Research on Digital Inclusive Finance and Financing Constraints of Small and Medium-Sized Agriculture-Related Enterprises

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Abstract: In the context of Rural Revitalization and the rapid development of Digital Inclusive Finance, this paper studies the question of financing constraints of Digital Inclusive Finance and small and medium-sized agriculture-related enterprises. The entropy weight method is used to construct the index to measure the development level of Digital Inclusive Finance. The dynamic panel is constructed by using the financial data of small and medium-sized agriculture-related enterprises, and the first-order difference GMM method is used for estimation. According to the results, we could obtain the conclusions including: there are obvious financing constraints for small and medium-sized agriculture-related enterprises, and the development of Digital Inclusive Finance can effectively alleviate this problem. Furthermore, it is concluded that there is a time lag in the Digital Inclusive Financial policy, and the lag of one period still has a significant impact. Finally, according to the research conclusions, this paper puts forward corresponding strategies and development suggestions from the aspects of system construction and enterprise management.

Keywords: Digital Inclusive Finance; Small and medium-sized agriculture-related enterprises; Financing constraints

1 Introduction

With the rapid development of science and technology, the digital economy has also emerged, which has brought a considerable impact on the global economic development and the economic life of individuals. However, under the impact of COVID-19, the use of Internet technology has become more mature, and the infrastructure construction of digital technology has been gradually improved. The radiation range of digital finance in China has been expanding, and the digital economy is playing an increasingly important role in national economic life.

As an emerging business form combining digital technology and Inclusive Finance, Digital Inclusive Finance can resolve financial exclusion and reduce the access threshold of services significantly. In this paper, Digital Inclusive Finance is defined as DIF. It has the advantage of combining online and offline to fully alleviate information asymmetry. Moreover, with the continuous progress of science and technology, digital finance has penetrated into all aspects of our life. The development of digital finance can drive the development of Inclusive Finance, which is becoming an important strategy for the development of our country. Therefore, it is necessary to complete the measurement of DIF through a certain method. However, the current

FFIT 2022, October 28-30, Shenzhen, People's Republic of China

DOI 10.4108/eai.28-10-2022.2328412

research on DIF is mainly based on the Digital Inclusive Financial Development Index compiled by the Digital Finance Research Center of Peking University and the research group of the ant group. The data depended on the "Alipay" platform in the compilation process, so the index has some limitations. Based on the above analysis, in order to better measure the development level of DIF, this paper takes the supply side of inclusive finance as the main entry point, selects appropriate indicators and collects relevant data to complete the calculation.

Under the strategic background of rural revitalization, the state is committed to the development of agriculture and rural areas, and puts the comprehensive promotion of rural revitalization in an important position. In our country, Agriculture-related enterprises are the main part of building the rural industrial system, which play an important role in the process of agricultural economy and rural development, and play an irreplaceable role in coordinating the allocation of agricultural resources. However, due to the weakness of agriculture, the limitation of enterprise scale and the existence of business risks, small and medium-sized agriculture-related enterprises have been in a weak position in the financial market for a long time. The phenomenon of "difficult financing, expensive financing and slow financing" is difficult to alleviate. The support of traditional finance to small and medium-sized agriculture-related enterprises is limited and the exclusion is serious. Therefore, realizing the inclusive supply of digital financial services will promote the further development of rural revitalization, and the financing constraints of small and medium-sized agriculture-related enterprises can be effectively alleviated.

The contributions of this paper are as follows: firstly, the entropy weight method is used to construct the evaluation system of the development level of DIF, and evaluate it from three aspects: digital, inclusive and finance, so as to enrich the quantitative methods of the development index of DIF. Secondly, empirical research on the impact of DIF on the financing constraints of small and medium-sized agriculture-related enterprises, so as to provide empirical support for Digital Inclusive Finance to alleviate the financing constraints of enterprises. Thirdly, considering the differences in the development level of various regions in China, this paper analyzes the heterogeneity of the implementation effect of the Digital Inclusive Financial policy in the eastern and central and western regions of China. Fourthly, the dynamic panel is constructed and estimated by using the first-order difference GMM method, which enriches the estimation methods of relevant research.

2 Theoretical Analysis and Research Assumptions

2.1 Digital Inclusive Finance and Financing Constraints of small and medium-sized Agriculture-related Enterprises

Agriculture-related enterprises play the important role in promoting the strategy of Rural Revitalization and make important contributions to effectively solving the problems of agriculture, rural areas and farmers. However, at the same time, the problem of financing constraints has always restricted the development of China's small and medium-sized enterprises and hindered the structural adjustment, transformation and upgrading of small and medium-sized enterprises, which is a common problem faced by small and medium-sized enterprises. Financing constraint is that the external financing cost of enterprises is too high, which makes it difficult for the return on investment to offset the financing cost, thus limiting

