Digital Inclusive Finance and Regional Economic Development Level——Empirical Evidence based on Provincial Panel Data from 2011-2020

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Abstract: Coordinated regional economic development, as an important national policy of China, has always been the future goal and direction of economic development, and its realization requires the help of many parties, including the Government and finance. On the financial side, because of the development of digital information technology, digital inclusive finance(DIFI) has emerged, breaking the inherent mode of traditional financial institutions, providing a new perspective for the development of inclusive finance, increasing the reach and depth of use of financial services, effectively driving the development of the real economy in various regions, and to a certain extent showing the spatial agglomeration effect, but the impact of the DIFI index on the coordinated development of the regional economy However, the impact of the DIFI index on the coordinated development of regional economies is not yet known.Therefore, based on the review of domestic and international data, this paper composes the lineage of DIFI development and analyzes the current situation of uneven regional economic development level（RED）. Secondly, this paper selects the panel data of 31 provinces in China from 2011 to 2020, measures the influence of each factor on the RED, and also uses the two-way fixed effect model, combines DIFI different dimensions to analyze the impact of DIFI development on the RED of each province in China from multiple perspectives. Finally, based on the empirical results, the impact of the DIFI index on the RED is discussed, and regional economic coordination in China by formulating development strategies to strengthening inter-provincial cooperation and rational allocation of resources.

1. Introduction

1.1. Background of the Study

In recent years, along with the rapid development of the Internet and mobile payment, digital

technology has been deeply integrated with inclusive finance, helping traditional inclusive finance break through business bottlenecks, prompting DIFI to benefit more groups, and pushing inclusive finance into a new stage of rapid development[1]. The plan was launched, calling for enhanced financial inclusion and emphasizing the improvement of a modern financial system with a high degree of applicability, competitiveness and inclusiveness. The Opinions of the State Council of the Central Committee of the Communist Party of China on Building a More Perfect Institutional Mechanism for Market-based Allocation of Factors further made general arrangements for optimizing the allocation of financial resources. However, in the process of accelerating the development of DIFI, it also faces problems such as innovation risks and the "digital divide"[2].

1.2. Significance of the Study

Theoretical level: DIFI has been developed for a relatively short period of time, and there is less literature at home and abroad on the impact of DIFI on macroeconomic activities, scholars mostly focus on the relationship between DIFI and economic activities such as urban-rural income gap, resident consumption[3], poverty reduction effect and economic growth, or focus on the development of DIFI and enterprise economic activities such as enterprise innovation and entrepreneurship, micro and small enterprise financing and technological progress. However, less literature studies the relationship between DIFI development and RED development[4].

At the practical level: The inclusion and inclusiveness of inclusive finance can effectively solve the commercialization and profit-seeking problems of financial institutions, help change the goal orientation of financial institutions in chasing short-term effects, promote the construction of a good ecological pattern of benign interaction, complementary advantages and win-win cooperation among the participants in inclusive finance[5], and promote the coordinated development of the national regional economy. Based on this, it is of certain theoretical and practical significance to study whether the development of DIFI in China in the new era can promote the level of RED development and through what channels it can act on the level of RED development[6].

2. Review of the Literature

At present, domestic and foreign studies on DIFI mainly concentrate on the impact of DIFI on the real economy, including macro and micro levels.The macro level mainly discusses the relationship between DIFI and poverty alleviation, urban-rural income gap, economic growth (Li, 2019; Song, 2017; Qian, Haizhang et al., 2020), etc., and the conclusions reached on the role played by DIFI vary. At the micro level, Zhang Xun et al. (2020) conducted an empirical study using micro-household data and found that the development of DIFI contributes to inclusive growth in China by increasing household income, especially for rural low-income groups. Xie, Gai-Li et al. (2018) studied the impact of DIFI on entrepreneurship and found that the total digital finance index as well as the three first-order dimension indicators significantly promoted entrepreneurship[7-8].

