Digital Finance's Influence on the Asset-Liability Ratio of China's Real Economy -Analysis of Provincial Panel Data Technology from China

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Abstract—The regression model is established by using the panel data of 30 provinces in China from 2011 to 2020 using STATA statistical software. The empirical results show that: the application of information technology and big data technology in the financial sector have significantly reduced the asset–liability ratio of enterprises; At the same time, the use of computer technology in finance plays a more remarkable effect on the asset-liability ratio of enterprises in the eastern region. Further analysis found that the effect of finance + IT on the asset-liability ratio of enterprises presents a significant inverted U-shaped effect relationship; Robustness test still meets the conclusion; The research is helpful to understand the role of growth of the combination of finance and technology in improving the asset-liability ratio of enterprises, driving entity enterprises to improve quality and efficiency, and enhancing the sustainable growth ability of manufacturing enterprises.

Keywords-internet+digital finance; asset liability ratio; inverted U-shape;

1. Introduction and literature review

In recent years, big data (BD), artificial intelligence (AI), block chain (BC), cloud computing (CC) and other advanced information technologies have brought new vitality to the traditional financial system, and the digital financial era is approaching. Vigorous internet finance has improved the efficiency of financial business, expanded the reach of financial services and improved the general financial benefits. Finance plays a pivotal role in the real economy (RE) and in promoting high-quality (hi-qt) economic development [1]. Further improving the operating performance of the real economy and improving its development efficiency is the foundation for China's economy development to be of hi-qt. Manufacturing is the main force in the physical economic development of China, facing pressure from the reality of stable growing. The development of the production sector has long shifted its own investment to the real estate sector, and there are some problems such as poor management and low added value, which make the real economy dominated by the manufacturing industry, have relatively high assets and liabilities, thus seriously affecting the upgrading and restructuring of the production sector itself. Therefore, it is necessary to further reduce the asset-liability ratio of manufacturing in-

BDEIM 2022, December 02-03, Zhengzhou, People's Republic of China

DOI 10.4108/eai.2-12-2022.2328707

dustry and contribute to the sustainability of manufacturing industry. Digital finance (DIGF), uses block chain technology to realize comprehensive joint innovation of information system and financial system based on BC, BD and AI [2]. This revolutionary and innovative way of financial service mode has become an important engine that empowers traditional industries to transform and upgrade, drives entity enterprises to improve quality and efficiency, and leads China's hi-qt economic development. Based on the background of the digital economy era, this article combines the application of computer technology, information technology, BD technology in the financial field with the asset-liability ratio of the real economy (RE-ALR), and discusses the influence of DIGF development on RE-ALR and its mechanism, which is of great practical importance for enhancing the sustainable growth of manufacturing enterprises and improving the function of financial services for the real economy, which is important for achieving hi-qt economic development in China.

Numerous literatures have empirically analyzed the relationship between financial growth and the RE growth. The findings show that real economy is the foundation of financial progress and finance is the lifeblood of RE, and the two complement each other (Wang, 2017) [3]. Finance contributes to the development of the real economy [4], with an inherent matching mechanism of "macro-system, meso-industry, micro-enterprise" coordinated development (Guo, 2022) [5]. However, as China's economic development enters a new normal, the need for economic restructuring is strong and the problems of "attribute mismatch", "field mismatch" and "stage mismatch" in traditional finance are prominent. (Tang et al., 2020) [6], the allocation of resources cannot meet the development needs of the RE, the real resources are transferred to virtual resources, and the phenomenon of money falling into "self-circulation" among financial institutions intensifies, which greatly inhibits the growth of the RE. The extensive application of contemporary IT in the field of financial services is conducive to breaking the framework of the classic financial system, with the innovative use of new generation technology, such as BD, CC, AI and block chain energy, to provide "high-efficiency, low-cost and low-threshold" financial services for more enterprise groups. Previous practical results show that DIGF can dramatically improve the level of industrial investment and reduce the degree of financialization, that is, DIGF can boost the economic growth of real enterprises. Huang and Huang (2018) [7] explored the path, development trend and profit model of financial services to provide support to the growth of the RE in a DIGF context. Further research found that digital finance exerts its enabling effect mainly through the following paths: Qi and Xiao (2022) [8] believe that digital technology drives the management innovation of enterprises, enhances the core competitiveness of enterprise products, and promotes enterprises to realize quality improvement and efficiency enhancement. Gu (2022) [9] further argues that DIGF can lower the level of corporate financing constraints through broadening the sources available, enhancing the ability to gather information and reducing the level of information asymmetry. The development of DIGF can effectively ease the problem of "difficult and expensive financing" and improve financial stability of enterprises. In addition, DIGF development has an important driving role in corporate technological innovation (Tang et al., 2020) [6]. Moreover, digital finance can mitigate under-investment, but it can exacerbate over-investment (Liu, 2022) [10]. It is thus clear that realizing the supporting role of digital technology in the financial sector through computers, tablet computers and smart phones, which is conducive to enhancing China's traditional financial system, exploring new paths for financial provision to the RE, and targeting support for sustainable business development.