the external financing of enterprises. Due to the weak characteristics of the agricultural industry, China's agricultural industrial policy is not perfect, resulting in the weak position of agricultural enterprises in the distribution of financial resources, the financial support for agricultural enterprises is not enough, and the borrowing and financing needs of agricultural enterprises are difficult to meet (GE Yongbo and Zhang Mengmeng, 2008)[1]. The products produced by agricultural related enterprises generally had low scientific and technological content, weak awareness of innovation and poor profitability. When enterprises increase investment for scale expansion, financial institutions were unwilling to provide financial support (Guo Jie and Gu Liyue, 2022)[2]. Moreover, the scale of small and medium-sized agriculture-related enterprises was small, and the economies of scale commonly existing in the market economy would also constitute the financing barriers of small and medium-sized enterprises (Zhang Jie and Wang Xiao, 2002)[3]. At the same time, the financial and other information disclosure of small and medium-sized enterprises was not timely and accurate, resulting in information asymmetry, which was also a major reason for the financing constraints of small and medium-sized enterprises (Jiang Fuxiu et al., 2016)[4]. The lack of collateral and imperfect financial system within small and medium-sized enterprises also further aggravated the financing constraints (Zhang Yuming and Zhao ruiruirui, 2019)[5]. These factors will lead to the risk of loans to small and medium-sized enterprises is much higher than that of large enterprises. Therefore, in order to reduce the non-performing loan rate and control the credit risk, banks and other financial institutions will reduce the loans to small and medium-sized enterprises as much as possible. In addition, the development of China's capital market was not mature enough, the construction of credit investigation system was not perfect, and the capital strength of guarantee institutions was not strong, which had limited ability to alleviate the financing constraints of small and medium-sized enterprises (Zhang Yuming and Zhao ruiruirui, 2019)[5].

In recent years, with the rapid development of information technology, the coverage of digital technology is becoming wider and wider. Big data, blockchain and cloud computing technology have also promoted the development of Inclusive Finance in China. Various digital technologies are continuously used in banks and other financial institutions, greatly reducing the operating costs of traditional financial institutions, expanding the scope of financial services and enhancing the availability of financial services. Inclusive financial innovation could effectively alleviate the financing constraints of small and medium-sized enterprises by broadening the financing channels of enterprises, reducing financing costs and improving service efficiency (Liang bang and Zhang Jianhua, 2018)[6]. Moreover, DIF could effectively alleviate the risk brought by information asymmetry between borrowers and borrowers, which can provide credit capital for small and medium-sized enterprises, and attract more financial capital to support the financing of small and medium-sized enterprises (Teng Lei, 2020)[7]. For banks and other financial institutions that provide financial services for enterprises, the development of bank's DIF could effectively alleviate the financing constraints faced by enterprises (Lei Hui and Jin min, 2021)[8]. The application of digital technology to different scenarios of financial institutions would help institutions more accurately identify the credit status of small and medium-sized enterprises and accurately select customers. China's small and medium-sized enterprises are difficult to achieve their own financial sustainable development due to many restrictions. The development of DIF helped to optimize the cash flow of enterprises, reduced the financial expenses and leverage ratio of enterprises (Ren Xiaoyi, 2020)[9], effectively alleviated the financing constraints and helped small and medium-sized enterprises achieve financial sustainability (Li Bin et al., 2021)[10]. Yang Yaping and Zhao

Haohua (2021) pointed out that the development of DIF would enable groups such as small and medium-sized enterprises with low status in the financial market to enjoy more benefits. But the most authors focuse on the macro level and does not focus on small and medium-sized agriculture-related enterprises. However, the development of DIF is gradually tilting towards agriculture-related enterprises [11].

Based on the above analysis, the following assumption is put forward:

H_1: DIF can significantly alleviate the financing constraints of small and medium-sized agriculture-related enterprises.

2.2 Regional heterogeneity of Digital Inclusive Finance

The difference of regional economic development in China significantly affects the development of regional finance. With the rapid economic development of the eastern region, in the eastern region of China has more financial resources, which is gradually widening the gap with the central and western regions directly. The eastern region can attract the inflow of financial resources and the concentration of human resources based on the advantages of location, it also can develop foreign trade and attract investment. The development foundation of the central and western regions is weak and the disadvantages are obvious. The eastern region will also benefit from the support of relevant national policies. The rapid marketization process will further lead to faster economic development, more financial resources, more perfect financial system and more obvious backwardness in the central and western regions. Compared with the central and western regions, the eastern region has higher openness and higher financial awareness. The central and western regions have weak financial awareness and high default rate of loans, which limits the further development of finance. As an emerging development model of the financial industry, DIF has different popularity in different regions. The more developed the regional economy, the better the development of DIF (Du Qiang and Pan Yi, 2016) [12]. Moreover, the development of science and technology in the central and western regions is slow and the overall strength is weak, which has not laid a good foundation for the development of DIF.

Based on this, the following assumption is put forward:

H_2: There are significant regional differences in the mitigation effects of DIF development on the financing constraints of small and medium-sized agriculture-related enterprises in different regions.

2.3 The lag of Digital Inclusive Finance

DIF is an innovation of Inclusive Finance, and the innovation of financial business is accompanied by the construction of financial infrastructure, which will play a certain supporting role in financial business. The construction of financial infrastructure mainly includes system construction. There is a time lag from formulation to implementation, and the infrastructure will be improved only after the innovation of services. Therefore, the construction of financial infrastructure lags behind the innovation of financial services. At the same time, the development of DIF is not independent, and the early policy effect will continue and affect the later stage. Therefore, the financing constraints of DIF on small and

medium-sized agriculture-related enterprises will not only have an effect in the current period, but also have an impact on the future.