At present, a large number of scholars have argued the relationship between DIFI and economic development from multiple perspectives, but mainly focus on relying on the "intermediary" effect, but both DIFI and RED are a more comprehensive indicator, and the factors affecting them are a comprehensive set of indicators. Therefore, this paper will directly measure the impact of DIFI and regional economic level with the help of entropy method comprehensive evaluation model, two-way fixed effect model and instrumental variable method, which will provide new ideas for the government to develop DIFI to alleviate the problem of unbalanced RED growth[9].

3. Research Design

3.1. Selection of Variables

3.1.1. Explained Variables

RED level. Referring to the indicators of the economic growth dimension layer in China's inclusive green growth indicator system proposed by Zhou Xiaoliang and Wu Wulin (2018), a combination of the fixed-base extreme difference method and the entropy weight method is used to construct an indicator of regional disparity between provinces in the country from two domain layers of economic output and income level as sown in Table 1.

Table 1. Definition of study variables

Dimensional level (math.)	Domain level	Name of indicator	Quality	Unit	Weight w
Level of regional economic development	Economic output	Gdp per capita	+	Yuan/person	0.1961434
		Share of fiscal revenue	+	Multiple	0.1334168
		Share of secondary sector	+	Multiple	0.1305634
		Share of tertiary sector	-	Multiple	0.1283524
	Income level	Net income per rural inhabitant	+	Yuan/person	0.1736771
		Per capita disposable income of urban residents	+	Yuan/person	0.1843684
		Ratio of per capita income between urban and rural residents	-	Multiple	0.0534786

3.1.2. Explanatory Variables

The value of the DIFI Index of Peking University, denoted as DIFI, is used as the explanatory variable.

3.1.3. Control Variables

The level of RED is influenced by many factors, and in the process of studying the impact of DIFI on the coordinated regional economic development of the country's provinces, this paper controls for the following variables as sown in Table 2.

Table 2. Research variables and definitions

Variable type	Variable name	Variable symbol	Calculation method
Explained variables	Level of regional economic development	Growth	Referring to Zhou, Xiaoliang and Wu, Wulin (2018) construct
Explanatory variables	Digital inclusive finance development index	DIFI	Peking University Digital Inclusive Finance Index (2011-2020)
	Breadth of coverage	Coverage	Ibid
	Depth of use	Usage	Ibid
	Degree of digitization	Digitalization	Ibid
	Urbanization rate	Urban	Urban population/total population
	Government action	Gov	Local fiscal expenditure/GDP
	Fixed asset investment	Fix	Fixed asset investment/GDP
	Industrial structure	Indus	Value added of secondary and tertiary industries/GDP
	Level of economic development	Rgdp	Log GDP per capita
	Degree of opening up	Open	(Total exports and imports + FDI)/GDP

3.2. Data Selection and Descriptive Statistics

The primary data used in this paper are mainly from the Peking University Digital Inclusive Finance Index (2011-2020), wind database, National Bureau of Statistics and provincial and municipal statistical yearbooks. The results are as follows as sown in Table 3.

Table 3. Descriptive statistics of variables

Variable	Variable meaning	Number of samples	Average value	(statistics) standard deviation	Minimum value	Maximum value
Difi	Same as above table	310	216.2	97.03	16.22	431.9
Coverage	Same as above table	310	196.9	96.76	1.960	397
Usage	Same as above table	310	211.6	98.43	6.760	488.7
Digitalization	Same as above table	310	290.2	117.3	7.580	462.2
Depth	Financial depth	310	0.357	0.191	-0.0255	1.451
Width	Financial breadth	310	0.00529	0.00212	0.00193	0.0152
Availability	Accessibility of financial services	310	1.665	0.295	1.104	2.361
Urban	Urbanization rate	310	0.581	0.131	0.228	0.896
Gov	Share of fiscal expenditure	310	0.284	0.209	0.110	1.379
Fix	Fixed asset investment	310	0.966	1.541	0.0902	16.98
Indus	Industrial structure	310	0.0723	0.0637	-0.334	0.208
Edu	Level of education	310	0.0505	0.0125	0.0196	0.0819
Rgdp	Log gdp per capita	310	10.83	0.441	9.706	12.01
Open	Degree of opening up	310	0.280	0.299	0.00824	1.576
Growth	Level of regional economic development	310	0.568	0.258	0.201	1.641

