

Environmental Effect of Digital Finance Based on Regression Model from the Perspective of Information Technology

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Abstract-Digital finance refers to a new generation of financial services that combines the Internet and information technology with traditional financial service formats. Based on the regression model, this paper analyze the the environmental impact and mechanism of Chinese digital finance. The results show that digital inclusive finance is of great significance to environmental by technological innovation channels. Therefore, it is necessary to strengthen the support of the digital financial industry, encourage technical innovation, improve the comprehensive efficiency of resources and utilization, promote the sustainable development of environment-friendly society.

Keywords- Digital finance, information Technology, Fintech, Environmental Effect.

1 INTRODUCTION

Digital finance is a booming force in China's financial market. At present, digital finance relies on cutting-edge computer technologies, such as cloud computing, blockchain, and artificial intelligence. Created financial products or services such as front-end electronic payment, big data credit analysis, and electronic cryptocurrency. Machine learning, deep learning, Reinforcement Learning algorithms, etc. are also playing an increasing role in financial transactions. The application of digital finance also has a significant impact on other fields. Since the reform and development, China's rapid industrialization and urbanization have created one Asian miracle after another, but along with the miracle, there are increasingly serious problems of pollution and excessive energy consumption. At the end of 2021, The State Council of China issued "opinions on promoting green development of urban and rural construction", manifests the government to the attention of the green development, also with China's carbon peak corresponding to the target. Financial services play an important role in any industry, especially where the resources integration ability is poorer, distribution differences of the first and second industry. Therefore, how to construct an efficient inclusive financial system is vital in realizing green development. It is also the objective demand of China to promote more financial resources to serve the green development industry. In recent years, the digital finance industry has developed rapidly, and digital inclusive finance has emerged accordingly. In the development of digital inclusive finance, the combination of finance and modern information technology breaks through the limitation of geographical space and facilitates the tilt of financial resources from developed regions to regions in need of

financial support. What impact digital inclusive finance has on green development and how much impact it has is an issue that needs in-depth study in this paper. The discussion of interactive mechanism and reasonable suggestions can provide a theoretical basis and advice reference for the formulation of relevant policies by the state, which has significant practical value and significance.

2 LITERATURE REVIEW

The existing literature mainly focuses on the relationship between digital financial inclusive index and green development. According to the definition of "Inclusive Finance" in the "Promotion of Inclusive Finance Development Plan (2016-2020)" issued by the State Council: based on the principles of business sustainability and equal opportunities, at a relatively low and affordable cost, provide small and micro businesses with Provide timely, appropriate and effective financial services to special groups such as business owners, farmers, urban low-income people, the poor, the elderly and the disabled. ^[1] It can be seen that "inclusive finance" focuses on two aspects: universality and benefiting the people. At present, China's domestic research on related fields can be divided into two aspects: First, digital inclusive finance can directly affect green development. Yin Feixiao (2020) Digital finance has improved the efficiency of green development in the region, and at the same time, it is also affecting the efficiency of green development in adjacent regions. In addition, under different economic development levels and innovation capabilities, digital finance has different effects on the efficiency of green innovation. ^[2] Regarding the green development innovation model, domestic scholars explore the impact of digital inclusive finance on green development by using variable coefficient models and error correction models. The results show that digital finance has a positive impact on green development innovation, and the enabling effect is more obvious in the eastern region and the long run. ^[3] Regarding how digital finance affects green development, some scholars believe that the improvement is mainly achieved through high innovation capabilities, enhancement of technological spillover effects, and promotion of industrial structure transformation and upgrading. ^[4] For research on low-carbon development, some scholars use the SBM-GML model to measure green total factor productivity and use the systematic GMM model to explore the impact of digital financial inclusive index on green total factor productivity. The study found that from 2011 to 2019, digital inclusive finance drove China's green total factor productivity to continue to increase. ^[5] Second, digital financial inclusive index and other factors synergize to influence green development. From the perspective of technological innovation, digital inclusive finance affects green development from a more competitive perspective. Digital inclusive finance has a positive role in promoting green technology innovation, which in turn promotes green development. ^[6] Regarding the differences in geographical structure, digital inclusive finance has a positive impact on agricultural green total factor productivity by improving technical efficiency and promoting technological progress but has a negative spillover effect on surrounding areas. ^[7] Wang Xia and Tian Xia (2022) believe that foreign direct investment has significantly inhibited the development of the green economy, and the depth of use of digital inclusive finance and the degree of digital support services can reduce the inhibitory effect of foreign direct investment on green development. ^[8] In general, there are few studies on the relationship between digital financial inclusive index and green development. The research