Based on the above analysis, the following assumption is put forward:

H_3: The development of DIF has a significant lag effect on the financing constraints of small and medium-sized agriculture-related enterprises.

3 Research Design

3.1 Date sources and Sample selection

Considering the availability of data, we select the relevant index data of 31 provinces in China (excluding Taiwan, Hong Kong and Macao) from 2011 to 2018 to construct the DIF Index of each province. At the same time, in order to measure the financing constraints of small and medium-sized agriculture-related enterprises, the relevant financial data of agriculture-related listed companies on the middle and lower board from 2011 to 2018 are selected for research. Among them, the index data of DIF comes from *China Statistical Yearbook, Statistical Report on Internet Development in China, China Science and Technology Statistical Yearbook and China Regional Financial Operation Report*. The enterprise financial data comes from the Wind database. In the database, enterprises listed on the middle and lower board are selected, and enterprises that have been listed by ST and *ST and companies that have been listed for less than one year are excluded, and the business types are limited and manually screened. Excel is used to calculate the required financial index data. At the same time, in order to avoid the influence of extreme values, Stata16 is used to winsorize the variables according to the levels of 1% and 99%, and finally 427 observed values are obtained.

3.2 Selection and Measurement of Digital Inclusive Financial Indicators

DIF has three meanings: first, digital, that is, using digital technology to realize Inclusive Finance, is the means and method of realization, connecting the supply side and demand side of financial services. The second aspect: universal benefit, that is, universal benefit, which indicates that the key service targets are vulnerable groups, including groups with serious financial exclusion such as enterprises and individuals. The third aspect: finance, that is, financial services, is the carrier of digital technology. Therefore, DIF is to use a variety of digital technologies on the basis of Inclusive Finance to provide better financial services, reduce the cost of financial services and improve the efficiency of financial services.

In recent years, with the support of the central and local governments, the financial operation environment has been becoming more and more perfect. The development of DIF is also gradually deepening, and the measurement of DIF is gradually valued by people, trying to quantitatively calculate the development index of DIF in China. Feng Xingyuan et al. (2021) measured China's County DIF Index from three dimensions: service depth, service breadth and service quality[13]. Guo Feng et al. (2020) used analytic hierarchy process to measure the DIF Index from three aspects: coverage, use depth and digitization degree[14]. Based on the existing research and the above related definitions, this paper takes "supply side" as the main selection basis, selects three aspects of digital, inclusive and finance, and measures DIF with nine specific indicators (see Table 1).

Table 1 Index System of DIF Index

Primary index	Secondary index	Tertiary indicators	Indicator definition	Nature
Digital	Technological	Internet penetration	$\frac{\text{the number of people using the internet}}{\text{population}}$	+
		Per capita share of high-tech enterprises	$\frac{\text{total number of high-tech enterprises}}{\text{population (thousands)}}$	+
	Credit	Non performing loan ratio	$\frac{\text{non-performing loan}}{\text{total loan balance}}$	—
Inclusive	Talent Policy	Years of education per capita	$\frac{\text{elementary school by 6 plus junior high school by 9 plus high school by 12 plus junior college and top 16}}{\text{population aged 6 and over}}$	+
		Employment level	$\frac{\text{number of newly employed people in the region in this year}}{\text{number of newly employed people in Chinain this year}}$	+
	Government support	Financial allocation per unit output value	$\frac{\text{approved central financial allocation}}{GDP}$	—
Finance	Financial institution network density	Per capita share of financial institutions	$\frac{\text{number of financial institutions}}{\text{population (thousands)}}$	+
		Geographical density of financial institutions	$\frac{\text{number of financial institutions}}{\text{land area (10,000 square kilometers)}}$	+
	Personnel density	Density of financial practitioners	$\frac{\text{number of financial practitioners}}{\text{population (thousands)}}$	+

The above evaluation system reflects the comprehensive indicator of DIF from three different perspectives: digital, inclusive and financial. Among them, digital reflects the digital development level of a region and is the premise and foundation for the development of DIF. Here, we choose the non-performing loan ratio as a negative indicator to measure credit. We believe that the non-performing loan ratio can reflect the development of credit investigation technology of banks and other financial institutions. The weak credit investigation technology, the greater the degree of information asymmetry between borrowers and borrowers, resulting in a higher non-performing loan ratio. Therefore, the higher the non-performing loan ratio, it indirectly reflects the development level of digital technology of lending financial institutions.

Inclusiveness mainly reflects the importance of a regional government to relatively vulnerable groups. If the value is larger, it indicates that the government attaches more importance to it, which is more conducive to the inclusiveness of digital finance. At the same time, this paper defines the index of government support as a negative index. We believe that the state will give more financial subsidies to relatively backward areas in order to promote the all-round development of all regions. It is defined as an indicator of national support for relatively backward areas. Finance mainly reflects the development of the financial industry in a region from the network density of financial institutions and financial practitioners. The greater the value of this index, the better the development of the financial industry in the region.

