Analysis of the Impact of Economic Growth on Digital Inclusive Finance
-----Quantile Regression Based on Panel Data

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Abstract
Based on the relevant provincial data of China from 2011 to 2020, the Granger causality test is used to verify that economic growth is the one-way Granger reason to promote the development of digital inclusive finance. Further, the quantile regression of panel data is used to analyze the impact of economic growth on digital inclusive finance. Finally, based on the findings of the study, it is proposed that each region should take into account its own advantages and vigorously improve its economic development so as to strengthen the construction of digital inclusive financial infrastructure, so that economic growth and the development of digital inclusive finance can complement each other.

Key words: *Digital inclusive finance, economic growth, panel data, quantile regression*

1. Introduction

Digital inclusive finance is a derivative of the integration of Inclusive Finance and the Internet. It not only reflects the supportive nature of Inclusive Finance, but also has a positive impact on the financial industry through digital products.

Regarding the relationship between digital inclusive finance and economic growth, domestic and foreign scholars have conducted extensive research: Burlacu Sorin[3] (2021) believes that digital financial services have penetrated into all fields of economic and financial activities; Syed Aamir Aijaz[4] (2021) analyzed with CUP-FM estimation method and found that the increase of digital finance helps to restrain the shadow economic development of some countries and promote national financial stability and economic growth; Chen Chancha[5] et al. (2018) discussed the role of digital inclusive finance Development in promoting economic growth through PVAR model, which can effectively narrow the gap between urban and rural areas, but also increase the abnormal growth of housing consumption, which is not conducive to economic growth; Wu Jinwang[10](2018) used fixed spatial autoregressive model to analyze the provincial panel data of 2011-2015 years. It found that digital inclusive finance had obvious spatial aggregation. Internet plus, economic development level and network consumption level all had significant positive effects on the development of digital inclusive finance in all provinces. Zhang Xun[9] et al (2019) used OLS to analyze rural and urban samples respectively. The results show that digital inclusive finance promotes China's inclusive economic growth by narrowing the income gap between urban and rural areas; Zhu Bing[6] (2021) tested the sub samples of 31 provinces and cities in China and two regions in the eastern and central and western regions, and found that scientific and technological progress is the most significant factor, while the impact of local government policies and financial market development on digital inclusive finance is not significant in the eastern region; Jin Fei[7] (2021) selected 294 prefecture level cities in China from 2011 to 2018 as the research object and found that digital inclusive finance has a significant role in promoting the per capita GDP of all regions and improving the economic development level of these regions.

To sum up, the existing literature mostly considers the impact of digital inclusive finance on economic growth, while there are few studies on whether economic

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growth will have an impact on digital inclusive finance; Most of the research methods use econometric models, and the method is relatively simple. Based on the relevant provincial data of China from 2011 to 2020, this paper uses Granger causality test to verify that economic growth can promote the development of digital inclusive finance. Further, it uses panel data quantile regression to analyze the impact of economic growth on digital inclusive finance.

2. DIGITAL INCLUSIVE FINANCIAL DEVELOPMENT

China's digital inclusive finance has achieved leapfrog development from 2011 to 2020. After the early rapid development, it has slowed down in recent years, but still maintain a considerable growth rate, Especially after the COVID-19 pneumonia epidemic, digital inclusive finance services still grow. Fig.1 is a line chart of the change of the average value of digital inclusive finance index in various provinces and cities from 2011 to 2020, It can be seen that the average value of the digital inclusive finance index of all provinces and cities in 2011 was 40.004, increased to 220.008 in 2015, and further increased to 341.219 in 2020, 8.52 times that of 2011, with an average annual increase of 26.88%. Take Beijing as an example. In 2011, the digital inclusive finance index of Beijing was 79.11. By 2015, the index increased to 276.37, approximately 3.5 times in 2011. In 2019, the digital inclusive financial index of Beijing was 399.00, and the growth rate slowed down. In 2020, COVID-19 broke out. The inclusive financial index for this year was 417.88. Although the increase was small, it still showed an upward trend.

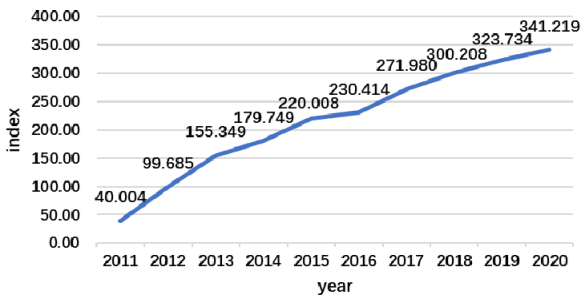

Figure 1. average value of digital inclusive financial index over the years

3. RESEARCH DESIGN

3.1. variable selection

3.1.1. Explained variable

Digital inclusive financial development: This is measured by the "Peking University Digital inclusive financial index (2011-2020)" prepared by the digital financial research center of Peking University.