mainly focuses on the direct impact of digital financial inclusive index on green development, while ignoring the indirect impact. At the same time, China has a vast territory and a large span from east to west. Geographical factors and regional development differences also have a very important impact on the level of green development. Therefore, the location heterogeneity is also more obvious. This paper hopes to make breakthroughs in the following two aspects: First, from the perspective of location heterogeneity, it explores the difference in the impact of digital financial inclusive index on the green development of different regions in China, to give more information based on the actual situation of different regions. for appropriate policy recommendations. Second, using the intermediary effect test, from the perspective of technological innovation, explore the internal mechanism of the impact of digital financial inclusive index on green development, and provide relevant policy thinking and suggestions for encouraging digital finance to promote technological innovation, and coordinated development, and then support green development.

3 VARIABLE SELECTION

3.1 Experimental hypothesis

As an emerging industry combining modern technology with traditional finance, digital inclusive finance has the advantages of high technology content, strong guidance ability, and high implementation efficiency. Therefore, it can promote the green development of the region. At the same time, it can also further promote scientific and technological innovation and development by using the advantages of information technology to integrate with other emerging technologies. Technological innovation can promote the iterative upgrading of industrial industries, improve energy efficiency, reduce pollution, and promote green development.

Therefore, this paper makes two reasonable assumptions:

1. Digital financial inclusive can promote green development.
2. Digital financial inclusive can indirectly promote green development by promoting technological innovation.

3.2 Variable Selection

Based on the research ideas of Shan Jinyu (2022), green total factor productivity (GTFP) is an important indicator to measure the quality of green development, which is helpful to scientifically judge the status of green development.^[9] Therefore, this paper selects green total factor productivity (GTFP) as the explained variable, which refers to the comprehensive efficiency of development and utilization of all input factors (including capital, labor, land and energy, etc.) of industrial enterprises under environmental constraints.

The core explanatory variable of this paper is the Digital Inclusive Finance Development Index (Finance), in which the digital inclusive Finance development Index in all panel data is calculated by natural logarithm to solve the problem of excessive index value

In this paper, a total of four control variables are added, namely, GDP deflator (GDP), regional population density (People), government financial expenditure (Gov) and foreign direct

investment (Invest). In order to solve the problem that the value is too high and affects the regression results, the 'Foreign direct investment' variable will use the data after the natural logarithm calculation.

The instrumental variables used in solving the endogeneity problem and the mediating variables used in the process of mediating effect analysis are the Internet penetration rate (Internet) and the number of patent audit acceptances (Tech).

3.3 Data Source

The data comes from the wind data platform and the China Provincial Statistical Yearbook, including the China Digital Financial inclusive Index, provincial government financial expenditures, GDP deflator, regional population density, Internet penetration, number of patent audits, and green total factor productivity. Through the above datasets, the 2011-2018 panel data is constructed according to the corresponding relationship between years and provinces. Due to the serious lack of data in the Tibet Autonomous Region, only the remaining 30 provinces and autonomous regions are included in the panel data.

Table 1 Descriptive statistical results

Variable types	Variable name	Sample size	Average	Standard deviation	Maximum	Minimum
Dependent variable	GTFP	240	1.634	0.44	3.14	0.85
Explanatory variables	Finance	240	5.073	0.67	5.93	2.91
Control variables	GDP	240	1.545	0.21	2.14	1.02
	People	240	469.29	702.64	3903.48	7.86
	Gov	240	4627.1	2463.7	15729.3	705.91
	Invest	240	12.88	1.68	15.59	7.31
Instrumental variable	Internet	240	46.91	13.16	77.8	19.8
Intervening variable	Tech	240	88702.59	123827.1	793819	732

3.4 Empirical analysis

$$y_{pt} = \beta_0 + \beta_1 Finance_{pt} + \beta_2 control_{pt} + \mu_p + \sigma_t + \epsilon_{pt} \quad (1)$$

In the model, the explanation variable y_{pt} represent green total factor productivity (GTFP), β_0 represents the factor not change with time and the provinces, $Finance_{pt}$ represents digital inclusive financial index, $control_{pt}$ represents control variables including the GDP deflator, regional population density, government spending, foreign direct investment. μ_p represents Provincial fixed effect. σ_t represents time fixed effect. ϵ_{pt} represents Random disturbance term.