In order to reflect the DIF Index more intuitively, we use the entropy weight method to perform a weighted average of each specific index and finally obtain an index. Firstly, we standardize the values of each indicator. The normalization of positive indicators is shown in formula (1), and the standardization of negative indicators is shown in formula (2).

$$X_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}, \qquad (1)$$

$$X_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})}, \qquad (2)$$

Among them, X_{ij} is the value after standardization, x_{ij} is the actual value of the index, max (x_{ij}) is the maximum value of the index, and min (x_{ij}) is the minimum value of the index. Secondly, we calculate the entropy value, difference degree and weight of each index, and finally obtain the Digital Inclusive Financial Development Index by weighted average. We use MATLAB software, processing the data and calculating the DIF Index of 31 major provinces in China from 2011 to 2018 (see Table 2). Among them, the eastern region includes 11 provinces such as Beijing, Hebei, Tianjin and Liaoning, and the central and western regions are the other 20 provinces (except Hong Kong, Macao and Taiwan).

Table 2 2011-2018 Digital Inclusive Financial Development Index of all provinces

Province	2011	2012	2013	2014	2015	2016	2017	2018	Average	Ranking
Beijing	0.7419	0.6942	0.6841	0.7193	0.7233	0.7273	0.7278	0.7030	0.7151	2
Shanghai	0.8067	0.7588	0.7434	0.7645	0.7801	0.7637	0.7696	0.7422	0.7661	1
Guangdong	0.4728	0.4937	0.4547	0.4740	0.4961	0.4649	0.4600	0.4728	0.4736	5
Fujian	0.3151	0.3041	0.2863	0.2780	0.3236	0.2959	0.3004	0.3023	0.3007	7
Zhejiang	0.4926	0.4412	0.5034	0.4530	0.5214	0.4727	0.4682	0.4492	0.4752	4
Tianjin	0.5444	0.4859	0.4811	0.4625	0.5017	0.5138	0.5275	0.4639	0.4976	3
Liaoning	0.3352	0.2828	0.3043	0.3071	0.3052	0.2881	0.2945	0.2498	0.2959	8
Jiangsu	0.4623	0.4504	0.4798	0.4118	0.4438	0.4366	0.4562	0.4023	0.4429	6
Shanxi	0.2062	0.2358	0.2118	0.1756	0.2097	0.2020	0.2141	0.2176	0.2091	13
Xinjiang	0.1647	0.1609	0.1543	0.1633	0.1708	0.1503	0.2177	0.1889	0.1714	22
Qinghai	0.1542	0.1520	0.1687	0.1857	0.1924	0.1892	0.1658	0.1705	0.1723	21
Hebei	0.1862	0.1727	0.1675	0.1965	0.2063	0.1973	0.2006	0.2071	0.1918	14
Shandong	0.2602	0.2549	0.2418	0.2562	0.2670	0.2566	0.2509	0.2328	0.2526	9
Shanxi	0.2068	0.2010	0.2139	0.2109	0.2170	0.2242	0.2326	0.2526	0.2199	11

Inner Mongolia	0.2119	0.2035	0.1888	0.1518	0.1762	0.1903	0.1775	0.1899	0.1862	18
Hainan	0.1831	0.1759	0.1793	0.1868	0.2044	0.2006	0.1970	0.1883	0.1894	16
Chongqing	0.2644	0.2852	0.2559	0.2727	0.2409	0.2300	0.2216	0.2446	0.2519	10
Hubei	0.1760	0.1792	0.1853	0.1886	0.1907	0.1934	0.2028	0.2125	0.1911	15
Jilin	0.2271	0.2091	0.2091	0.2107	0.2185	0.2103	0.2083	0.2073	0.2125	12
Ningxia	0.1826	0.1711	0.1802	0.1826	0.2254	0.1992	0.1929	0.1765	0.1888	17
Heilongjiang	0.1597	0.1659	0.1538	0.1396	0.1497	0.1716	0.1721	0.1784	0.1613	25
Tibet	0.1190	0.1172	0.1365	0.1483	0.1377	0.1429	0.1388	0.1466	0.1359	27
Guangxi	0.1283	0.1298	0.1134	0.1170	0.1213	0.1268	0.1367	0.1480	0.1277	29
Jiangxi	0.1584	0.1309	0.1355	0.1594	0.1760	0.1895	0.1873	0.2122	0.1686	23
Hunan	0.1812	0.1778	0.1690	0.1819	0.1695	0.1624	0.1808	0.2039	0.1783	19
Anhui	0.1594	0.1365	0.1525	0.1639	0.1807	0.1984	0.1968	0.2098	0.1748	20
Sichuan	0.1521	0.1667	0.1520	0.1705	0.1955	0.1653	0.1558	0.1897	0.1685	24
Henan	0.1557	0.1324	0.1277	0.1596	0.1577	0.1672	0.1709	0.1633	0.1543	26
Guizhou	0.0919	0.0945	0.1003	0.1142	0.1255	0.1251	0.1146	0.1513	0.1147	30
Gansu	0.1309	0.1219	0.1296	0.1494	0.1331	0.1597	0.1254	0.1077	0.1322	28
Yunnan	0.0755	0.0764	0.0741	0.0852	0.0616	0.0570	0.0612	0.0813	0.0715	31
National average	0.2615	0.2504	0.2496	0.2529	0.2652	0.2604	0.2621	0.2602	0.2578	
Eastern average	0.4364	0.4104	0.4114	0.4100	0.4339	0.4198	0.4230	0.4012	0.4183	
Central average	0.1780	0.1710	0.1681	0.1724	0.1816	0.1868	0.1916	0.2006	0.1813	
Western average	0.1569	0.1567	0.1556	0.1626	0.1664	0.1633	0.1617	0.1706	0.1617	

