The Influence of Digital Finance on the Innovation Capability of Cities in Western China

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Abstract:

In this paper, the panel data of 87 cities in western China from 2011 to 2016 were used to empirically analyze the influence of digital finance on the innovation capability of cities in western China. The results show that the development of digital finance has a significant positive impact on the innovation capability of western cities. China should fully tap the development potential of digital finance in western China, improve the ecological environment of digital finance development in western China, strengthen the financial knowledge education of digital financial users, encourage digital financial institutions to adhere to the inclusive orientation to promote the sinking of services, encourage digital financial institutions to optimize the product and service structure, speed up the transformation and upgrading, and play a more effective supporting role in enhancing the innovation capability of cities in western China.

Keywords: Digital Finance, Urban Innovation Capability, China.

I. INTRODUCTION

Digital finance is a financial business model in which traditional financial institutions and internet companies use digital technology to realize financing, payment, investment and other new services[1]. In recent years, due to the rapid development of digital economy, insufficient supply of financial services of traditional financial institutions and relatively loose regulatory environment of regulatory authorities, some internet financial platforms have used technical tools such as mobile terminals and big data analysis to support financial decision-making, which has reduced the customer acquisition cost and improved the accessibility of different groups to financial services, thus making digital finance flourish. In 2004, the launch of Alipay account system marked the germination of China's new financial development. After more than ten years of development, a number of influential digital financial enterprises such as Ant Financial, JD Finance and Lufax have been fostered in China, and the businesses of third-party payment, online loan, digital currency and digital insurance have developed rapidly. The development practice of digital finance shows that its development model is characterized by low cost, wide coverage and sustainable inclusion, which not only offers the possibility for economically backward regions to catch up with and surpass inclusive finance, but also offers the possibility for economically backward regions to form latecomer advantages and "overtake on a curve"[2].

The development of digital finance is conducive to improving the efficiency and quality of the real economy. The new financial development supported by information technology can reduce the degree of information asymmetry and transaction costs, expand the coverage of financial services, improve the availability of financial services for small and micro enterprises, and effectively optimize the rational allocation of financial resources[3]. So digital finance has become an important path to achieve financial inclusion. In China, digital financial enterprises provide small and micro enterprises, innovative enterprises and supply chain enterprises with services that traditional financial institutions cannot provide, which promotes the development, recovery and transformation of the real economy. In recent years, more and more literatures have paid attention to the influence of digital finance on economic growth, innovation and entrepreneurship, but less research has been done on the influence of digital finance development on urban innovation capability.

In this paper, the digital financial index in *Peking University Digital Inclusive Finance Index* was used to reflect the level of new financial development, and the panel data of western cities from 2011 to 2016 was used for empirical analysis, which provides empirical evidence for analyzing the influence of new financial integration on the innovation capability of western cities.

II. LITERATURE REVIEW

In recent years, the bottom-up financial innovation, the development of new technologies and financial demand have promoted the rapid development of digital finance. The financial function has played a catalytic role in capital accumulation and technological innovation, thus promoting economic growth. Internet finance can promote the upgrading of industrial structure by affecting the upgrading of corporate products and technology as well as the upgrading of consumption structure. Therefore, more and more scholars pay attention to the influence of digital finance on innovation, mainly focusing on the influence of digital finance on enterprise innovation and entrepreneurship and regional innovation and development.

Some researches show that digital finance promotes the development of inclusive finance[4], increases the availability of formal finance for SMEs[5], helps to improve the financing constraints for SMEs[6], and promotes the innovation and entrepreneurship development of SMEs. Based on the ability to collect, process and analyze big data, digital finance can not only solve the problem of credit evaluation of small and micro enterprises[7], but also make full use of the advantages of integrating social resources and information sharing of digital financial platform to comprehensively evaluate the characteristics of enterprises, and provide accurate marketing services and supply chain integration services for small enterprises, thus improving the innovation capability of enterprises, so digital finance has a structural driving effect on technological innovation of enterprises, especially the innovation and development of private enterprises[8-9]. Digital finance has a heterogeneous impact on enterprise innovation, and it has a greater incentive effect on the technological innovation level of high-tech SMEs, which varies according to the nature of enterprise ownership, regional economic development level and institutional environment[10].