A fixed-effect model is used in regression analysis, which can control the influence of factors that do not change with time in the short term on explanatory variables and explained variable.

The endogeneity problem is solved by a two-stage analysis using the instrumental variable method. Referring to the relevant research of Sun C.H. (2020), the provincial Internet penetration rate from 2011 to 2018 is used as an instrument variable. There are two reasons for this choice. First, the Internet is the infrastructure of the digital inclusive finance industry. Digital inclusive finance relies on the Internet to develop further, so it has a very close relationship with explanatory variables. Second, there is no obvious relationship between Internet penetration and green total factor productivity. When using the instrumental variable method, use the weak instrumental variable test and the Wald test to improve the reliability of the instrumental variable. ^[10]

Table 2 shows the regression results of the digital financial inclusive index on green total factor productivity. Column (1) is the regression result without control variables. Column (2) adds the GDP deflator as a control variable, column (3) adds regional population density as a control variable, column (4) adds foreign direct investment as a control variable, and column (5) adds Government financial expenditure is used as a control variable. Column (6) introduces the instrumental variable "Internet penetration rate" to explore the endogeneity in the analysis.

By observing the regression results, it can be seen that the regression coefficient of the digital financial inclusive index remains significant at the 1% level, which indicates that the development of digital financial inclusive has a significant positive impact on the improvement of green total factor productivity. When all control variables are added, every 10% increase in the digital financial inclusive index increases green GTFP by 0.939%. In column (6), a two-stage estimation was performed using Internet penetration rate as an instrumental variable, and the F-value of the first stage was 27.19, which is much larger than 10. Therefore, there is no weak instrumental variable problem in this result. The regression coefficient of the data financial inclusive index is 0.413, which is significant at the 1% significance level. Therefore, the results of the instrumental variable method further show that the development of digital financial inclusive can improve green total factor productivity.

The regression results of the control variables are analyzed. In the regression results of column (5), the regression coefficient of the GDP deflator is 0.859, which is significant at the 1% significance level, which indicates that the increase of the GDP deflator will promote the Regional green development. The regression coefficient of regional population density is not significant, which shows that the relationship between population density and green development is not obvious. The regression coefficient of foreign direct investment is negative, which shows that foreign investment will have a certain degree of restraint on local green development. The regression coefficient of government financial expenditure is positive, which shows that green development is inseparable from the strong support of the government, and the increase of government financial investment can promote the improvement of the degree of green development.

Table 2 Baseline regression result

	(1)	(2)	(3)	(4)	(5)	(6)
Finance	0.225*** (0)	0.185*** (8.15e-09)	0.181*** (2.04e-08)	0.173*** (7.14e-08)	0.0939** (0.0414)	0.413*** (2.94e-07)
GDP		1.427*** (7.22e-06)	1.393*** (1.39e-05)	1.370*** (4.21e-05)	1.118*** (0.000480)	0.169 (0.222)

People			0.000577 (0.613)	0.00111 (0.401)	-0.000178 (0.867)	4.12e-05 (0.366)
Invest				-0.0717 (0.296)	-0.0966 (0.170)	0.0202 (0.418)
Gov					7.44e-05* (0.0592)	-4.15e-05** (0.0357)
Constant	0.491*** (0.000145)	-1.510*** (0.00106)	-1.709*** (0.00536)	-0.970 (0.293)	0.413 (0.697)	-0.814 (0.144)
Sample size	240	240	240	240	240	240
Provincial fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.355	0.479	0.480	0.463	0.511	0.081
Wald chi2						37.08***
F value of the first stage						27.19***

4 INFLUENCE MECHANISM ANALYSIS

4.1 Build the mediation effect model

Referring to the research idea of Liu Huake and He Chun. (2021), Build a mediation effect model to analyze the impact mechanism of mediating variables.^[11] First, use the number of patent audit acceptances(Tech) as the explained variable and the digital financial inclusive index (Finance) as the explanatory variable to perform regression. Second, take green total factor productivity (GTFP) as the explained variable and digital financial inclusive index (Finance) as the explanatory variable to perform regression. Third, select the green total factor productivity as the explained variable, the digital financial inclusive index index (Finance) and the number of patent audit acceptances (Tech) as the explanatory variables, and perform regression. In this model, the number of patent audit acceptances (Tech) is the intermediary variable.

