

The impact of digital finance on the rate of return of China's substantial economy

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Abstract. At present, along with the reform and progress of science and technology, the digital financial industry is booming in our country, which has had a profound impact on economic development, industrial production and other aspects. At the same time, the substantial economy is confronted with challenges of transformation and a series of demands for high-quality development. Therefore, it is necessary to speed up the integration between digital finance and the substantial economy, and form a benign mutual promotion while mastering the effects of the two, so as to promote economic transformation and upgrading. Using panel data of 30 provinces, municipalities and autonomous regions in mainland China from 2011 to 2020 and digital financial Inclusion index released by the Digital Finance Center of Peking University, this paper focuses on the impact of digital finance on the return rate of China's substantial economy. The study found that there is a significant U-shaped relationship between the two, and different dimensions of digital finance have different effects on the return rate of the substantial economy. At the same time, there is regional heterogeneity in the impact of digital finance on the return rate of the substantial economy, with the most obvious inhibitory effect on the central and western regions. Based on the above conclusions, this paper also provides certain policy suggestions for the high-quality development of digital finance and the substantial economy.

Keywords: Digital finance; Substantial economy rate of return; Heterogeneity of region; High-quality economic development.

1. Introduction and Literature Review

With the development of big data, block-chain and other technologies, digital finance, as an emerging product empowered by science and technology, plays a key role in the development of digital economy and has a significant impact on boosting high-quality economic development and building a new development pattern. At present, the digital finance in China is playing an important supporting role in the economic development. Due to its distinctive features of science and technology, policy, inclusiveness and targeting, digital finance plays a significant role in accelerating capital circulation, promoting regional economic growth and supporting the development of digital economy. At the same time, it can also expand the coverage of financial services, guide financial resources to infrastructure, micro, small and medium-sized enterprises, "agriculture, rural areas" and other key areas of economic development and weak links, which greatly promote the high-quality development of our economy.

The report of the 19th National Congress of the Communist Party of China(CPC) pointed out: "We must continue to deepen the reform of the financial system and enhance the ability of financial services to serve the substantial economy." Based on the strategy of "high quality economic development" currently carried out by China, it is a key goal to develop the substantial economy and improve the rate of return of the substantial economy. In addition, with the continuation of the COVID-19 epidemic and the increasing downward pressure on the economy in recent years, the motivation of real enterprises to pursue profits by participating in the financial industry has been greatly stimulated, which leads to the serious tendency of financialization of real enterprises, causing the economy to "move from real to virtual", and bringing great challenges to financial stability. Therefore, we should pay more attention to the steady development of the substantial economy, and combine it with the booming digital finance, so as to realize the benign mutual promotion of digital finance and the substantial economy, avoid economic risks, and improve the efficiency of economic development.

The literature related to this paper is mainly divided into two aspects: one is the evaluation of the development of digital finance and its impact. Ross (2005) pointed out in his paper that a more developed financial system can effectively alleviate the external financing constraints of enterprises, thus effectively solving the difficult and expensive financing problems. At present, the digital finance industry in China has developed a lot. Liu et al. (2021) found that the development of digital finance can promote technological progress and drive high-quality economic development, but there are certain differences in the driving effects of different dimensions of digital finance on the quality of economic development. Felix and Valev (2004) found through an empirical test of 74 countries' panel data from 1961 to 1995 that financial development can promote the rational distribution of production factors in developed countries and have a positive impact on total factor productivity. Gong (2020) found that digital finance can promote the growth of the substantial economy, and tested the adjustment effect of the level of informatization and the level of technological innovation of enterprises. Yang (2021) used the mediation effect model, and the development of digital finance can help improve the efficiency of capital allocation in the substantial economy, and there is a conclusion that the mediation effect takes the upgrading of the industrial structure as the transmission mechanism. Xu and Fan (2022) found that for enterprises with good development strength and development environment, digital finance inhibits the financialization trend of enterprises and promotes enterprise development by driving technological innovation. Zhang and Liu (2022) demonstrated that the way digital finance reduces financial friction and optimizes capital allocation has a positive impact on the efficiency of capital allocation in the substantial economy. Zhou and Zhang (2022) concluded that digital finance promotes shared development through consumption and industrial structure. Jiang (2022) pointed out that digital finance can promote the development of rural economy, and then achieve the macro goal of rural revitalization. Wang and Zhang (2022) concluded that digital finance can promote technological innovation of enterprises, thereby reducing the cost of enterprise development and ultimately improving the production efficiency of enterprises. Chen and Zhao (2022) concluded that digital finance can promote the optimization of industrial structure but there are differences in different regions.

