP is obtained from the *China Statistical Yearbook of Science and Technology*. Financial regulatory expense data from Shenzhen Zhongshang Industry Research Institute Co.,Ltd.. Opening to the outside world index comprehensive score data from *China's regional opening index report* (2008-2017). Economic development level data from the China National Bureau of Statistics. Human capital level data from the Central University of Finance and Economics and *China human capital report 2020* of the human capital and labor economy research center.

**Table 1:** Descriptive statistics of the variables

type of variables	Variables name	Variable	Accounting method	Unit	Measurement	least value	crest value
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ble	sym	bol	ue	ue	ue	ue	
explained variable	Regional innovation	lnINNO	Number of patent applications	10.673	10.2927	11.0767	
			Digital Finance Index	—	4.9401	3.5139	5.5869
				Coverage breadth index	—	4.7906	3.3652
explanatory variable	Digital finance	lnDIF	Use the depth index	—	4.9956	3.85373	
			Digital degree index	—	5.309	3.6976	5.9717
			Actual human capital per person	Thousand yuan / person	5.6315	5.3732	5.8459
Other variables	human capital	lnhcap	Financial regulatory expenses	100 million	1.8362	1.5536	2.1732
			The proportion of internal R & D expenditure in GDP	%	0.1648	0.0232	0.2576
			Actual GDP per person	Yuan / person	8.625	8.4246	8.8131
open door to the outside world	lnopen	lnop	Opening-up index composite score	composent	2.6098	2.3476	2.8702

### 3.3. Specification of variables

#### 1) Interpreted Variable — Area Innovation (INNO)

The common measurement indexes of regional innovation level mainly include innovation output and sales revenue of new products. Because the data of new product sales revenue is seriously incomplete and

difficult to collect, innovation output is selected as the proxy variable of regional innovation level in this paper. As a direct output of innovation, patent can better represent the innovation ability of a region. Therefore, this paper uses the number of patent applications as an indicator of regional innovation level.

#### 2) Interpretive variable — Digital Financial Development Index (DIF)

Digital finance refers to the new generation of financial services that are combined with the traditional financial services through the Internet and information technology. In the past few years, China's digital finance has made great progress and exerted a great influence in the world, but it has always lacked an indicator system to measure its overall development level. To this end, the research team of Peking University Digital Finance Research Center and Ant Group Research Institute has compiled a set of "Peking University Digital Financial Inclusion Index" since 2016, using ant Group's massive data on digital financial inclusion. This paper selects the data of the total Digital Finance Development Index (DIF), the coverage breadth (DIF\_CB), the depth of use (DIF\_UD), and the degree of digitalization (DL) from the 2020 report.

#### 3) Control variables (other variables)

According to the internal and external factors that will affect the development level of digital finance, This paper uses the data of the proportion of internal R&D expenditure in GDP from China Statistical Yearbook of Science and Technology as the research index of internal factor R&D intensity. The human capital level data from China Human Capital Report 2020 are selected as the research index of human capital level of external factors. The expenditure data of financial regulation expenditure of China Business Industry Research Institute is used as the research indicator of the level of financial regulation of external factors, and the comprehensive score data of the opening index in *China Regional Opening Index Report (2008-2017)* is used as the research indicator of the degree of opening of external factors. The real per capital GDP data of The National Bureau of Statistics of China is used as the research index of the economic development level of external factors.

### 3.4. Measurement model setting

To test the first four study hypotheses, the regression model is set as follows:

$$\ln INNO_{it} = \alpha_0 + \beta_1 \ln DIF_{it} + \beta_2 \ln DIF\_CB_{it} + \beta_3 \ln DIF\_UD_{it} + \beta_4 \ln DIF\_DL_{it} + \beta_5 X_{control} + \varepsilon_{it} \quad (1)$$

In equation (1), the subscript *i* represents the province, *t* indicates the year;  $INNO_{it}$  represents a regional innovation, the  $DIF_{it}$  means digital finance.

DIF\_CB<sub>it</sub> indicates coverage breadth. DIF\_UD<sub>it</sub> indicates the depth of use. DIF\_DL<sub>it</sub> represents the degree of digitization. X<sub>control</sub> represents a series of control variable. ε<sub>it</sub> represents a random perturbation term.