This paper seeks to contribute in the following ways: first, most studies have focused on the impact of the new combination of financial services and information technology on corporate investment, ignoring the possible effect of financial technology development on corporate debt ratio. This paper focuses on verifying the relationship between "digital economy and real economy (corporate debt ratio)", which not only deepens the theoretical cognition of the internal logical relationship between DIGF and corporate behavior, but also provides a new perspective and an important focus for a profound understanding of the relationship between DIGF and corporate development. Secondly, this article clarifies the specific mechanism of BD and other computer technology industrial economic development from various perspectives. This paper finds that DIGF may increase the debt ratio of the RE in the short term and reduce the debt ratio of the RE in the long term, which is helpful to provide important theoretical guidance and decision-making reference for the institutional design of developing DIGF. Thirdly, this paper examines the influence of DF and the debt ratio of China's RE assets industry not only from a linear perspective but also from a non-linear perspective, and finds that an obvious inverted U-shaped relationship is formed between DIGF and the debt ratio of China's real economy assets industry, which provides a reference.

2. Empirical study design

2.1 Econometric model setting

Based on the theoretical analysis above, in considering the effect of DIGF on corporate debt ratio, this paper establishes the following regression model:

$$debt_{it} = \alpha_0 + \alpha_1 index_{it} + \alpha_2 control_{it} + \lambda_i + \eta_t + \varepsilon_{it} \quad (1)$$

Where, $debt_{it}$ represents the asset-liability ratio of Region I in Year T; $index_{it}$ denotes the degree of growth of digital financial in Region I at Year T; $control_{it}$ is the set of control variables, which include investment, environmental regulation, government intervention, demographic factors, and industry structure; λ_i is an area fixed effect, η_t is a year fixed effect, ε_{it} is a random disturbance term.

2.2 Variable selection and measurement

2.2.1 The explained variable:

Asset-liability ratio of enterprises (ALR-ENT). Using the asset-liability ratio of above-scale industrial companies to reflect the ratio of capital supplied by the creditors to total capital of the total corporate assets as an explanatory variable. According to the views of Zhang (2008) [11] and Kang (2010) [12], debt ratio refers to the percentage of total corporate debt to corporate assets and the degree to which corporate assets protect the interests of creditors. Among them, the total assets of the enterprise refers to the total value of the assets formed by the enterprise's liabilities and the total value of the assets formed by the investment of each investment entity (Li, 2000) [13].

2.2.2 Core explanatory variables:

Digital finance. This essay directly adopts the "Digital inclusive finance Index (PKU-DFIIC)" 2011-2020, Issue 3, prepared by Peking University Internet Finance Research Center and Ant Group Research Institute. This paper uses provincial data. In addition, we choose the breadth and depth of digital inclusive finance development and the degree of digitalization in inclusive finance to further investigate the effect of digital financial segmentation index on corporate debt ratio.

2.2.3 Control variable:

To mitigate endogeneity problems arising from missing variables, this paper chooses investment $(invest)$, environmental regulation (em_{it}), government intervention $(gover_{it})$, population factors $(popul)$ and industrial structure (is) as the control variables.

2.2.3.1 Investment: A higher level of fixed asset investments will improve the ability of the region to attract capital and the real economic performance of enterprises. The pulling effect of investment on economic growth is crucial.

2.2.3.2 Environmental regulation: Industrial pollution control is closely related to dynamic economic growth. If the growth rate of governance investment is less than 1 times, it will have a negative effect on economic growth. If the growth rate of governance investment is more than double, it will have a growth effect on the economy (Chen et al., 2015) [14].