The second aspect is the research and evaluation of the rate of return of the substantial economy. Wang (2017) pointed out that there is currently a disconnect between my country's substantial economy and the financial industry, and it is necessary to strengthen the development of the substantial economy to reduce financial risks. Wang and Tao (2022) used a variety of econometric models to conclude that the digital economy promotes the development of the substantial economy and has a positive spillover effect on the substantial economy in adjacent areas.

At present, the research on digital finance is mostly related to the quality and speed of macroeconomic development or enterprise development, capital allocation efficiency and other factors. There are few studies on the relationship between it and the rate of return of the substantial economy, and most of them are theoretical studies between finance and the substantial economy, and there are few empirical studies on the relationship between the two. From the perspective of empirical analysis, this paper uses a fixed effect model, adopts the "Peking University Digital Financial Inclusion Index" and "the ratio of the total profit of industrial enterprises above designated size to the net value of fixed assets" to specifically study the return of the development of digital finance to the substantial economy. The impact of the rate has effectively expanded the perspective of digital finance research.

In addition, this paper provides a new and diversified perspective for understanding the development of digital finance by using the impact of different dimensions of digital finance on the return rate of the substantial economy and the impact of digital finance on different regions. Based on the conclusion that "digital finance has an inhibitory effect on the rate of return of the substantial economy in the short term, but can promote the development of the substantial economy in the long run, and there is a U-shaped relationship between the two". The conclusion provides meaningful inspiration for the development of digital finance, and also provides insights for the development of digital finance, offering reference to subsequent related studies.

Finally, through the above conclusions and the results of the impact of digital finance on the return rate of the substantial economy in different regions, we can conclude the long-term effectiveness of the development of digital finance, and provide policy enlightenment for the sustainable development of the financial industry at the macro level and the future development planning of the substantial economy.

2. Demonstration Design

2.1 Measurement model setting

In order to investigate whether the development of China's digital financial industry will have a certain impact on the rate of return of the substantial economy, this paper designs the following empirical model:

$$return_{it} = \alpha_0 + \alpha_1 digital_{it} + \eta * Control_{it} + \gamma_i + \lambda_t + \varepsilon_{it}$$

Among them, the subscripts i and t represent the city and year respectively. Return is the explained variable, representing the rate of return of the substantial economy. Digital is the core explanatory variable, representing the development level of the digital financial industry (digital financial inclusion index). Control represents the control variable Set, γ_i and λ_t represent the regional fixed effect and the time fixed effect. And ε_{it} is random disturbance terms.

2.2 Variable description

The selection and measure of explained variables. This paper selects the return of the substantial economy as the explained variable, which measures the ratio between the total profit of industrial enterprises above designated size and the net value of fixed assets. Relevant data are mainly from EPS database and 2011-2020 "China Statistical Yearbook" and "China Industrial Statistical Yearbook".

Selection and measurement of core explanatory variables. The core explanatory variable uses the digital financial Inclusion index to explore its impact on the substantial economy rate of return. The data source is the 2011-2020 Provincial Digital Financial Inclusion Index (digital) released by the Digital Finance Research Center of Peking University to measure the development status of digital financial inclusion in various regions. The index consists of three dimensions: width, depth and degree of digital financial inclusion.

Control variable. Referring to the existing literature, this paper also considers the following five factors that are closely related to the return of the substantial economy as control variables. (1) CPI, consumer price index, reflects the relative trend and degree of price changes of consumer goods and services purchased by urban and rural residents in a certain period of time. (2) Urbanization, the urbanization rate, indicates the ratio of the urban population to the total population of the region. (3) Trade, which represents the ratio of total import and export trade to GDP. (4) Supervision, the degree of financial supervision*100, where the degree of financial supervision represents the ratio of financial supervision expenditure to the added value of the financial industry. (5) Workless, the unemployment rate, which represents the ratio of the unemployed population to the total urban population.