To study the H5 research hypothesis, the regression model is set as follows:

$$\ln DIF_{it} = \alpha_0 + \beta_1 X_{control} + \varepsilon_{it} \tag{2}$$

In formula (2), subscript i indicates province. t indicates year. DIF<sub>it</sub> represents digital finance. X<sub>control</sub> means a series of control variables containing internal and external factors affecting the development of digital finance.

$$\ln DIF_{it} = \alpha_0 + \beta_1 \ln hc_{it} + \beta_2 \ln sup_{it} + \beta_3 \ln rdc_{it} + \beta_4 \ln gdp_{it} + \beta_5 open_{it} + \varepsilon_{it} \tag{3}$$

In formula (3), hc<sub>it</sub> represents actual human capital

per capital. sup<sub>it</sub> represents financial regulatory expenses. rdc<sub>it</sub> represents the proportion of internal R&D expenditure in GDP. gdp<sub>it</sub> represents actual GDP per capital. open<sub>it</sub> represents opening-up index composite score.

### 3.5. Empirical results and analysis

#### 1) Benchmark estimate analysis of innovation incentive effect of overall financial development level and various sub-index

To test the study assumptions H1, H2, H3, and H4, the data are respectively brought into equation (1),(2) to conduct t-test on relevant variables. Table 2 below reports the benchmark estimates for the relevant variables. Among them, models (1), (3), (5) and (7) are only to consider the incentive effect of explanatory variables on innovation, while models (2), (4), (6), (6) and (8) add control variables to consider the random effect.

**Table 2** Results of The Benchmark Estimates

explanatory variable	Digital finance		Cover breadth		Use depth		Digitization degree	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnDIF	0.101 (0.220)	-0.210 (-0.490)						
lnDIF_CB			0.456 (1.550)	0.178 (0.630)				
lnDIF_UD					1.596*** (4.20)	1.114*** (3.07)		
lnDIF_DL							1.264*** (-5.000)	-0.652** (-2.530)
controlled variable	NO	YES	NO	YES	NO	YES	NO	YES
observed value	217	217	217	217	217	217	217	217

Note: t value in parentheses, \*, \*\*, \*\*\* indicate significant levels at 10%, 5% and 1% respectively, the same below.

As known from Table 3-1, the benchmark estimates were not significantly different whether the control variables were included. There is insufficient evidence to prove that the digital financial aggregate index and coverage breadth have a significant positive incentive effect on regional innovation. The reason for this phenomenon may lie in the related problems with the sample size and the model setting. In addition, the coverage breadth is through the electronic account number namely pay treasure users, but users can not represent the usage and user activity, and the elderly and elderly groups for online mobile payment demand and usage is not high, so there is not enough data to support coverage breadth has significant positive incentive effect on regional innovation. The model (5) ~ (8) is the estimation result of the depth of use and the degree of digitization of the sub-index. The results can be seen that the depth and coverage of digital finance have positive incentive effect on regional innovation, but there are certain differences in the incentive degree, and the incentive effect of the depth of use is greater than the

degree of digitization. The reason for this difference may lie in that the depth of use is measured according to the situation of digital financial services, including the actual index total index, use activity index, etc., which can directly reflect the subjective initiative of user's funds on regional innovation incentive, and have a direct role in promoting regional innovation. The degree of digitization is measured from the aspects of mobile, affordable, credit and facilitation, and is the premise of the depth of use and the breadth of coverage. The incentive effect on regional innovation is indirect, and the response speed lags behind the depth of use and the breadth of coverage, so the incentive effect is weak.

#### 2) Benchmark estimates of internal and external factors for digital finance development

To test the hypothesis H5, the data are respectively brought into equation (3) to conduct t-test on relevant variables. Results of the benchmark estimates of the relevant variables are reported in Table 3 below.