2.2.3.3 Government intervention: The investment efficiency of enterprises is influenced by the government's policy support. The higher the local investment level of companies encouraged or supported by industrial policies. At the same time, the higher the government subsidy, the higher the company's long-term debt, and the higher the degree of over-investment (Wang et al., 2017) [15]. In this paper, the ratio of public expenditure to regional GDP in this paper measures the extent of government intervention.

2.2.3.4 Demographic factors: Population density has a positive contribution to economic growth, and the quantitative and qualitative demographic dividend is an important contribution way of population density to economic growth (Li et al., 2022) [16]. In the regression, the ratio of year-end permanent residence to total area is expressed in the regressions, and and the population factor is logarithmic to eliminate the influence of heteroscedasticity and data dispersion.

2.2.3.5 *Industrial structure:* The financial sector is part of the tertiary sector and the growth of the finance service industry can provide adequate capital build-up for the regional growth of the economy. In the regression, the ratio of the value added of the tertiary sector to regional GDP is used in the regression to measure the industrial structure.

2.3 The data sources

Panel data covering30 provinces in China (except Tibet, Hong Kong, Macau and Taiwan) are used for the period 2011-2020.

The variables are mostly derived from the Yearbook of China Statistical Yearbook, China Yearbook of Science and Technology Statistics, and China Yearbook of Environmental Statis-

tics. The DIGF index is derived from the Peking University Digital Inclusive Finance Initiative (PKU-DFIIC) Detailed descriptive statistical analysis results are presented in Table 1.

Table 1 Descriptive Statistics of Main Variables

	Sample size	***mean***	***standard deviation***	***min***	***max***
debt	300	58.212	5.936	42.08	76.08
index	300	217.246	96.968	18.33	431.93
invest	300	79.301	25.78	20.999	147.955
em_{it}	300	0.253	0.227	0.005	2.035
$gover_{it}$	300	0.316	1.143	0.110	19.968
popul	300	468.737	706.400	7.878	3949.206
is	300	47.148	9.761	29.7	83.9

3. Empirical results and discussion

3.1 Full sample analysis

A two-way fixed effect model is used in this paper, and the test results are reported in Table 2. Columns (1)-(2) represent regression results that do not contain control variables, and columns (3)-(4) contain regression results for control variables in the model. The regression of each column show that the regression coefficient of single item of DIGF $index$ to the corporate ALRis significantly negative, on the gearing ratio of enterprises, indicating that DIGF can significantly lower the corporate asset-liability ratio. Digital finance greatly provides convenient and abundant credit funds for the development of the RE, which helps enterprises to increase economic performance and thus reduce the debt ratio.

Also, we find that the total DIGF index has a significantly positive primary term $index$ and a significantly negative squared term variable $index2$ at the 1% statistical level. It shows that the effect of DIGF on corporate gearing shows an inverted U-shape. The inhibitory effect of DIGF on corporate indebtedness arises only at a certain stage of the digital finance development. This may be due to a series of interest costs and financial burdens incurred by enterprises in the early stage of development when using DIGF leading to a transient increase in corporate liabilities, but with the development of the RE, the asset-liability ratio continues to decline.

Table 2 Test results of the impact of DIGF index on asset-liability ratio of industrial enterprises in China

	Model 1	***Model 2***	***Model 3***	***Model 4***
index	-0.051^{**} (-2.49)	0.114^{***} (2.87)	-0.036^{*} (-1.66)	0.111^{***} (2.66)
index2		-0.0002^{***} (-4.76)		-0.0002^{***} (-4.05)
invest			0.012 (1.10)	-0.003 (-0.28)
em_{it}			0.204	1.098

			(0.21）	(1.15)
$gover_{it}$			0.002 （0.02）	-0.237 (-0.20)
lnpopul			-3.018 (-0.51)	0.421 (0.07)
is			0.322*** (4.90)	0.28*** (4.33)
Constant	60.682*** (60.88)	54.289*** (33.61)	62.808* (1.91)	40.942 (1.27)
Provincial fixed	control	control	control	control
Year fixed	control	control	control	control
Adjusted-R2	0.096	0.169	0.192	0.241
N	300	300	300	300

3.2 Estimation results of sub-dimensions

In addition, the impact of the sub-dimensional development of DIGF on enterprise gearing was further explored. In this paper, we examined whether there are differences in the effects of different dimensional indicators of DIGF on enterprise gearing from three dimensions: DIGF coverage breadth, DIGF usage depth and DIGF digital service degree. Table 3 summarizes the results.