Some scholars believe that digital finance, with its strong inclusive growth characteristics, has become a powerful complement to the traditional financial system, helping to enliven entrepreneurial activities. China's digital finance helps significantly increase the income of households, especially the rural low-income groups, and improve the entrepreneurial behavior of rural residents, bringing about equal opportunities for entrepreneurship[11-12]. The coverage, depth of use and degree of digital support services of digital finance can significantly promote entrepreneurship, and the business development model of digital finance can not only improve the accessibility of financial services and reduce the cost of venture financing[13-14], but also handle active entrepreneurial activities based on big data information and analysis[15], promote the innovation of business development model and derive new entrepreneurial opportunities[16]. Some scholars believe that the development of digital finance has a limited effect on the innovative and entrepreneurial activities of SMEs. Internet finance is not conducive to financial stability and economic development due to the problems of information asymmetry, credit risk and imperfect related systems in digital finance supervision[17]. The problems existing in the development of digital finance itself limit its support for the development of small and medium-sized enterprises, especially the strong information asymmetry in peer-to-peer lending market leads to stronger adverse selection and moral hazard than traditional finance[18].

Some literatures pay attention to the influence of digital finance on urban innovation or regional innovation capability. The interaction mechanism between technology innovation and financial innovation is one of the driving forces of long-term growth, but only good interaction between them can promote economic growth, otherwise it will hinder economic growth[19]. The development of digital finance not only helps to solve the financing difficulty and reduce financing costs, but also significantly boosts China's real economy through the intermediary role of innovation and the development in both coverage breadth and use depth of digital finance. However, the promotion role of digital finance on regional economy has regional heterogeneity, and its promotion effect on the eastern region is stronger than that in the central region and western region in China[20]. At the same time, digital finance also affects urban innovation through transmission mechanisms such as income effect and human capital effect[21]. Digital finance has an inclusive role in bridging the innovation gap between cities and has a more significant role for small and medium-sized cities[22]. Digital finance can significantly improve the efficiency of regional innovation, and its impact has regional differences and single-threshold effect based on the degree of regional marketization and internet penetration rate[23]. However, the influence of digital finance on the regional innovation gap is mainly due to the "Matthew effect" generated by the siphon effect of human capital and financial resources, and the "Matthew effect" is different due to urban heterogeneity such as intellectual property protection, financial supervision, internet penetration rate[24]. Some literatures also show that digital finance has heterogeneous influence on urban innovation, and the innovation effect of digital finance is more significant before the commercial system reform, in cities with high human capital level and in second-and third-tier cities[25].

In the existing literatures, abundant research results have been formed on the influence of digital

finance on innovation and development, but less research has been done on the influence of digital finance on the innovation capability of cities in western China. Therefore, this paper attempts to empirically test whether digital finance promotes the innovation capability of cities in western China.

III. VARIABLE SELECTION AND MODEL SETTING

3.1 Variable Selection

3.1.1 Explained variable

The explained variable in the model is urban innovation capability, which is expressed by the comprehensive index of urban innovation capability (UIC). The index value was derived from *China's Urban and Industrial Innovation Capability Report 2017*. The use of the innovation index was divided into two steps. First, using the patent update model of Pakes &Schankerman (1984) for reference, all expired invention patents applied from 1987 to 1997 were used for value estimation. Then the distribution of patent value was simulated according to the estimated parameters, and the average value of patents of different ages was further calculated, which was used as the value weighting coefficient of the corresponding patent. Second, the invention patents that are still valid at the observation time point (year-end, i.e. December 31) (which are authorized and still in existence) were selected to add the patent value of different cities to get their patent value inventory. Finally, the national patent value in 2001 was standardized to 100, and the urban innovation index from 2001 to 2016 was calculated. The value of expired invention patents was estimated using the measurement model, and the average value of patents at different ages was calculated as the value weighting coefficient of the corresponding patents. The invention patents that are still valid at the observation time point (year-end, i.e. December 31) were selected to add the patent value of different cities to get their patent value inventory. Finally, the total national patent value in 2001 was standardized to 100, and the urban innovation index from 2001 to 2016 was calculated.

3.1.2 Core explanatory variable

The core explanatory variable in the model is the development level of digital finance. In this paper, the digital financial index in *Peking University Digital Inclusive Finance Index* was used to express the development level of digital finance in each city.