3.1.2. Explanatory variable

Per capita GDP: measured by the ratio of local GDP to the population of the region;

Per capita consumption: measured by the ratio of the total retail sales of social consumer goods in each region to the population of the region;

Proportion of secondary industry: measured by the ratio of the secondary industry of each region to the GDP of the region;

Proportion of tertiary industry: measured by the ratio of tertiary industry to GDP of each region;

Macro tax burden (small caliber): measured by the ratio of tax revenue of each region to GDP of the region;

Aging level: measured by the ratio of the population over 65 years old in each region to the total population of the region;

Government intervention: measured by the ratio of fiscal expenditure of each region to GDP of the region.

3.2. Statistics Description

The data in this paper comes from the Digital Finance Research Center of Peking University, Guotaian database, China Statistical Yearbook 2011-2020, and provincial and municipal statistical yearbooks.

The descriptive statistical analysis of the above variables is shown in Table 1,It can be seen that the minimum value of the digital inclusive financial index is 18.33, the maximum value is 431.928, and the standard deviation is 97.03， indicating that digital inclusive finance has achieved good development in the past 10 years, but the distribution is relatively discrete; The minimum value of per capita GDP is 16165, the maximum value is 164889, and the standard deviation is 26989.89, indicating that China's economic development level is good, but the regional differences are large; The minimum value of per capita consumption is 5476.852, the maximum value is 68780.649, and the standard deviation is 12037.086, indicating that the living standard of residents has improved significantly in recent years, and there are obvious differences in consumption levels in different regions; The minimum value of the proportion of the secondary industry is 0.132, the maximum value is 0.62, and the standard deviation is 0.088, indicating that the secondary industry in China has developed rapidly and balanced; The minimum value of the proportion of tertiary industry is 0.214, the maximum value is 0.839, and the standard deviation is 0.108, indicating that China's industrial structure is continuously optimized and the development is relatively stable; The minimum value of macro tax burden is 0.005, the maximum value is 0.48, and the standard deviation is 0.089, indicating that the state's macro-economic

regulation and control efforts are increasing, and there is little difference among regions; The minimum value of the population aging level is 0.048, the maximum value is 0.257, and the standard deviation is 0.035, indicating that the phenomenon of population aging in my country is relatively common. Although there are changes, the magnitude is not large. The minimum value of government intervention is 0.119, the maximum value is 1.379, and the standard deviation is 0.214, indicating that there are great differences in fiscal expenditure among regions.

TABLE 1. DESCRIPTIVE STATISTICS OF VARIABLES

Variable symbol	Variable meaning	Mean	Standard Deviation	Min	Max
difi	Digital inclusive financial index	216.235	97.03	16.22	431.928
pgdp	Per capita GDP	53357.281	26989.89	16165	164889
rjxf	Per capita consumption	21245.298	12037.086	5476.852	68780.649
decyzb	Proportion of secondary industry	0.402	0.088	0.132	0.62
dscyzb	Proportion of tertiary industry	0.469	0.108	0.214	0.839
hgsf	Macro tax burden(small caliber)	0.089	0.053	0.005	0.48
old	Aging level	0.109	0.035	0.048	0.257
gov	Government intervention	0.297	0.214	0.119	1.379

4. ANALYSIS OF THE IMPACT OF ECONOMIC GROWTH ON DIGITAL INCLUSIVE FINANCE

4.1. Granger causality test

For the convenience of analysis, the per capita GDP and the digital inclusive finance index are taken as natural logarithms of $\ln pgdp$ and $\ln difi$, respectively. After the unit root test of LLC panel data, it can be concluded that both $\ln pgdp$ and $\ln difi$ are stationary. Table 2 shows the results of the Granger causality test, It can be seen that at the significance level of 0.05, the per capita GDP level is the Granger cause of digital inclusive finance, and digital inclusive finance is not the Granger cause of per capita GDP. Therefore, per capita GDP affects digital inclusive finance in a one-way, that is, the impact of economic growth on digital inclusive finance is more significant.