From the statistical description of the data, it can be seen that the standard deviation of China's

DIFI development index, coverage breadth and usage depth is large, while the extreme deviation is also large, indicating that the DIFI index varies widely among provinces, reflecting different characteristics and significant differences at the level of different provinces. At the provincial level, the logarithmic treatment is used in the empirical process because of the large value of GDP per capita[10]. Also, it can be seen from the data that the standard deviation of fixed asset investment is large compared to other factors, but the data is overall within a manageable range.

4. Empirical Analysis of the Impact of DIFI on the Level of RED in the Country's Provinces

4.1. Empirical Strategy

4.1.1. Model Setting: DIFI Development and RED

In order to test the impact of digital financial inclusion development on the level of regional economic development in each province of the country, the following two-way fixed effects basic test model:

$$Growth_{it} = \alpha_{0+}\alpha_1 DIFI_{it} + \alpha_2 CV_{it} + \varphi_i + u_i + \varepsilon_{it} \qquad (1)$$

Where, i stands for national provinces, t stands for time, Growth stands for RED,a composite indicator to measure the level of regional economic development, borrowed from Zhou Xiaoliang and Wu Wulin (2018), who selected seven indicators from two domain layers of economic output and income level[11], measured using the fixed-base extreme difference entropy weighting method.DIFI represents the national development of digital financial inclusion, and CV including financial depthdepth, financial breadthwidth, availabilityavailability of financial services, urbanization rateurban, government actiongov, fixed asset investmentfix, industrial structureindus, education leveledu, economic development levelrgdp[12], and openness to the outside worldopen.In addition, this paper further controls for year fixed effect and regional fixed effect.φ_i denotes the time fixed effect, andu_i denotes the factors that do not vary over time in each province, and is used to control for regional fixed effects.ε_{it} is the error disturbance term shown in Figure 1-4.

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First-stage regression summary statistics

                      Adjusted     Partial
     Variable   R-sq.    R-sq.      R-sq.    F(1,259)   Prob > F

         DIFI   0.9985   0.9982     0.4004   172.976    0.0000


Shea's partial R-squared

                   Shea's              Shea's
     Variable   partial R-sq.   adj. partial R-sq.

         DIFI      0.4004            0.2819
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Figure 1. Weak instrumental variable test results

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Underidentification test (Kleibergen-Paap rk LM statistic):           61.578
                                             Chi-sq(1) P-val =          0.0000

Weak identification test (Cragg-Donald Wald F statistic):            172.976
                         (Kleibergen-Paap rk Wald F statistic):      147.662
Stock-Yogo weak ID test critical values: 10% maximal IV size         16.38
                                          15% maximal IV size          8.96
                                          20% maximal IV size          6.66
                                          25% maximal IV size          5.53
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Hansen J statistic (overidentification test of all instruments):      0.000
                                            (equation exactly identified)

Instrumented:         DIFI
Included instruments: depth width availability urban gov fix indus edu rgdp
                      open 2012.year 2013.year 2014.year 2015.year 2016.year
                      2017.year 2018.year 2019.year 2020.year 2.city 3.city
                      4.city 5.city 6.city 7.city 8.city 9.city 10.city 11.city
                      12.city 13.city 14.city 15.city 16.city 17.city 18.city
                      19.city 20.city 21.city 22.city 23.city 24.city 25.city
                      26.city 27.city 28.city 29.city 30.city 31.city
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Figure2. Test results of three instrumental variables

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. xtset city year

Panel variable: city (strongly balanced)
 Time variable: year, 2011 to 2020
          Delta: 1 unit

. xtreg growth DIFI depth width availability urban gov fix indus edu rgdp open ,f
> e

Fixed-effects (within) regression            Number of obs    =       310
Group variable: city                         Number of groups =        31

R-squared:                                   Obs per group:
     Within  = 0.9452                                    min =        10
     Between = 0.6877                                    avg =      10.0
     Overall = 0.0597                                    max =        10