A first-level index system of Digital Inclusive Finance Index include the coverage, depth of use and degree of digital support services of digital finance, and then a second-level index system was constructed. In the second-level index system. Finally, the coverage breadth index, the depth index and the digitalization degree index were weighted to get the digital finance comprehensive index of each city.

Account coverage is one of the secondary index, which aims to reflect the availability and geographical coverage of financial services provided by digital finance to all social strata and groups in all aspects.

The secondary index of depth of use of digital finance mainly takes into account the multi-level and diversified development of financial services. The secondary index cover the main businesses of digital financial services, including digital finance services in the aspects of bank credit services, digital payment services, investment services, insurance services, monetary fund services, credit services. Therefore, to reflect the depth of use of digital finance, The secondary index of depth of use of digital finance include the total number of people actually using digital financial services in various adopts s businesses (the number of people using these services per 10,000 Alipay users), the activity of using digital finance (the number of transactions per capita) and the depth of use of digital finance (the transaction amount per capita).

The degree of digital support service mainly considers the convenience, cost of obtaining digital financial services and other major factors that affect the coverage and depth of use of digital financial services, so it mainly adopts two-level indicators such as convenience and financial service cost to reflect the degree of digital support service.

3.1.3 Control variables

In the academic literature on the influencing factors of urban innovation capability, factors such as regional economic development level, stock of human capital, economic openness, regional public services, accessibility of traditional financial services are usually introduced into the measurement model as control variables affecting urban innovation capability. Therefore, in this paper, the above factors will be introduced into the empirical analysis model as control variables. Per capita GDP of each city and the high degree of industrial structure (i.e. the proportion of non-agricultural industrial output value to GDP) are used to indicate the level of urban economic development. The number of college students per 10,000 people in each city is used to indicate the stock of urban human capital. The proportion of FDI in each city is used to indicate the city's economic openness. The proportion of expenditure on science and technology in the fiscal budget is used to indicate the city's public service situation, and the proportion of loan balance of financial institutions to GDP at the end of the city is used to indicate the accessibility of traditional financial services for microeconomic unit. All variables and their meanings are shown in Table I.

TABLE I. Variable definitions and their descriptions

Types of variables	Name	Symbols	Descriptions
explained variables	Urban innovation capability	uic	Urban innovation capability is a comprehensive index. The index was calculated by the following methods. All expired invention patents are used for value estimation by the measurement model. Then

			the average value of patents of different ages is further calculated, which is used as the value weighting coefficient of the corresponding patent. The invention patents that are still valid at the observation time point (year-end, i.e. December 31) are selected to add the patent value of different cities to get their patent value inventory. Finally, the national patent value in 2001 is standardized to 100, and the urban innovation index from 2001 to 2016 is calculated. In regression, the logarithm is taken.
Explanatory variables	Digital financial index	dfi	The comprehensive index is obtained by weighting the coverage breadth index, the use depth index and the digitalization index. In regression, the logarithm is taken.
Control variables	Regional per capita GDP	pgdp	Ln (GDP per capita)
	Industrial structure	stru	Proportion of non-agricultural output value to regional GDP
	Regional economic openness	fdi	Proportion of foreign enterprises' import and export to regional GDP
	Regional technological development environment	tech	Proportion of fiscal expenditure on science and technology in fiscal budget expenditure
	Human capital	hc	The number of students per ten thousand people in the school, take the log.
	Accessibility of traditional financial services	fin	Proportion of loan balance of financial institutions to GDP at the end of the year

3.2 Modeling

Based on the above analysis, the following econometric model was used to analyze the influence of digital finance on urban innovation capability:

$$LN(uic)_{it} = \alpha_0 + \alpha_1 LN(dfi_{it}) + \alpha_2 LN(hc_{it}) + \alpha_3 LN(pgdp_{it}) + \alpha_4 struc_{it} + \alpha_5 fdi_{it}$$

$$+ \alpha_6 tech_{it} + \alpha_7 fina_{it} + \varepsilon_{it} \qquad (1)$$

In the above model, the city's innovation capability is expressed by uic, and the index is taken by the logarithm (lnuic) and put into the model. Among the model, the explanatory variables of the model adopts digital financial index (dfi), which reflect the development level of urban digital finance, and the logarithm is taken in the model.