It can be noticed that the coefficient of the primary term for the extent of digital finance coverage cov and depth *dep* of use is significantly positive, while its squared term variable is significantly negative at the 1% statistical level. This indicates a clear inverted U-shaped relationship between the growth of the breadth and depth of digital financial inclusion and corporate gearing.

Conversely the primary term coefficient for the degree of digitisation of digital *dig* finance is negative, while its squared term *dig*2 is positive, and there is a clear U-shaped relationship between the extent of digitisation of financial inclusion and corporate gearing. In summary, the results suggest that there are some differences in the impact of different dimensions of digital economy growth on the gearing ratio of the RE.

Table 3 Subdivision Index on Debt Ratio of Industrial Enterprises in China Impact of Digital Financial

	Model 1	Model 2	Model 3
cov	0.069** (2.12)		
cov2	-0.001*** (-3.60)		
dep		0.078*** (3.08)	
dep2		-0.0001*** (-4.38)	
dig			-0.086*** (-3.81)
dig2			0.0001***

			(3.31)
invest	-0.004 (-0.33)	0.006 (0.52)	0.005 (0.43)
emit	0.874 (0.91)	1.232 (1.30)	0.550 (0.59）
goverit	-0.046 (-0.37)	0.042 (0.35)	0.010 （0.08）
lnpopul	-0.344 (-0.05)	-0.085 (-0.02)	-4.752 (-0.85)
is	0.288*** (4.40)	0.262*** (4.03)	0.302*** (4.66)
Constant	46.900 (60.88)	54.289 (1.42)	75.748** (2.43)
Provincial fixed effect	control	control	control
Year fixed effect	control	control	control
Adjusted-R2	0.229	0.253	0.230
N	300	300	300

3.3 Sub-regional estimation results

As shown in the results of Table 4, the primary term of digital finance shows a remarkable negative value in the East, while the results in the Midwest are not significant, indicating that DIGF has a stronger effect on reducing the asset-liability ratio of entities in the East. This is probably because of the higher level of developed DIGF in the eastern region, which can significantly bring good performance to the business growth in the east region, reducing their gearing and improving their profits. The lower level of DIGF development in the mid-west has no significant influence on the gearing ratio of enterprises. At the same time, it is found that the impact of the development of digital finance in the east, the middle and the west on the corporate asset-liability ratio still presents a significant inverted U-shaped effect relationship.

Table 4 East, Central and Western Regions Grouping

	eastern region		***Middle region***		***West region***	
index	-0.075** (-2.14)	0.321*** (4.34)	0.046 (0.57)	0.268* (1.67)	0.019 (0.46)	0.194*** (3.71)
index2		-0.00*** (-5.58)		-0.00 (-1.60)		-0.00*** (-4.67)
invest	-0.042** (-2.09)	-0.073*** (-4.11)	-0.021 (-0.82)	-0.021 (-0.82)	0.053*** (3.83)	0.043*** (3.36)
em_{it}	-1.671 (-0.82)	1.663 (0.92)	0.313 (0.07）	2.043** (2.19）	0.124 (0.15)	0.800 (1.07)
$gover_{it}$	-0.05 (-0.41)	0.014 (0.13)	58.584** (2.50)	-0.162** (-0.04)	47.993*** (6.30)	39.210*** (5.54)
lnpopul	16.105 (1.25)	21.705* (1.98)	11.338 (0.55)	9.418 (0.47)	26.358*** (3.02)	28.190*** (3.90)

is	0.575*** (3.59)	0.345** (2.45)	0.452*** (3.48）	0.443*** (3.46)	0.160** (2.22)	0.226*** (2.75)
Constant	-66.842 (-0.78)	-113.372 (-1.55)	-32.065 (-0.28)	68.983* (1.84)	-79.054** (-2.03)	-90.943** (-2.60)
Provincial fixed	control	control	control	control	control	control
Year fixed	control	control	control	control	control	control
Adjusted-R2	0.383	0.563	0.348	0.376	0.644	0.718
N	110	110	80	80	110	110

3.4 Results of robustness test

In testing the robustness of the results and to reduce the interference caused by reverse causality, a lag phase is adopted to replace the original explanatory variable for digital finance in the actual regression, and the regression result of this variable on the corporate asset-liability ratio is examined. From column (1) of Table 5, it can be seen that the role of DIGF in relation to the asset-liability ratio of real companies continues to show an inverted U-shaped relationship. This article adopts the2SLS (two-stage) estimation method for robustness testing, with one-period lag of DIGF as the instrumental variable for estimation (see column 2 of Table 5). The results of the study indicate that DIGF shows a remarkably inverted U-shaped effect relationship on the asset-liability ratio of the real economy. Therefore, the empirical analysis results are robust.