                                             F(11,268)        =    420.22
corr(u_i, Xb) = -0.7599                       Prob > F         =    0.0000
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Figure3. Model 1 Operation password and result

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. est store fe

. xtreg growth DIFI depth width availability urban gov fix indus edu rgdp open,re

Random-effects GLS regression                Number of obs    =       310
Group variable: city                         Number of groups =        31

R-squared:                                   Obs per group:
     Within  = 0.8885                                    min =        10
     Between = 0.8358                                    avg =      10.0
     Overall = 0.8178                                    max =        10

                                             Wald chi2(11)    =   2035.61
corr(u_i, X) = 0 (assumed)                    Prob > chi2      =    0.0000
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Figure 4. Accept the fixed effect test chart

4.1.2. Further Analysis: Dimensions of DIFI Development and RED

The breadth of coverage of DIFI reflects the supply of digital financial services, and the advantages of convenience, low threshold and high efficiency of the network make the coverage more extensive and can break through geographical restrictions, which greatly increases the supply of financial services and also enhances the ability to reach users. The depth of use of DIFI mainly emphasizes the quality of the use of financial services, which can start from the user side and truly reflect the effective use of digital financial services by users[13]. DIFI mainly reflects the advantages of technology in reducing costs, thresholds and risks, and provides technical support for the above two. Thus, this paper further tests the influence of digital inclusion on national and RED from the above three dimensions of digital inclusion, and constructs the following two-way fixed effect model.

$$Growth_{it} = \beta_0 + \beta_1 Coverage_{it} + \beta_2 CV_{it} + \varphi_i + u_i + \varepsilon_{it} \qquad (2)$$

$$Growth_{it} = \gamma_0 + \gamma_1 Usage_{it} + \gamma_2 CV_{it} + \varphi_i + u_i + \varepsilon_{it} \qquad (3)$$

$$Growth_{it} = \omega_0 + \omega_1 Digitalization_{it} + \omega_2 CV_{it} + \varphi_i + u_i + \varepsilon_{it} \qquad (4)$$

Where i represents the national provinces, t represents time, Coversage represents the breadth of digital financial coverage, Usage represents the depth of digital financial use, and Digitalization measures the degree of digitalization of digital finance. The rest of the variables are defined in the same way as in equation (1).

4.1.3. Endogeneity and Instrumental Variability

The causes of endogeneity problems generally include measurement error, omitted variables and reciprocal causation. The BYU Inclusive Finance Index used in this paper, which is compiled using

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a subjective and objective assignment method, has less impact on measurement error. At the same time, the regression model can effectively control the time-specific factors that do not vary with regions and the region-specific factors that do not vary with time, and attenuate the influence of omitted variables. Therefore, this essay uses the average of digital inclusion indices of provinces in the province other than those bordering its own province as the instrumental variable of digital inclusion to address the endogeneity bias[14].

In addition, the above-mentioned instrumental variables are used to satisfy the conditions of exclusivity and correlation: firstly, digital financial development is correlated with the digital financial development of this province and its neighboring provinces due to the existence of path dependency and a certain degree of consistency in its policies, planning, infrastructure, etc. across the country. Second, the average of digital financial inclusion development level in provinces other than those bordering one's own province does not have a direct impact on the current province's economic development level, regional gap, or urban-rural gap. Therefore, instrumental variables are correlated with the development level of DIFI of the current period, but not directly related to the RED, regional economic gap and urban-rural gap of the current period, and meet the conditions of exclusivity and correlation[15].

4.2 Overall Impact of DIFI

In the benchmark model, the fixed effects model and random effects model are used to investigate the relationship between the development of DIFI and the level of RED development, without considering the endogeneity and the results show that the model is applicable to the fixed effect model through p-value and hausman test, so this paper adopts the double fixed effect model controlling for individual and time. And the instrumental variable passed the unidentifiable test and weak instrumental variable test, for the sake of enhancing the robustness of the empirical results, at the same time, the mean value of digital inclusion finance in other provinces within the country other than the province bordering its own province was used as the instrumental variable of digital inclusion finance for the model regression, and the method was used to estimate the model.