TABLE 2. GRANGER CAUSALITY TEST

Equation	Excluded	chi2	df	Prob > chi2
$\ln difi$	$\ln pgdp$	7.361	2	0.025
$\ln difi$	ALL	7.361	2	0.025
$\ln pgdp$	$\ln difi$	0.62183	2	0.733
$\ln pgdp$	ALL	0.62183	2	0.733

4.2. The impact of economic growth on digital financial inclusion

This paper selects panel data quantile regression to analyze the impact of economic growth on digital inclusive finance. The established model is as follows:

$$\ln difi_{it} = \alpha_0 + \alpha_1 \ln pgdp_{it} + \alpha_2 \ln rjxf_{it} + \alpha_3 decyzb_{it} + \alpha_4 dscyzb_{it} + \alpha_5 hgsf_{it} + \alpha_6 old_{it} + \alpha_7 gov_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

Among them, $\ln difi_{it}$ is the explained variable, $\ln pgdp_{it}$ is the core explanatory variable, the remaining variables are control variables, μ_i represents the individual effect, γ_t represents the time effect, ε_{it} represents the residual item, and i and t represent the province (city) and year, respectively.

Through Hausmann test, the P value is significantly 0, so a quantile regression model based on fixed effect should be established. In this paper, five quartiles of 10%, 25%, 50%, 75%, and 90% were selected for the panel data quantile regression of fixed effects, and the results are shown in Table 3.

TABLE 3. QUANTILE REGRESSION RESULTS

Quantile level	0.1	0.25	0.5	0.75	0.9
VARIABLES	$\ln difi$	$\ln difi$	$\ln difi$	$\ln difi$	$\ln difi$
$\ln pgdp$	2.968***	2.577***	2.059***	1.812***	1.713***
	(1.040)	(0.683)	(0.293)	(0.279)	(0.328)
$\ln rjxf$	0.400	0.428	0.465***	0.482***	0.490**
	(0.618)	(0.405)	(0.171)	(0.166)	(0.195)
decyzb	0.850	-0.562	-0.179	0.00271	0.0760
	(2.014)	(1.318)	(0.558)	(0.540)	(0.635)
dscyzb	0.130	0.149	0.175	0.187	0.192
	(1.076)	(0.704)	(0.298)	(0.288)	(0.339)
hgsf	1.128	1.147	1.172***	1.184***	1.189***
	(1.124)	(0.736)	(0.311)	(0.301)	(0.355)
old	3.581	-2.916*	2.036***	-1.616**	-1.447*
	(2.530)	(1.659)	(0.707)	(0.678)	(0.798)
gov	7.891**	6.164***	3.874***	2.785***	2.346**
	(3.344)	(2.204)	(0.959)	(0.897)	(1.055)
Observations	310	310	310	310	310

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As can be seen from Table 3, at a specific quantile level of digital inclusion financial development, the

magnitude of the effects of economic development and other control variables on digital inclusion finance are all different, i.e., at different quantile levels of the explained variable digital inclusive finance index ($\ln difi$), the coefficients of the explanatory variables per capita GDP ($\ln pgdp$), per capita consumption ($\ln rjxf$), proportion of tertiary industry (*dscyzb*), macro tax burden(*hgsf*), and government intervention (*gov*) are all positive, while the coefficients of aging level (*old*) are all negative, and the coefficients of Proportion of secondary industry (*decyzb*) vary in positive and negative values at different quantile levels; in absolute terms, the coefficient of government intervention (*gov*) is the largest, the coefficients of per capita GDP ($\ln pgdp$) and aging level (*old*) are the second largest, and the coefficient of Proportion of tertiary industry (*dscyzb*) is the smallest.

At the 0.1 quantile level, only per capita GDP and government intervention have significant positive effects on the development of digital inclusion finance, with per capita GDP significant at the 1% level and government intervention significant at the 5% level; all other variables have insignificant effects on the development of digital inclusion finance, with the proportion of secondary industry and the aging level having insignificant negative effects on the development of digital inclusive finance.

At the 0.25 quantile level, per capita GDP and government intervention both have a significant positive effect on digital inclusion at the 1% level, aging level has a significant negative effect at the 10% level, and the other variables remain insignificant.

At the 0.5 quantile level, per capita GDP, per capita consumption, macro tax burden, aging level, and government intervention are all significant at the 1% level, with per capita GDP, per capita consumption, macro tax burden, and government intervention having a positive effect on digital inclusion finance. Aging level has a negative effect. The reasons are: people's aversion to risk increases as they age, and digital inclusive finance uses Internet technology as a carrier, and older people have little exposure to Internet financial products, so aging has a significant inhibiting effect on its development. From the coefficient, the coefficient of government intervention is the highest at 3.874, and the coefficient of per capita GDP is the second highest at 2.059. Possible reasons: at the medium level of development of digital inclusive finance, many regions have adopted the approach of government guidance + financial subsidies + market operation in practice, which is conducive to the development and growth of digital inclusive finance at the initial stage of promoting its development. To a certain extent, per capita GDP can reflect people's living standards. The higher per capita GDP, the higher people's living standards and the higher people's consumption of financial products.