2.3 Data declaration

The research sample of this paper is panel data of 30 provinces, municipalities and autonomous regions in mainland China from 2011 to 2020 (excluding Tibet, Hong Kong, Macao and Taiwan). The core explanatory variables are derived from the Digital Finance Research Center of Peking University. The original data of other economic indicators are from China Statistical Yearbook, China Financial Yearbook, China Labor Statistics Yearbook, the official website of the National Bureau of Statistics, EPS database, etc.(as illustrated in Table1)

At the same time, this paper takes the logarithm and partial logarithm of all other variables except the explained variable return of the substantial economy (return), and the corresponding symbols remain unchanged.

Table 1. Descriptive statistics of variables

Variable	Obs	Mean	Std.Dev.	Min	Max
return	300	0.177	0.090	-0.184	0.400
digital	300	216.913	97.165	18.33	431.93
CPI	300	102.504	1.178	100.567	106.338
urbanization	300	0.590	0.122	0.350	0.896
trade	300	0.268	0.297	0.008	1.548
supervision	300	1.036	1.370	0.007	11.157
workless	300	0.033	0.006	0.012	0.046

3. Empirical Results and Discussion

3.1 Whole sample analysis

This paper uses the 2011-2020 Chinese provincial panel data. In order to facilitate data analysis, the core explanatory variables and all control variables are logarithmically processed. Digital is the primary term of the digital financial index, and digital2 represents the quadratic term of the digital financial index. Starting from the two-way fixed effect model, this paper investigates the impact of the first and second terms of the digital financial index on the return rate of the substantial economy and the impact of the first and second terms of the digital financial index on the return rate of the substantial economy after adding five control variables, respectively. The regression results are shown in Table 2.

It can be seen from columns (1) and (2) that the coefficient of the primary term of the single digital finance index is significantly negative, indicating that the development of digital finance has a restraining effect on the return rate of the substantial economy. When adding the quadratic term, the coefficient of the first term of the digital financial index is significantly negative, and the coefficient of the quadratic term is significantly positive. It shows that the development of digital finance will inhibit the growth of the return rate of the substantial economy in the short term, but it will promote the growth of the return rate of the substantial economy in the long term. In summary, there is a significant U-shaped relationship between the development of digital finance and the rate of return in the substantial economy.

According to the last two columns of the table, after the inclusion of CPI, urbanization, trade, supervision and workless, five control variables, the significant U-shaped relationship between the development of digital finance and the rate of return of the substantial economy will still exist. Therefore, under the premise of controlling the effect of time and region, the development of digital finance will inhibit the improvement of the return rate of substantial economy in the short term, but in the long term, digital finance will play a significant role in promoting the return rate of substantial economy.

Table 2. Digital Financial Index and Substantial economy return: Benchmark regression results

	(1)	(2)	(3)	(4)
digital	-0.076***(-3.82)	-0.269***(-2.74)	-0.088***(-3.68)	-0.282***(-2.85)
digital2		0.028**(2.01)		0.028**(2.02)
CPI			1.649*** (2.68)	1.707*** (2.79)
urbanization			0.085(1.04)	0.082(1.01)
trade			-0.001(-0.13)	-0.004(-0.43)
supervision			0.00001(0.00)	-0.0002(-0.06)
workless			-0.025(-1.01)	-0.023(-0.95)
cons	0.495*** (6.89)	0.821*** (4.63)	-7.172**(-2.48)	-7.115**(-2.48)
time and region effects	control	control	control	control
r ²	0.31	0.32	0.34	0.35
sample size	300	300	300	300

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

3.2 Different dimensions of digital financial results analysis

According to the relevant content released by the Digital Finance Research Center of Peking University, this paper divides the digital financial inclusion index into three dimensions: digital financial coverage width, digital financial use depth and digital financial inclusion degree.

At the same time, the impact of digital finance on the return rate of the substantial economy is analyzed from the above three different dimensions. Among them, width2, depth2 and degree2 are the quadratic terms of corresponding digital financial dimension indicators.

As shown in Table 3, it can be seen from the second and third columns that the first term of the digital financial breadth index is significantly negative, that is, it has a restraining effect on the return rate of the substantial economy. When the quadratic term is added, the coefficient of the first term is significantly positive, and the coefficient of the quadratic term is significantly negative, showing an inverted U-shaped relationship. It said when digital financial coverage level rising, returns to the substantial economy have a significant role in promoting, but when digital financial coverage reaches a certain degree after the promoting effect to peak and thereafter as digital financial coverage continues to increase, and the obstacles that returns to the substantial economy.