3.3 Model Design

The first measure of financing constraints is the Investment-Cash Flow Sensitivity Model proposed by fazzari et al. (1988), and believes that the more serious the financing constraints are, the more sensitive the investment cash flow will be. In view of the shortcomings of the above model, Almeida et al. (2004) improved and proposed the Cash-Cash Flow Sensitivity Model to identify the strength of financing constraints. The model can be simply attributed to the regression coefficient between the change of enterprise's cash holding and cash flow. It can be explained as follows: when the enterprise has no financing constraints, the change of enterprise's cash holding has nothing to do with cash flow, when the company has financing constraints, the change of cash held by the company will show a positive correlation with cash flow, and the more serious the financing constraints are, the greater the sensitivity of flow will be. The reason is that in order to meet the cash demand of subsequent production and operation, enterprises with financing constraints retain more liquid assets for subsequent investment.

Based on the modeling idea of Cash-Cash Flow Sensitivity Model, the benchmark model of this paper is constructed:

$$\Delta Cash_{i,t} = \beta_0 + \beta_1 \times CF_{i,t} + \beta_2 \times Growth_{i,t} + \beta_3 \times Size_{i,t} + \beta_4 \times \Delta SD_{i,t} + \beta_5 \times \Delta NWC_{i,t} + \beta_6 \times \Delta Cash_{i,t-1} + \mu_{i,t} \quad (3)$$

At the same time, in order to better measure the effect of DIF on small and medium-sized agriculture-related enterprises, this paper constructs the following extended model:

$$\Delta Cash_{i,t} = \beta_0 + \beta_1 \times CF_{i,t} + \beta_2 \times CF_{i,t} \times DIF_{i,t} + \beta_3 \times Growth_{i,t} + \beta_4 \times Size_{i,t} + \beta_5 \times \Delta SD_{i,t} + \beta_6 \times \Delta NWC_{i,t} + \beta_7 \times \Delta Cash_{i,t-1} + \mu_{i,t} \quad (4)$$

In the above model, ΔCash represents the increase of the enterprise's cash and current equivalents in the current year compared to the previous year. In order to avoid being affected by the size of the enterprise, it is divided by the total assets of the enterprise at the beginning of the year to get the final result. CF represents the cash flow generated by the company's operating activities in the current year, and the coefficient in front of it reflects whether the company faces financing constraints. Therefore, when the coefficient is positive, it means that small and medium-sized agriculture-related enterprises have financing constraints. The interaction term between cash flow from business activities and DIF Index reflects the impact of DIF on financing constraints. According to the hypothesis of this paper, DIF can alleviate the financing constraints of agricultural small and medium-sized enterprises. Therefore, it can be predicted that the value of the interaction term is negative.

Growth is an indicator reflecting the growth ability of an enterprise, expressed by the growth rate of operating revenue. The stronger the growth ability of an enterprise and the faster the growth rate, the shorter the capital turnover period of the enterprise and the less cash the enterprise holds, so the prediction coefficient is negative; Size is the scale of the enterprise. The larger the scale of the enterprise, the stronger the motivation for external expansion. Therefore, the prediction coefficient of this paper is positive; Δ SD is the change of enterprise's short-term debt. Enterprise's short-term debt needs cash with strong liquidity to pay, so when the short-term debt increases, the cash held by the enterprise will also increase, so the prediction coefficient is positive; Δ NWC uses the enterprise's current assets minus current liabilities to obtain the change of the enterprise's net working capital, and the most liquid asset is cash. Therefore, when the enterprise's net working capital increases, the enterprise's cash holdings will also increase, so it is predicted that its coefficient is positive. At the same time, the explained variable with a lag of one period is also introduced into the model as the explanatory variable, and the more cash the enterprise held in the previous period, the cash holding may be reduced in the current period, so the coefficient of the predicted lagged explained variable is negative.

The detailed definitions and calculation methods of the above variables are shown in Table 3.