At the quantile level of 0.75 and 0.9, corresponding to the higher development level of digital inclusive finance, at this time, per capita GDP, per capita consumption, macro tax burden and government intervention are still significant positive effects, while the level of population aging is still significant negative effects. Relative to lower levels of digital inclusive finance, their effects are all slightly weaker.

Based on the above analysis, per capita GDP has a significant positive impact on digital inclusive finance at any quantile level, that is, economic development promotes the growth of digital inclusive finance index. The impact of per capita consumption and macro tax burden on digital inclusive finance is not significant at the low quantile level, but begins to be significant at the 0.5 quantile level. With the increase of quantile, its coefficient slowly increases, but the overall fluctuation is relatively small. The coefficients of the proportion of the secondary industry and the proportion of the tertiary industry are not significant, which means that the proportion of the secondary industry and the proportion of the tertiary industry will not have a significant impact on the development of digital inclusive finance. The effect of population aging on digital inclusive finance is not significant at the 0.1 quantile level and starts to show a significant negative effect at the 0.25 quantile level. And the higher the quantile level, the smaller the absolute value of the coefficient of aging and the smaller the degree of impact. The effect of government interventions on digital inclusive finance is significantly positive, and its coefficient decreases as the quantile rises, indicating that this growth effect is negatively correlated with the quantile.

4.3. Robustness tests

Through the analysis, we get that: economic growth can promote the development of digital Inclusion Finance, and this promotion is greater for areas with weak digital Inclusion Finance development, thus reducing the regional differences in digital Inclusion Finance. To illustrate the reliability of the conclusions of this paper, we selected the secondary indicators of digital inclusive finance coverage breadth index (*coverage*), usage depth index (*usage*), and digitalization degree index (*digitization*) to replace the digital inclusive finance index respectively, and the economic development indicators still use per capita GDP, and the results obtained are shown in Table 4.

TABLE 4. REGRESSION RESULTS OF BREADTH OF COVERAGE, DEPTH OF USE, DIGITIZATION AND PER CAPITA GDP

Quartile level	Dependent variable	ln *pgdp*
0.1	*coverage*	313.7***
	usage	323.9***
	digitization	387.1***
0.25	*coverage*	308.3***
	usage	320.0***
	digitization	354.9***
0.5	*coverage*	299.1***
	usage	315.8***
	digitization	305.1***
0.75	*coverage*	292.6***
	usage	308.3***
	digitization	242.1***
0.9	*coverage*	288.2***
	usage	303.2**
	digitization	171.7

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

It can be seen from Table 4 that under the low quantile level, the influence coefficients of economic growth on the coverage, use depth and digitization degree of digital inclusive finance are significantly positive, and the coefficients are greater than those under the high quantile level, indicating that economic growth can promote the development of digital inclusive finance from the coverage, use depth and digitization degree.

5. CONCLUSIONS AND RECOMMENDATIONS

This paper analyzes the impact of economic growth on digital inclusion finance using Granger causality tests and quantile regressions using inter-provincial panel data from 2011-2020. The main conclusions are as follows:

(1) Per capita GDP affects the development of digital inclusive finance unidirectionally, while the impact of digital inclusive finance on per capita GDP is not significant. Regions with better economic foundation (manifested as higher GDP per capita) have higher per capita income levels, better infrastructure, better educated people and stronger financial awareness, and thus have better development of financial services such as payment, credit and insurance, and a greater concentration of financial resources, which provide good conditions for the development of digital inclusive finance.

(2) Economic growth can promote the development of digital inclusion finance in each region. At any quantile level, GDP per capita has a positive effect on digital inclusion finance, and the effect of this positive effect decreases as the quantile increases, thus reducing the regional differences in digital inclusion finance development.

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

(1) From the perspective of economic development, the level of economic development is an important factor affecting the development of digital inclusive finance. The policy adjustment program of digital inclusive finance must match the needs of regional economic development. Regions with different levels of digital inclusive financial development combine their own socio-economic conditions and give full play to their regional economic, technological and other advantages, so as to strengthen the construction of digital inclusive financial infrastructure and optimize the environment for digital inclusive financial services, so that economic growth and the development of digital inclusive finance can complement each other.

(2) From the perspective of balanced development of digital inclusive finance, the eastern regions are more economically developed and should give full play to their regional, technological and other advantages. It should combine financial development and technological progress, and actively explore innovations in digital inclusive financial products and services. The central and western regions should vigorously improve their economic development to create a favorable economic environment for the development of digital inclusive finance and promote high-quality development of the financial industry. They should also give full play to the role of local policies in guiding financial development to improve the coverage and accessibility of financial services.

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