As can be seen from the fourth and fifth columns, the first term of the digital finance use depth index is significantly negative, indicating that it has a restraining effect on the return rate of the substantial economy. When the quadratic term is added, the first term is significantly negative while the quadratic term is insignificant, that is, there is no U-shaped relationship between the use depth of digital finance and the rate of return of the substantial economy.

According to the last two columns of the table, it can be concluded that the first term of the digitalization degree index of financial inclusion is significantly positive, indicating that it plays a significant role in promoting the return rate of the substantial economy. When the quadratic term is added, the first term is significantly positive, but the quadratic term is not. Therefore, there is no U-shaped relationship between the digitalization degree index of financial inclusion and the return rate of the substantial economy.

Table 3. Regression results of different dimensions of digital financial index data on substantial economy returns

	width(1)	width(2)	depth(1)	depth(2)	degree(1)	degree(2)
digital						
digital2						
width	-0.032***(-3.17)	0.096** (2.50)				
width2		-0.028***(-3.46)				
depth			-0.0645***(-3.88)	-0.112*(-1.78)		
depth2				0.008(0.78)		
degree					0.045*** (3.92)	0.099** (2.48)
degree2						-0.006(-1.42)
CPI	1.826*** (2.97)	1.533** (2.52)	1.547** (2.51)	1.641** (2.61)	1.430** (2.30)	1.451** (2.34)
urbanization	0.068(0.82)	0.297*** (2.84)	0.003(0.04)	0.006(0.08)	0.013(0.18)	0.023(0.31)
trade	-0.004(-0.38)	-0.0005(-0.05)	-0.007(-0.75)	-0.008(-0.83)	-0.002(-0.18)	-0.001(-0.12)
supervision	0.0003(0.09)	-0.0008(-0.28)	0.00007(0.02)	0.00007(0.03)	0.0005(0.18)	0.0009(0.32)
workless	-0.022(-0.88)	-0.020(-0.85)	-0.023(-0.97)	-0.025(-1.04)	-0.017(-0.71)	-0.016(-0.66)
cons	-8.217***(-2.85)	-6.790** (-2.38)	-6.833** (-2.36)	-7.206** (-2.46)	-6.659** (-2.30)	-6.863** (-2.37)
Time and region effects	control	control	control	control	control	control
r ²	0.33	0.36	0.34	0.34	0.34	0.34
sample size	300	300	300	300	300	300

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

3.3 Regional heterogeneity analysis

According to the geographical division of China, the selected 30 provinces are divided into coastal area and inland area, eastern area and central and western area. According to the different geographical location of each province, the impact of the development of digital finance on the return rate of substantial economy in different regions is analyzed.

As can be seen from the second and third columns of Table 4, in coastal areas, the primary term of digital financial index is not significant, so there is no U-shaped relationship between it and the rate of return of substantial economy in coastal provinces. However, in inland areas, the first term of the digital financial development index is significantly negative, indicating that the development of digital finance has a short-term inhibitory effect on the return rate of the substantial economy in inland provinces. It can be seen from the regression results that when the quadratic term of the digital finance index is added, the regression results of inland regions show that the first term is significantly negative and the quadratic term is significantly positive. That is, from the long-term perspective, the continuous development of digital finance will promote the improvement of the substantial economy

return rate of inland provinces. And through the comparisons of the coastal and inland areas can be concluded that the digital financial inhibition of return on the substantial economy is mainly in the inland, this may be because the low level of economic development in the interior, the overall economic environment, so that the number of financial and cannot obtain the very good development so as to exert its return to the substantial economy.

As can be seen from the last two columns of the table, the first term of the digital finance index is significantly negative, indicating that the development of digital finance has a short-term inhibitory effect on the return rate of the substantial economy in the eastern coastal areas. Similarly, in the central and western provinces, the development of digital finance also has a certain inhibitory effect on the return rate of the substantial economy in the short term.

Table 4. Regression results of the impact of digital financial index on substantial economy returns in different regions

	coastal region	inland region	eastern area	central and western area
digital	-0.718(-1.18)	-0.082***(-2.80)	-0.257***(-3.97)	-0.550*(-1.65)
CPI	-0.232(-0.20)	2.689*** (3.22)	-1.019(-1.01)	2.497** (3.09)
urbanization	-0.087(-0.52)	0.132(1.26)	0.099(0.63)	0.400*** (3.26)
trade	-0.036(-1.17)	-0.001(-0.11)	-0.102***(-3.25)	0.012(1.15)
supervision	-0.002(-0.33)	-0.00003(-0.01)	-0.005(-0.84)	0.00005(0.02)
workless	-0.137*(-2.62)	0.008(0.29)	-0.109**(-2.48)	-0.022(-0.76)
cons	1.056(0.19)	-11.923***(-3.05)	5.638(1.18)	-10.985***(-2.91)
time and region effects	control	control	control	control
r ²	0.26	0.44	0.43	0.45
sample size	110	190	110	190

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

4. Robustness test

In order to prove the reliability of the empirical results in this paper, the following robustness tests are conducted.