Table 3 Variable Description

Name	Symbol	Calculation method
Cash holding	ΔCash	Increase in cash and cash equivalents/ total assets at the beginning of the year

Cash Flow	CF	Net cash flow from operating activities/ total assets at the beginning of the year
Digital Inclusive Finance	DIF	Digital Inclusive Financial Development Index
Enterprise growth ability	Growth	Growth rate of operating revenue
Enterprise scale	Size	Natural logarithm of total assets at the end of the year
Changes in net working capital	ΔNWC	(total current assets - total current liabilities) /total assets at the beginning of the year
Changes in short-term debt	ΔSD	Increase in current liabilities /total assets at the beginning of the year

3.4 Descriptive statistics

The descriptive statistical analysis of the main variables is listed in Table 4. The average cash holding level of enterprises is 0.0150, the median is 0.0022, the minimum is -0.2684 and the maximum is 0.5631. Therefore, there are great differences in cash holding levels among different enterprises. The average cash flow is 0.0842 and the median is 0.0747, with little difference. The minimum value of Digital Inclusive Finance Development Index is 0.0616 and the maximum value is 0.7645. It can be seen that the development level of DIF is different among different provinces. The detailed descriptive statistical results of other variables are shown in Table 4, which will not be described one by one here.

Table 4 Descriptive Statistics

Variable	Number of samples	Average	Median	Standard deviation	Minimum	Maximum
ΔCash	427	0.0150	0.0022	0.1221	-0.2684	0.5631
CF	427	0.0842	0.0747	0.1003	-0.1472	0.3646
DIF	427	0.2988	0.2328	0.1762	0.0616	0.7645
Growth	427	0.1324	0.1068	0.2723	-0.4976	1.2442
Size	427	12.4581	12.4250	0.9549	10.3586	15.0715
ΔNWC	427	0.0228	-0.0007	0.1795	-0.3560	0.7976
ΔSD	427	0.0525	0.0446	0.1285	-0.2874	0.4705

4 Empirical Results and Analysis

4.1 Digital Inclusive Finance and financing constraints of small and medium-sized agriculture-related enterprises

We use Hausman test in order to test endogenous phenomenon of explanatory variables. The test results show that the explanatory variables are not all exogenous explanatory variables, and the correlation test is carried out for the lag term of endogenous explanatory variables. Therefore, this paper regards the enterprise scale, short-term debt changes and net working capital in the relevant financial data of enterprises from 2011 to 2018 as exogenous variables. Firstly, taking the second-order to fourth-order lag terms of the explained variable of enterprise cash holdings, the first-order and second-order lag terms of cash flow in the explanatory variable and enterprise growth ability as the set of instrumental variables, the first-order difference GMM of the benchmark model is carried out. Secondly, taking the second-order to fourth-order lag terms of the explained variable of enterprise cash holdings, the second-order and later lag terms of cash flow in the explanatory variable and enterprise growth ability as the set of instrumental variables, the first-order difference GMM of the extended model is carried out. The specific regression results are shown in Table 5.

Table 5 Regression Results

Variable	ΔCash	
	Benchmark model	Extended model
C	-0.6538*	-0.6529**
	(0.3578)	(0.2830)
CF	0.4817***	1.1091***
	(0.1551)	(0.3653)
CF×DIF		-2.5540***
		(0.8899)
Growth	-0.0681	-0.0501
	(0.0643)	(0.0662)
Size	0.0488*	0.0487**
	(0.0286)	(0.0218)
ΔSD	0.4025***	0.4059***
	(0.0769)	(0.1101)
ΔNWC	0.4746***	0.4824***
	(0.0766)	(0.0937)
ΔCash (-1)	-0.1564**	-0.1806***
	(0.0751)	(0.0617)
AR (1)	0.000	0.001
AR (2)	0.867	0.757
sargan test	0.159	0.438
hansen	0.520	0.378

Note: (1) the standard error of estimation is in brackets;(2) *, * *, * * * respectively indicate that the regression coefficient is significant at the level of 10%, 5% and 1%.

The second column in Table 5 is the regression result of the benchmark model. It can be concluded that the coefficient of cash flow CF is significantly positive at the level of 1%,

indicating that there are serious financing constraints for agricultural small and medium-sized enterprises. In model (4), the coefficient of the interaction term between cash flow and DIF is significantly negative at the level of 1%. The reason is the DIF has a negative impact on the level of cash holdings of enterprises, indicating that the development of DIF can effectively alleviate the financing constraints of small and medium-sized agricultural enterprises. Hypothesis 1 of this paper is tenable, and the absolute value of its coefficient is large. The development of DIF can have a good effect on the mitigation of financing constraints.

In the regression results of the benchmark model, the coefficient of enterprise growth is negative, which is in line with expectations, but not significant. Changes in enterprise size and enterprise short-term debt net working capital of the enterprise are significantly positive, in line with expectations, indicating that these three variables have a significant positive impact on enterprise cash holdings. The first-order lag term of the enterprise's cash holdings is significantly negative, which can explain that the more cash holdings in the previous period, the lower the current cash holdings level. It can be further explained as: the more liquid funds accumulated by the enterprise in the early stage, it will provide a certain guarantee for the enterprise and further alleviate the financing constraints of the enterprise.

Through the estimation results of the two models, it is concluded that there are serious financing constraints for small and medium-sized agricultural enterprises in China, and the development of DIF can effectively alleviate the financing constraints of agricultural enterprises.