Considering that the economic advantages of Beijing, Shanghai, Tianjin and Chongqing may interfere with the analysis results, the regression after excluding the samples in this paper finds that the inverted U-shaped relationship between DIGF and real economy asset-liability ratio still exists. The stability of the core results of this paper is verified by the results fully finding that the empirical results are relatively stable.

Table 5 Robustness Test

	Model 1	***Model 2***	***Model 3***
index	0.174*** (4.09)	0.424*** (5.10)	0.170*** (3.50)
index2	-.0002*** (-4.29)	-0.0003*** (-5.42)	-.0001*** (-2.73)
invest	0.0001 (0.01)	-0.034** (-2.31)	0.001 (0.09)
em_{it}	2.043** (2.19）	1.713** (2.37)	2.084** (2.13）
$gover_{it}$	0.142 （1.22）	56.126*** (7.56)	21.828** （2.45）
lnpopul	-4.800 (-0.72)	8.932 (1.58)	-0.995 (-0.13)
is	0.217*** (3.18)	0.197*** (2.91)	0.202*** (2.75)
Constant	68.983* (1.84)	-96.059** (-2.17)	44.956 (1.12)

Provincial fixed effect	control	control	control
Year fixed effect	control	control	control
Adjusted-R2	0.263	0.909	0.212
N	270	270	234

4. Conclusions and Enlightenment

4.1 Research conclusions

The advancement of finance is driven by technology. Finance has gone through electronicization, automation, and Internetization, and is now advancing on the path of blockchainization, digitization, and wisdom. With the active use of the Internet, financial development has taken a qualitative leap forward. DIGF actively leverages digital technologies such as BD, big data, AI, artificial intelligence, MI, mobile internet, CC, cloud computing. to process, analyze, and process information with machine intelligence. In-depth integration of digital finance with the real economy may have an import impact on the development of the RE. By covering the panel data of 30 provinces in 2011-2020 in China using STATA statistical software based on a two-way fixed effects model, and draws some conclusions. (1) It is found, digital finance observably reduces the asset-liability ratio of the real economy, but it have an obvious inverted U-shaped relationship between the two. (2) The test of the depth, breadth and digitalization degree of DIGF will make a high-impact on the debt ratio of the RE, the impact is different among different dimensions. (3) The real economy asset-liability ratio is affected by digital finance which is obviously regional and mainly reduces the impact of the debt ratio in the eastern region, but has no obviously impact in the mid-west.

4.2 Inspiration and Countermeasures

First, increase the application of new technologies such as CC in entity enterprises, and improve the construction of deep integration of innovative technologies and financial development. The full use of BC, BD, AI, CC, Internet of Things, robotics and other financial technologies will provide a more open, transparent and fair financial ecology, integrate digital technology more deeply into all aspects of the RE, achieve a wider allocation of resources, promote the transformation and upgrading of traditional real enterprises, and drive the real economy to good development.

Second, entity enterprises should seize the opportunities brought by the development of DIGF by taking the opportunity. Digital technology and finance cooperate to reduce corporate debt ratio, improve corporate performance and promote capital accumulation. In addition, enterprises should formulate phased and targeted policies, and should not blindly expand the integration of digital technology.

Third, the government should take full account of the state of growth of the RE, establish a financial supervision system that conforms to the characteristics of the RE. Through the establishment of a financial regulatory system to achieve a series of risks from the security of physical communication links, the security of physical computing devices, to software security, data security, model security, algorithm security, etc. for penetrating supervision. Continuously promote the deep integration of technology and finance. This paper finds that the influence of DIGF on the asset-liability ratio of the RE in the central and western regions is not remark-

able. Therefore, the government should increase its efforts to guide the development of digital technology in mid-western enterprises and make full use of innovative means such as the Internet to enable enterprises to innovate and develop. In addition, the government should also take note of the pertinence of policies to prevent the risks brought by over-financialization of enterprises.

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