The regression results show that digital inclusive financial development has a positive impact on the core explanatory variable DIFI at the 1% significance level, indicating that digital inclusive financial development significantly contributes to the increase in the level of RED in the provinces, side-by-side indicating that the benchmark regression results of the regression model are robust.

The control variables also show different effects on the level of RED. In terms of the impact effect, under the two-way fixed effect model, the increase in log GDP per capita can significantly help to improve the level of RED, and the increase in GDP per capita means that residents create more wealth through labor, and the wage level increases, which helps to increase the consumption level and promote the development of local industries. The urbanization rate and the degree of opening up will have a negative impact on the level of RED, meaning that the rural labor force moves to the cities, the lack of talent for regional industrial construction in the hometown is not conducive to balancing the income gap between urban and rural areas, thus making the level of RED decline. The opening degree of foreign trade has a high requirement on regional facilities and resources, which to some extent will lead to the decline of the economic development level of urban areas with scarce resources or not dense population. Meanwhile, under the application of instrumental variable method, in addition to the above two control variables, the proportion of fiscal expenditure can also have a positive impact on the level of RED. The financial expenditure of the government supports the development of regional construction and helps to improve the level of economic development.

Table 4. Table of regression results of model (4.1) DIFI development on RED

Explanatory variables	Two-way fixed effects regression (1)	Instrumental variables regression (2)
DIFI	0.241***	0.367***
	(3.93)	(6.13)
Depth	0.011	-0.003
	(0.51)	(-0.22)
Width	-3.036	-3.454
	(-0.51)	(-0.93)
Availability	0.001	0.003
	(0.06)	(0.14)
Urban	-1.683***	-1.460***
	(-4.44)	(-5.31)
Gov	0.236	0.311***
	(1.26)	(2.62)
Fix	0.001	0.001
	(0.73)	(0.58)
Indus	0.046	0.059
	(0.95)	(1.63)
Edu	1.366	1.110**
	(1.37)	(2.28)
Rgdp	0.194***	0.156***
	(3.84)	(4.35)
Open	-0.155**	-0.145***
	(-2.47)	(-3.04)
Constant term (math.)	-0.976**	0.093
	(-2.28)	(0.29)
Individual fixed effects	control	control
Time fixed effect	control	control
Sample size	310	310

4.3. Impact of Different Dimensions of Digital Inclusion Finance

This paper further explores the role of three Chinese DIFI indicator system sub-indicator dimensions on the level of RED. Since the coverage breadth of DIFI reflects the supply of financial services and the accessibility of users, the depth of use of DIFI reflects the actual use of digital financial services by users, and the digitalization degree of DIFI reflects the advantages of low threshold and low cost of digital financial services, which affects users' use of financial services, we want to explore which factors contribute to this facilitating effect, whether wide audience and high supply, or low threshold and low risk, or include several of these factors. The regressions were run using a two-way fixed effects model and an instrumental variables approach, respectively.

The regression results show that the regression coefficients of the depth of use and digitalization of DIFI and the RED of all provinces in the country are positive and still pass the statistical significance test of 1% after considering the endogeneity results, indicating that the increase of the depth of use and digitalization contributes to the increase of the RED, where a 1% increase of the depth of use can bring 0.27% of the RED A 1% increase in depth of use leads to a 0.27% increase

in the level of RED, and a 1% increase in digitization leads to a 0.233% increase in the level of RED.

The supply of financial services that help realize the effective demand of users is the effective supply, and the effective supply can promote economic development; the degree of digitization is the main driving force of DIFI, reflecting the cost scale and convenience of using digital financial services, the low threshold promotes the promotion and use of DIFI, which further affects the connection between effective demand and effective supply. The usage depth measures the degree of use of DIFI, and measures the actual use of financial services from the perspective of users, which helps to put effective supply in place and show the development of DIFI. In the bidirectional fixed-effect model, the influence of coverage breadth on national RED is not obvious, indicating that the marginal utility of DIFI coverage breadth has no effect on the improvement of RED to a certain extent, and the improvement of RED only by increasing the number of users and pursuing the supply of financial services has no relevant influence. Rational allocation and use of financial resources. It is the key to developing DIFI. Therefore, the regression significance results indicate that "quality" development that focuses on the depth of use and digitization of DIFI can better promote RED.