4.2 Impulse Response and Variance Decomposition

Based on the above assumptions, this paper believes that the current financing constraints are still affected by the previous DIF. Therefore, in this part, we mainly investigate whether the lag term of the interaction term between cash flow and DIF Index has an impact on the cash holding level. Therefore, a panel vector autoregression (PVAR) model is constructed. After the stationarity test, the optimal lag order is determined, as shown in Table 6.

Table 6 Selection of lag order of PVAR model

Lag	AIC	BIC	HQIC
1	-5.0938*	-3.4602*	-4.4400*
2	-4.7302	-2.7281	-3.9231
3	-4.1600	-1.5879	-3.1164
4	-3.2410	0.3145	-1.7991
5	-0.7201	4.8335	1.4090

It is determined that the optimal lag order is order 1, and the impulse response function diagram is drawn accordingly, as shown in Figure 1.

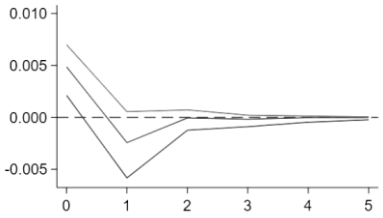

Figure 1 impulse response function of DIF to cash holding level

It can be seen from the impulse response function diagram that the interaction term has a significant negative impact on cash holdings in the lag period, and the impact reaches the maximum. After the lag of two periods and beyond, there is basically no impact on the level of enterprise cash holdings, so the time lag of the role of DIF is about one year, and the third hypothesis in this paper is verified. The development of DIF is mainly to alleviate the cash flow problems of small and medium-sized agriculture-related enterprises, rather than the cash flow generated in the daily business activities of small and medium-sized enterprises. Therefore, after the implementation of relevant measures of DIF, it needs a certain time lag to have an effect on the cash flow of agriculture-related enterprises. The financing constraints of enterprises still exist at first. With the continuous development of DIF, the financing constraints of enterprises can be gradually alleviated, so the DIF, which lags behind the first phase, still has obvious effects. In order to better quantify the impact of DIF on cash holdings, the variance decomposition is carried out. Since the data used in this paper are between 2011 and 2018, combined with the results of impulse response function diagram, this study carries out 5-order decomposition. The specific results are shown in Table 7.

Table 7 Variance Decomposition

	Lag	CF×DIF	CF
CF	1	0.036	0.964
CF	2	0.035	0.965
CF	3	0.035	0.965
CF	4	0.035	0.965
CF	5	0.035	0.965

The above variance decomposition results show that the contribution of Digital Inclusive Finance to the explanation of cash holdings is about 3.5%, reaching the maximum in the first period, which is 3.6%; The largest contribution to the explanation of enterprise cash holdings is still itself, so the amount of cash holdings will also have a certain effect on financing constraints.

4.3 Heterogeneity Analysis

On this basis, according to the classification standard, this paper divides small and medium-sized enterprises into eastern and central and western regions, estimates and compares

the benchmark model and extended model respectively. And the regression results of the two groups are summarized in Table 8.

Table 8 Regional Heterogeneity Analysis Results

Variance	Central and Western Regions		Eastern Region	
	Model (3)	Model (4)	Model (3)	Model (4)
C	-0.9132**	-1.0142***	-0.2278	-0.2682
	(0.023)	(0.008)	(0.736)	(0.512)
CF	0.6351***	1.0075*	0.2222	0.0826
	(0.000)	(0.056)	(0.477)	(0.907)
CF×DIF		-1.9921		-0.0264
		(0.508)		(0.986)
Growth	-0.0879	-0.1236	-0.1370	-0.0806
	(0.166)	(0.133)	(0.163)	(0.207)
Size	0.0690**	0.0771**	0.0156	0.0199
	(0.032)	(0.011)	(0.771)	(0.537)
ΔSD	0.3218***	0.3623***	0.4545***	0.3870***
	(0.000)	(0.002)	(0.000)	(0.002)
ΔNWC	0.4971***	0.4943***	0.5573***	0.5290***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔCash (-1)	-0.2678***	-0.2672***	-0.0759	-0.0838
	(0.001)	(0.006)	(0.480)	(0.347)
AR (1)	0.018	0.019	0.001	0.012
AR (2)	0.913	0.884	0.953	0.964
sargan test	0.974	0.346	0.711	0.288
hansen	0.784	0.634	0.508	0.760

Note: (1) the p value of coefficient estimation is in brackets; (2) *, * *, * * * respectively indicate that the regression coefficient is significant at the level of 10%, 5% and 1%.

Based on the regression results in Table 8, the cash flow coefficient of small and medium-sized agricultural enterprises in the central and western regions is significantly positive under both models, indicating that small and medium-sized agricultural enterprises in the central and western regions are facing serious financing constraints. Although the cash flow coefficient of enterprises in the eastern region is also positive, it is not significant, so the small and medium-sized agriculture-related enterprises in the eastern region do not have obvious financing constraints. Further explore the reasons: due to the backwardness and imperfection of the financial system in the central and western regions, traditional financial institutions exclude small and medium-sized agricultural enterprises from the financial system. Therefore, serious financing constraints situations are occurred frequently of small and medium-sized agricultural enterprises in the western region, while the external financing environment of enterprises in the Eastern region is better, because of developed financial market and the smaller degree of information asymmetry. The government of the eastern region will give certain financing and credit policy support to agricultural enterprises in a weak position, so the problem of financing constraints is not prominent in the eastern region.