In the model, i represents a city, where i = 1,2, ..., 87, representing 87 cities in 12 provinces (autonomous regions and municipalities) in western China. t represents the year (2011-2016) and ε_{it} represents the random disturbance term. α_1 is the coefficient of explanatory variable such as digital financial index (dfi). If the coefficient of the above explanatory variables are greater than 0, it indicates that the improvement of the development level of digital finance will contribute to the improvement of urban innovation capability.

IV. DATA DESCRIPTION AND DESCRIPTIVE STATISTICS

In this paper, the value of the digital financial index came from *Peking University Digital Inclusive Finance Index 2011-2018* compiled by the Digital Finance Research Center of Peking University, and its comprehensive index system for calculating the digital financial index is shown in Table I. The value of the urban innovation index was derived from *China's Urban and Industrial Innovation Report 2017* released by Industrial Development Research Center and China Economic Research Center of Fudan University. The data of other control variables were all from the *China Urban Statistical Yearbook* of the relevant year.

Descriptive statistics of variables are shown in Table II.

TABLE II. Descriptive statistics of major variables

Variables	Observed value	Mean	SD	Min.	Max.
Lnuic	522	-0.1473	1.6390	-4.605	5.025
Lndfi	522	4.704	0.522	2.834	5.471
Lnpgdp	522	10.402	0.625	8.773	12.456
Lnhc	522	4.615	0.610	1.141	6.038
fin	522	0.962	0.657	0.165	4.733
tech	522	0.004	0.007	0.00005	0.088
fdi	522	0.069	0.011	0.000	0.076
stru	522	85.547	7.66	67.77	99.49

V. EMPIRICAL RESULTS AND DISCUSSION

The regression analysis of fixed effect model and random effect model was performed in Table III. The basic regression results are shown in column (1) and column (2) in the table. The estimation results show

that the coefficient of digital financial index (Lndfi) is significantly positive, indicating that the digital financial index of cities in western China has a significant positive impact on their innovation capability, and the development of digital finance improves the urban innovation capability.

Considering that urban innovation capacity may also be affected by other factors, in Table III, the models(3) and (4) are added control variables such as regional per capita GDP, industrial structure, regional economic openness, regional scientific and technological development environment, human capital and the accessibility of traditional financial services. The estimation results of columns (3) and (4) show that the coefficient of digital financial index (lndfi) is still significantly positive.

TABLE III. Influence of digital finance on innovation capability of cities in western China

Explained variables	(1) re lnuic	(2) fe lnuic	(3) re lnuic	(4) fe lnuic
lndfi	0.989***	0.982***	0.735***	0.720***
	(0.0280)	(0.0265)	(0.0465)	(0.0457)
lnpergdp			0.378***	0.443***
			(0.123)	(0.122)
stru			0.0397***	0.0227*
			(0.0108)	(0.0120)
fdi			1.902	-4.702
			(3.105)	(2.904)
fin			4.373	5.347*
			(3.418)	(3.123)
tech			-0.0886*	-0.170***
			(0.0525)	(0.0487)
lnhc			0.393***	0.328***
			(0.0649)	(0.0626)
Constant	-4.800***	-4.768***	-10.93***	-9.591***
	(0.182)	(0.126)	(1.038)	(1.280)
P value	0.000	0.000	0.000	0.000
Observed value	522	522	520	520
Number of id	87	87	87	87

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In order to further ensure the robustness of the empirical results, in Table IV, the model replaces the explained variable. The explained variable was expressed by the per capita index (piec). Zhang X B established a comprehensive evaluation index system to express the development level of urban innovation and Entrepreneurship capability[26]. The index system includes the following primary indicators, such as small and micro enterprise registration, attracting foreign investment, attracting venture capital, the number of patent authorizations and the number of trademark registrations, a composite index of China's innovation and entrepreneurship regional index is measured. Then the per capita index (piec) is calculated

based on this comprehensive evaluation index. In Table IV,the model takes logarithm of the per capita index (lnpiec).The enterprises covered by the index include all industries in mainland China, enterprises in all sizes, especially small and micro businesses with high innovation activity and entrepreneurial enterprises. Digital finance index was used as explanatory variable, per capita index of urban innovation and Entrepreneurship capability was used as an explained variable, and the regression results are shown in Table IV. In Table IV, models (1) and (2) are the robustness test of benchmark regression results, and models (3) and (4) are the regression results after adding control variables. The regression results of models (1), (2), (3) and (4) in Table IV show that the coefficient of digital financial index (lndfi) is always significantly positive, indicating that the aforementioned empirical results have certain robustness.