**Table 3** Results of The Benchmark Estimates

explanatory variable	lnEF	lnHC	lnFS	lnrdc	lngdp	lnopen
lnEF	0.746*** (7.720)					
lnHC		-0.800 (-1.000)				
lnFS			-0.745 (-1.730)			
lnrdc				0.828 (1.810)		
lngdp					5.694 (2.110)	
lnopen						0.964 (2.480)
observed value	217	217	217	217	217	217

By the result, internal and external factors overall to digital financial development has significant positive incentive effect, and research and development strength, financial regulation, economic development and opening to the outside world have no significant incentive effect for the development of digital financial, reflect the internal and external factors for digital financial development has larger positive incentive effect, thus indirectly promote regional innovation and development.

#### 4. MAIN CONCLUSIONS AND POLICY RECOMMENDATIONS

##### 4.1. MAIN CONCLUSION

Based on the panel data of 31 provinces in China from 2011 to 2017, this paper empirically analyzes the impact of digital finance on regional innovation level by using the method of econometric regression model. The main conclusions are as follows:

1) The breadth of coverage, the depth of use and the degree of digitization of digital finance can significantly and positively stimulate the innovation ability of the region, and improve the overall innovation level of the region. The incentive effect, from weak to strong, is the degree of digitization, the depth of use and the breadth of coverage. However, the data study sample in this paper cannot prove that the overall level of digital finance has a significant incentive effect on the overall level of regional innovation, which needs to be proved by further research.

2) The development of digital finance is influenced by regional internal and external factors, which shows that digital finance can not only directly stimulate regional innovation, but also indirectly stimulate regional innovation through both internal factors and external factors. The regional internal research and development intensity, financial supervision level, human capital level, economic level and opening up level all have a significant positive impact on the

development of digital finance, and then have an indirect impact on the level of regional innovation. Among them, research and development intensity plays a main role in internal factors, and economic development dominates in external factors.

##### 4.2. POLICY RECOMMENDATIONS

Based on the above research conclusions, this paper proposes the following policy recommendations:

1) *Further improve the digital finance development policy.* National and regional policies play a fundamental role in the development of digital finance included the breadth of coverage, the depth of use and the degree of digitization. The government should further improve the development policies of digital finance to help the development and maturity of the digital finance industry, formulate appropriate development plans and preferential policies for the economically developed areas and poor areas, and promote the balanced development of digital finance in China.

2) *Strengthen scientific and technological innovation and help the digitization process of the financial industry.* Regional innovation entities should increase their internal research and development intensity, improve the level of digital technology innovation, promote cross-regional information sharing, and help the digital process of the financial industry. The regional financial departments should encourage and promote the deep integration of financial services and digital technology, actively cooperate with digital financial service platforms such as Alipay and WeChat, so as to expand the universality of financial services, improve the structural constraints of innovative financing, and promote the high-quality development of regional innovation level.

3) *The digital financial regulatory system, human capital and other indirect factors need be improved to*

help digital finance play a role. Financial regulation should construct a comprehensive digital financial supervision system, supervise digital financial trading platform, trading process and transaction content to prevent various potential risks for the development of digital finance, so as to Create conditions for the normal development of digital finance.

4) *Improve the level of Regional Opening-up and economic development, and promote the development of digital finance.* Under the guidance of national policies, local governments in all regions should appropriately expand opening-up, improve the competition and cooperation relationship between technology introduction and independent innovation, guide the upgrading of high-tech industries, and make every effort to improve their own economic development level, create favorable conditions for the development and popularization of digital finance, and promote the high-quality development of regional innovation. Under the guidance of national policies, local governments should moderately expand the opening to the outside world, improve the competition and cooperation relationship between technology introduction and independent innovation, guide the upgrading of high-tech industries, and make every effort to improve their own economic development level, create favorable conditions for the development and popularization of digital finance, and then promote the high-quality development of regional innovation.

5) *Build an interconnected digital financial ecosystem.* At present, there are still differences in the development of China's digital finance in eastern and western regions, economically developed and poor areas. This unbalanced development pattern of digital finance has significant inequality in the incentive validity of regional innovation. Therefore, the development of China's digital finance should aim at building a digital financial ecosystem, strive to achieve interoperability, compliance and effective layout of new financial instruments and traditional financial instruments, and realize the seamless connection of digital financial elements in different regions, so as to help regional digital finance complement each other and share achievements, so as to promote the equal development of regional innovation

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