At the same time, the coefficient of DIF is negative, which shows that DIF can alleviate the financing constraints of small and medium-sized agricultural enterprises in the region. By comparing the absolute value of the coefficient between the central and western regions and the eastern region, the absolute value of the coefficient in the central and western regions is much

larger than that in the eastern region, which shows that there are differences in the mitigation effect of DIF on the financing constraints. According to the previous measurement results of the DIF Index, it can be concluded that there is a certain gap in the development level of DIF between the eastern region and the central and western regions. Therefore, the second hypothesis of this paper is tested. The mitigation effects of DIF Development on the financing constraints of small and medium-sized agriculture-related enterprises in different regions are different.

4.4 Robustness check

In the previous empirical process, the first-order difference GMM method is used to estimate the model and control the possible endogenous problems, which is also a robustness test to a certain extent. The data from 2012 to 2018 are used to regress the model to test its stability. At the same time, two variables of return on assets ROA and enterprise long-term capital expenditure Expand are introduced to estimate the benchmark model and extended model by using the first-order difference GMM method. The specific results are shown in Table 9.

Table 9 Robustness check

Variance	Supplementary variable		2012-2018 Subsample	
	Model (3)	Model (4)	Model (3)	Model (4)
CF	0.4427***	0.9574**	0.5530***	1.0170**
	(0.1446)	(0.4259)	(0.1875)	(0.4012)
CF×DIF		-1.7397*		-1.8763**
		(0.080)		(0.9201)
Growth	-0.0674**	-0.1011*	-0.1431	-0.0865
	(0.0323)	(0.0542)	(0.1211)	(0.0536)
Size	0.0430**	0.0515*	0.0470	0.0574*
	(0.0192)	(0.0266)	(0.0347)	(0.0297)
ΔSD	0.3892***	0.4474***	0.4618***	0.4314***
	(0.0818)	(0.1119)	(0.0891)	(0.0986)
ΔNWC	0.5172***	0.5286***	0.4909***	0.4878***
	(0.0807)	(0.1193)	(0.0853)	(0.0913)
ΔCash(-1)	-0.1373**	-0.1310	-0.1184	-0.1175*
	(0.0652)	(0.0811)	(0.0815)	(0.0696)
ROA	-0.1143	-0.1120		
	(0.1947)	(0.1532)		
Expend	-0.0420	0.0061		
	(0.1289)	(0.1799)		
AR(1)	0.000	0.001	0.001	0.000
AR(2)	0.821	0.758	0.689	0.550
sargan test	0.489	0.542	0.373	0.401
hansen	0.903	0.573	0.433	0.617

Note: (1) the standard error of estimation is in brackets; (2) *, * *, * * * respectively indicate that the regression coefficient is significant at the level of 10%, 5% and 1%.

It can be concluded that the coefficient of cash flow CF in the triple regression is significantly positive at the level of 1% and 5%, indicating that small and medium-sized agricultural enterprises have serious financing constraints. The coefficient of Digital Inclusive Finance is significantly negative, indicating that the development of DIF can alleviate this phenomenon.

Therefore, the research conclusion is stable.

5 Conclusions and Suggestions

By constructing the development index of DIF in 2011 to 2018, and taking the agricultural enterprises listed on the SME board from 2011 to 2018 as a sample, this paper studies the relationship between DIF and the financing constraints of small and medium-sized agricultural enterprises. The study found: Firstly, the small and medium-sized agricultural enterprises have financing constraints, and the development of DIF can alleviate the financing constraints of enterprises. Secondly, compared with small and medium-sized enterprises located in the eastern region, the mitigation effect of DIF on small and medium-sized enterprises in the central and western regions is more obvious, and the formulation and implementation of DIF policy will be affected in the early stage, but also affect the future situation. Moreover, the DIF lagging behind the first period will still have an impact on the current period, and the lagging period has the greatest impact.

The policy implications of this paper are: (1) accelerate the construction of the financial system so that the policy can be fully implemented and achieve the expected results; (2) the governments of backward areas such as the central and western regions should strengthen the support of relevant policies to ensure the effective implementation of policies and reduce service costs; (3) strengthen financial supervision and create a more perfect external financing environment for enterprises; (4) Digital Inclusive Financial services should be more inclusive, strengthen the digital innovation of Inclusive Finance, expand service boundaries, break geographical restrictions and serve the majority of groups; (5) the managers of small and medium-sized agriculture-related enterprises should improve their own quality, comprehensively interpret the policies, reduce their own exclusion, and take the initiative to understand and make use of the current digital inclusive financial policies to reduce their dependence on traditional finance.

Future research trends: the development of DIF and economic development affect each other. The development of one region will also drive the development of other regions. Therefore, we can further study whether there is spatial spillover effect of DIF.

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