TABLE IV. Robustness test of the influence of digital finance on urban innovation capability

VARIABLES	(1) m1 lnpiec	(2) m2 lnpiec	(3) m7 lnpiec	(4) m8 lnpiec
lndfi	0.0760**	0.0745**	0.0969*	0.109**
	(0.0302)	(0.0302)	(0.0557)	(0.0509)
lnpgdp			-0.0906	-0.175
			(0.149)	(0.135)
stru			-0.0116	-0.00649
			(0.0147)	(0.0119)
fdi			2.044	0.995
			(3.576)	(3.419)
tech			3.591	4.269
			(3.804)	(3.716)
lnhc			0.0179	0.0303
			(0.0593)	(0.0572)
fin			0.0847	0.112
			(0.0763)	(0.0710)
Constant	2.937***	2.944***	4.585***	4.888***
	(0.143)	(0.184)	(1.561)	(1.159)
F value	6.32	6.07	1.93	14.81
P value	0.0123	0.0137	0.0745	0.0385
Observations	516	516	514	514
Number of id	86	86	86	86

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

VI. CONCLUSIONS AND SUGGESTIONS

6.1 Main Conclusions

In this paper, the digital financial index is used to represent the development level of digital finance, and the panel data of 87 cities in western China from 2011 to 2016 is used to empirically test the influence of digital finance development on the innovation capability of cities in western China. The result shows the

development of digital finance has a significant positive impact on the innovation capability of cities in western China.

Based on the results of the regression analysis as described above, this paper holds that digital finance has strong geographical penetration and inclusiveness. The development of digital finance in western China can further enhance financial inclusion and improve the allocation efficiency of financial resources, which is an important way to promote the innovation capability and high-quality development of urban economy in western China.

6.2 Suggestions

China should pay attention to the development of the digital finance, fully tap the development potential of digital finance in western China. It is necessary for the western region of China to improve the ecological environment of digital finance development, deepen the service orientation of inclusive finance, do a good job of service sinking, and accelerate the transformation and upgrading of digital financial institutions.

Firstly, strengthen the education of digital financial users in western China. Relevant regulatory agencies and digital finance enterprises in western China should speed up the construction of corresponding digital finance education system, formulate digital finance consumer education plan, and pay attention to digital skills training for key service target groups such as small and micro enterprises, long tail consumers, internet investment and wealth management customers. Provide training on basic financial knowledge, enhancement of digital finance skills and enhancement of risk prevention and control awareness for them.

Secondly, promote the transformation and upgrading of new financial institutions. At present, digital finance on internet insurance business, supply chain finance and other digital support services have been developing slowly in western China, the profitability and sustainability need to be improved. It is urgent to accelerate the transformation and upgrading of digital finance enterprises. On the one hand, Digital financial institutions should vigorously strengthen internal corporate governance, optimize product and business structure, improve service quality, and improve their own development quality by polishing and refining business capabilities to ensure the healthy and sustainable development of the new financial industry. On the other hand, it is necessary to improve their digital service capabilities, and make full use of next-generation information technologies such as cloud computing, Internet of Things, big data and blockchain to develop comprehensive services of big data finance, and provide personalized financial support services with emphasis and pertinence, so as to improve the service ability and efficiency of digital finance for enterprises in western China.

Thirdly, vigorously develop digital inclusive finance services. The construction of digital inclusive finance infrastructure in western China should be strengthened, and efforts should be made to improve the

coverage and use of digital inclusive finance, to promote the development of inclusive finance in western China, so that digital finance can better serve the innovative enterprises. The digital service market environment in inclusive finance should be further standardized, the sharing mechanism of credit information system should be strengthened, and the risk control ability of inclusive finance should be enhanced. The western region should accelerate the construction of a new finance service platform, and establish a settlement mechanism, credit sharing mechanism, and risk prevention and control mechanism for digital inclusive finance products and services.

Fourthly, optimize the digital financial ecological environment. The ecological environment for the development of new finance should be improved quickly, and the new financial supervision system and mechanism should be innovated to prevent financial arbitrage and enlarge financial risks due to the existence of new finance and traditional financial supervision depression. The regulatory methods should be innovated, the application of big data, block chain and other technologies in financial supervision, and the real-time dynamic monitoring of market behavior of new financial enterprises should be strengthened.

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