4.4. Robustness Tests

In this paper, in order to address the endogeneity issue, we not only use instrumental variables for two-stage least squares regression, but also lag both explanatory and control variables by one period, i.e., the previous year's DIFI inclusion index, financial depth, financial breadth, availability of financial services, urbanization rate, government behavior, fixed asset investment, industrial structure, education level, economic development level, and openness to the outside world, to further reduce the reverse causality and conduct robustness tests. The regression results are as follows.

After the explanatory variables are lagged one period and regressed by the instrumental variables method instead, the results of the regression analysis regarding the digital inclusion finance index, depth of use, and degree of digitization are similar to the original regression results, with differences in the magnitude of the coefficient values of each variable and essentially no differences in significance. That is to say, after accounting for endogeneity, the regression results of the model are still robust and not disturbed by the endogeneity problem, which also indicates that DIFI can contribute to the improvement of RED through multi-dimensionality.

4.5. Heterogeneity Analysis

This paper further explores whether there is heterogeneity in the impact of DIFI development on the economic development level of the East and western regions at the national level. The regression results show that DIFI has an east-west heterogeneity on the regional differences of RED. First, DIFI can play a significant positive role in the RED of China's three major regions (east, central and west) without any interference from regional characteristics. Second, no matter which dimension of DIFI, the DIFI development in the eastern region has a more obvious influence on the RED, among which the digitalization degree is the strongest in the eastern region, the second in the central region and the weakest in the western region. The DIFI index, the depth of use and coverage are the strongest in the eastern region, the second in the western region and the weakest in the central region. Thirdly, the promotion effect of digital financial inclusion index on RED is stronger than others.

5. Main Conclusions and Recommendations

5.1. Research Findings

This paper uses panel data from 2011 to 2020 at the national provincial level to analyze the relationship between the development of DIFI and the level of RED nationwide, and dissects the impact mechanism of the development of DIFI on the level of RED, and finally obtains the following conclusions: first, the development of DIFI significantly promotes the level of RED nationwide. DIFI has higher accessibility, wider coverage, lower service cost and higher service efficiency compared with traditional finance. Second, from the segmentation dimension, the depth of use and digitalization of DIFI has a significant positive effect on the level of RED across the country, reflecting that the more the actual use of financial services on the user side, the more the RED will be improved, which shows that the "high-quality" development of digital financial inclusion is more conducive to RED. This shows that increasing the supply of financial services and the number of users by digital financial inclusion alone will not necessarily promote RED, and pursuing "quantity" growth alone may lead to "big but empty". Therefore, in the process of developing DIFI, it is more important to pay attention to the effective demand and "quality" development of the user end to promote RED.

5.2. Policy Recommendations

Through the results of the overall study, it provides suggestions for the development of national digital financial regulation and the balanced development of regional economy.

The development of DIFI should not simply pursue "quantitative" growth, but should focus on "qualitative development". Relying solely on the increase in the supply of financial services and the number of users reached while ignoring the demand and docking on the user side may lead to a certain degree of idleness and waste of financial resources, resulting in consequences such as "big but empty".Therefore, it is not only necessary to improve user access from the supply side, but also to pay more attention to the effective use of the demand side and the subsequent deepening of use.It is recommended that the construction of regional digital information infrastructure be continuously improved. The digital economy is developing rapidly, and data assets have become an essential factor of production in economic life. Provinces should improve the level of planning and management of government data, key industries and key areas of public information data, and establish an open sharing platform for data resources. In the process of digital transformation, financial institutions can effectively cut into residents' lives and production scenarios, use big data to reduce financial exclusion, expand the beneficiary groups of DIFI, and make high-quality financial services available to the most dynamic small, medium and micro enterprises and farmers in remote areas.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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