$$M_{pt} = \alpha_0 + \alpha_1 Finance_{pt} + \alpha_2 control_{pt} + \mu_p + \sigma_t + \varepsilon_{pt} \quad (2)$$

$$y_{pt} = \beta_0 + \beta_1 Finance_{pt} + \beta_2 control_{pt} + \mu_p + \sigma_t + \varepsilon_{pt} \quad (3)$$

$$y_{pt} = \gamma_0 + \gamma_1 Finance_{pt} + \gamma_2 M_{pt} + \gamma_3 control_{pt} + \mu_p + \sigma_t + \varepsilon_{pt} \quad (4)$$

4.2 Influence Mechanism Analysis

Column (1) of Table 4 represents the regression result of the digital financial inclusive index index on the number of patent audits accepted, and column (2) represents the regression result of the digital financial inclusive index index on green total factor productivity. The regression coefficients of the index are all significant, so model (4) can be verified. By observing column (3), it can be found that the regression coefficient of the digital financial inclusive index index

is significant, while the regression coefficient of the number of patent audit acceptances is not significant. At the same time, the regression coefficient of the digital financial inclusive index in column (3) is lower than that in column (2), which proves that the number of patent audit acceptances plays an intermediary role. Therefore, data financial inclusive can indirectly promote the improvement of green total factor productivity by promoting the increase in the number of patent audit acceptances.

Table 3 Influence mechanism analysis

	(1)	(2)	(3)
Finance	-16,713*** (0.00482)	0.105*** (7.31e-05)	0.0820** (0.0486)
Tech			-4.21e-07 (0.418)
Control variables	Control	Control	Control
Constant	3,454 (0.980)	0.383 (0.459)	0.415 (0.704)
Provincial fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Sample size	240	240	240
R2	0.36	0.05	0.01

5 HETEROGENEOUS REGRESSION BY SAMPLE

5.1 Provincial location heterogeneity

Digital inclusive finance plays a driving role in the green development of provinces. However, due to the different geographical locations of different provinces, digital inclusive finance also brings different impacts. According to geographical location, 30 sample provinces are divided into eastern region, central and western regions. The empirical results are shown in Table (3) and can be observed according to the results in columns (1) and (2). The digital financial inclusive index coefficient of eastern provinces is 0.207, and that of central and western provinces is 0.348 and is also significant at the significance level of 1%.

For the occurrence of this result, the possible reason is: Eastern provinces have earlier infrastructure construction and relevant facilities are perfect. The technological development level is high, so the development advantage has been established. At the same time, the pollution problem is not serious. As a result, the effectiveness created by digital financial inclusive index has been reduced, masking the impact on green development. However, the central and western provinces, as regions with a late start, have imperfect infrastructure construction, low technological innovation ability and low financial development level. Therefore, digital inclusive finance is a vital factor affecting local green development and plays a crucial role in the development of the financial industry.

5.2 Level of development heterogeneity

The sample of 30 Chinese provinces is divided into developed and underdeveloped regions according to their level of development (Ranked by GDP per capita). The empirical analysis results are shown in columns (3) and (4) in the table. As can be seen from the observation, the coefficient of digital financial inclusive index in developed areas is 0.119 and not significant, while that in underdeveloped areas is 0.264 and significant at the significance level of 1%.

Table 4 Heterogeneity analysis

Type	Location heterogeneity		Developmental heterogeneity	
	Eastern region	Central and western Regions	Developed area	Underdeveloped area
	(1)	(2)	(3)	(4)
Finance	0.207*** (0.00208)	0.348*** (1.39e-07)	0.119 (0.142)	0.264*** (1.11e-06)
Constant	0.300 (0.690)	2.704*** (0.00202)	1.992** (0.0247)	0.881 (0.176)
Control variables	Control	Control	Control	Control
Provincial fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
R2	0.25	0.19	0.35	0.19

For the occurrence of this result, the possible reason is: developed areas fully developed, perfect legal construction. And the tertiary industry is booming, while the proportion of the secondary industry with heavy pollution is low. Therefore, the influence of digital inclusive finance on green development is more like icing on the cake, which cannot play a decisive role. On the contrary, in the underdeveloped areas, the primary and secondary industries account for a higher proportion, and the green development is poor. Digital inclusive finance, as an emerging industry, effectively makes up for local demand and effectively promotes green development through its universality, so it plays a significant role.