An alternative measure of the core explanatory variable. In this paper, the lag effect is applied and the lag period of digital financial index is taken as the core explanatory variable, which is expressed as digitalL1 and digital2L1 respectively. The two factors are also re-incorporated into the regression model to study the impact of the digital financial index of the previous year on the return rate of the substantial economy of this year, so as to solve the reverse causality problem. According to Table 5, when the core explanatory variables lag one period, the primary term of the digital financial index is still significantly negative. When the quadratic term is included, the first term of the digital finance index is significantly negative and the quadratic term is significantly positive. Therefore, the U-shaped relationship between digital finance and substantial economy returns still exists. The above tests show that the development of digital finance inhibits the development of the rate of return of the substantial economy in the short term, but it can promote the development of the rate of return of the substantial economy in the long term. So this conclusion is robust.

Table 5. Robustness test

	hysteresis effect(1)	hysteresis effect(2)
digitalL1	-0.0956***(-4.02)	-0.266***(-2.79)
digital2L1		0.025*(1.84)
CPI	1.233**(1.99)	1.249**(2.02)
urbanization	0.192**(2.04)	0.187**(2.00)
trade	0.007(0.66)	0.006(0.51)
supervision	-0.002(-0.72)	-0.002(-0.69)
workless	-0.005(-0.21)	-0.006(-0.23)
cons	-5.050*(-1.74)	-4.850*(-1.67)
time and region effects	control	control
r ²	0.27	0.28
sample size	270	270

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

5. Conclusion and Enlightenment

Based on China's provincial panel data from 2011 to 2020, this paper uses a two-way fixed effects model to study the impact and transmission mechanism of digital finance on the return rate of the substantial economy. The main conclusions are as follows. First, from the macro level, there is a significant U-shaped relationship between the development of digital finance and the rate of return of the substantial economy, that is, the development of digital finance inhibits the improvement of the rate of return of the substantial economy in the short term but plays a significant role in promoting the rate of return of the substantial economy in the long term. Second, different dimension indices of digital finance have different effects on the return rate of the substantial economy. Digital financial coverage inverted U-shaped relationship between return and the substantial economy, namely digital financial coverage will promote the development of substantial economy returns in the short term. But in the long term suppression effect, the digital level of financial development index, the index of digitized degree and the substantial economy show no U-shaped relationship between the rate of return. Third, the impact of the digital financial development index on the return rate of the substantial economy in different regions is also different. There is no U-shaped relationship between the development index of digital finance and the eastern region, the central and western regions and the coastal regions, but there is a U-shaped relationship between the development index of digital finance and the return time of the substantial economy of the inland region in the short-term inhibition and long-term promotion.

Based on the above conclusions, the policy implications of this paper lie below. First, strengthen the construction of digital infrastructure and promote the efficient and sustainable development of digital finance. We should also improve the construction of relevant basic digital facilities, strengthen the popularity of digital finance, and promote the vertical development of digital finance. Second, accelerate the degree of digitalization of the financial industry, the integration of digital finance and the substantial economy, so as to closely integrate digital finance and the substantial economy. To encourage commercial banks, industrial enterprises and other substantial economies to actively introduce the concept of digitalization and attach importance to the application of digitalization. At the same time, the digital financial industry should firmly serve the original aspiration and mission of the substantial economy. Third, we should balance the regional differences in the development of digital finance and implement the reform to the eastern and western regions. However, it is still necessary to take the coastal developed areas as the focus of development, focus on improving the level of digital financial development in the developed areas, and take into account the introduction of technology in the eastern and western regions on the basis of realizing benign mutual promotion between it and the substantial economy. We should also actively use East-West cooperation and technological exchanges to form a virtuous circle between digital finance and the rate of return of the

substantial economy across the country, and finally achieve the overall goal of high-quality economic development.

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