6 POLICY RECOMMENDATIONS

The results of this paper show that: First, the development of digital inclusive finance can play a significant role in improving the level of green development in each province. Second, digital financial inclusive can indirectly promote green development through channels that promote local technological innovation.^[12] Third, the impact of digital financial inclusive on green development in central and western China or underdeveloped regions is more significant than that in eastern or developed regions.

Based on the research conclusions, the following two policy recommendations are put forward:

1. Guide the flow of funds from digital inclusive finance to high-tech innovation and high

value-added industries. Promote the positive feedback of scientific and technological innovation to green development. Through the two modern advantages of digital financial inclusive and technological innovation, high-polluting enterprises are encouraged to accelerate the speed of industrial innovation and green transformation.

2. Establish digital financial inclusive policies suitable for different regions. For now, in central and western provinces or underdeveloped provinces, digital financial inclusive has a more significant impact. Therefore, these regions should introduce more policies to promote the development of the digital inclusive finance industry, enhance the universal applicability of digital inclusive finance to the real industry, and give full play to the flexible and efficient advantages of digital inclusive finance.

7 CONCLUSION

Through empirical analysis of panel data, this paper finds that China's digital financial inclusion has an important impact on green development, and indirectly affects green development by affecting technological innovation. Therefore, digital finance plays a very important role in promoting China's green development. At the same time, in different regions of China, the effect of digital financial inclusion on green development is different. The impact in backward regions is more obvious than in developed regions. The Chinese government should adapt to local conditions and formulate corresponding policies for different regions to support the development of digital inclusive finance, encourage technological innovation, and then promote green development.

REFERENCES

- [1] Wu Jinwang & Gu Zhouyi. (2018). Literature Review of Digital Financial inclusive. *Journal of Finance and Accounting* (19), 123-129. doi:10.19641/j.cnki.42-1290/f.2018.19.019.
- [2] Yin Feixiao. (2020). Spatial econometric analysis of the impact of digital finance on regional green innovation efficiency. *Journal of Economics and Management* (11), 4-79.
- [3] Wang Lixiao & Han Xianfeng. (2022). The Heterogeneous Enabling Effect of Digital Finance on Regional Green Innovation: An Empirical Analysis Based on the Perspective of Spatio-temporal Heterogeneity. *Research in Technological Economy and Management* (03), 40-45.
- [4] Hou Ceng & Li Beiwei. (2020). Full Financial Wealth Management Index - an index from Peking University's Inclusive Digital Benefit. *Financial Science* (12), 1-12.
- [5] Zhang Heng, Li Lu & Zhao Mao. (2022). Digital Financial inclusive and Green Total Factor Productivity: An Empirical Test Based on System GMM. *New Finance* (03), 31-40.
- [6] Fei Qian & Zhao Jingfeng. (2021). Digital Inclusive Finance, Industrial Structure Upgrade and Green Technology Innovation. *Journal of Guiyang Municipal Party School* (06), 38-44.
- [7] Zhang Aoxiang & Deng Rongrong. (2022). The impact of digital inclusive finance on agricultural green total factor productivity and its spatial spillover effect. *Wuhan Finance* (01), 65-74.

- [8] Wang Xia & Tian Xia. (2022). Foreign direct investment, digital financial inclusive and green economic development. *Business Economics Research* (07), 168- 171.
- [9] Shan Jinyu. (2022). Digital economy, industrial structure optimization and green total factor productivity. *Journal of Social Sciences, Jiamusi University* (02),51- 52+56.
- [10] Sun, C. H. (2020). Digital Finance, Technology Innovation, and Marine Ecological Efficiency. *Journal of Coastal Research*. 108(SI):109-112.
- [11] Liu Huake & He Chun. (2021). Empirical research on green finance supporting high-quality economic development based on mediating effect model. *The new financial* (10), 21-27.
- [12] Hui Xianbo. (2021). Digital inclusive finance and urban green total factor productivity: internal mechanism and empirical evidence. *Southern Finance* (05), 20-31.