

Article

Can Digital Inclusive Finance Help Small- and Medium-Sized Enterprises Deleverage in China?

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Abstract: Digital technology has energized the development of inclusive finance in China and is beneficial in lowering the threshold and transaction costs of financial services and expanding financial coverage. However, it is a key issue whether digital inclusive finance can help SMEs overcome financing difficulties, obtain liquidity, reduce corporate leverage, and thus achieve sustainable development. By using the data from China's small- and medium-sized listed companies and an aggregate development index of digital inclusive finance at the county level in China from 2015–2019, this empirical analysis finds that the development of digital inclusive finance can significantly reduce the leverage ratio of SMEs; specifically, the development of digital inclusive finance can cut down the leverage ratio of enterprises through easing financing constraints and reducing finance costs. Heterogeneity analysis shows that digital inclusive finance is more effective in reducing leverage for those low- and medium-leverage and non-private enterprises. Accordingly, it is suggested that the government continue to promote the development of digital inclusive finance, deepen the financial supply-side structural reform, and improve the efficiency of financial recycling. SMEs should speed up digital transformation to enable digital finance to provide precise financing services and achieve high-quality sustainable development. Digital financial institutions should improve the digital inclusive financial system as soon as possible, realize scientific supervision and risk prevention, and promote the sustainable development of digital finance.



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1. Introduction

Digital inclusive finance has become a major driving force for the all-around development of financial services, with a significant impact on the expansion, empowerment, and sinking of financial development [1,2]. In December 2015, the China Strategic Plan for Promoting the Development of Inclusive Finance (2016–2020) pointed out these needs to sustain the development of inclusive finance, promote its integration with the Internet to form mobile digital finance, and make full use of its advantages [3]. In October 2017, the report of the 19th Party Congress pointed out that the development of inclusive finance is a key link in increasing the coverage of the real economy and improving the efficiency of financial services and is an effective measure to eradicate poverty and build a well-off society across the board in China. Therefore, the development of digital inclusive finance has become the core of contemporary financial construction and development, and the continuous promotion of digital finance development will provide strong support for technology-enabled finance and dual-cycle development patterns at home and abroad [4].

Since the financial crisis, leverage, a nascent regulatory indicator, has begun to appear in the field of economic research. Leverage is a measure of an enterprise's exposure to risk and, at a micro level, refers to the quantitative relationship between an enterprise's assets and its liabilities [5]. Monitoring the changes in this index is of great significance

to enhancing the core competitiveness of enterprises, improving the financial ecological environment, and promoting the sustainable development of the economy. A high leverage ratio means that companies are exposed to greater risks, that their asset structure needs to be improved, and that their solvency needs to be enhanced [6]. Therefore, China's central government attaches great importance to controlling leverage and reducing financial risks and takes deleveraging as a major task of supply-side structural reform. With the macro deleveraging policies continuing, the leverage ratio of China's state-owned enterprises (SOEs) has declined gradually and orderly, while that of private enterprises has increased massively. Of course, it is very valuable to observe the leverage ratio changes for non-financial industrial enterprises with state-owned and private patterns.

The change in the leverage ratio of Chinese industrial enterprises from 2005 to early 2019 is shown in Figure 1. The private enterprise leverage levels have risen significantly since the start of 2018. As they comprise the vast majority of the private enterprise, SMEs are facing leverage rising likely due to enterprises undertaking investment and production expansion activities, while downward economic pressure and financial deleveraging led to a passive increase in leverage under financing and operating difficulties.

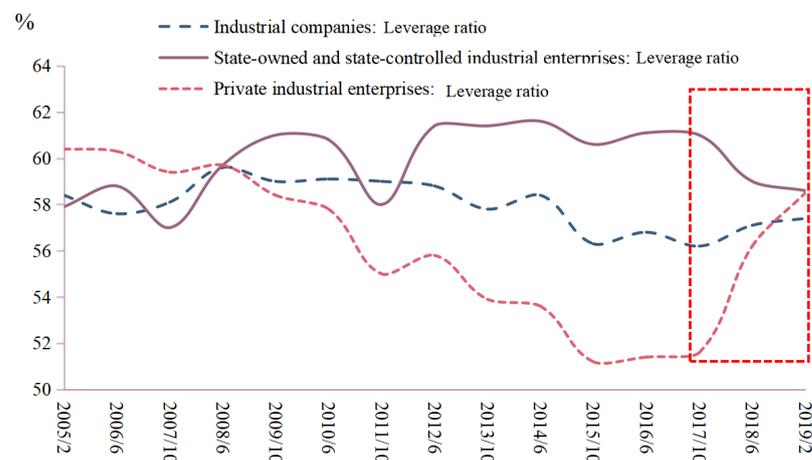


Figure 1. Trends in the leverage ratio of industrial enterprises in 2005–2019. Note: “the red square” indicates the private enterprise leverage levels have risen significantly since the start of 2018.

SMEs are an important component of China's market economy and a solid force in driving economic development on a high level. At the same time, promoting the development of SMEs is a strategic requirement for employment, innovation, and economic structure optimization, as well as strong support for building a sustainable development pattern. So, improving the development qualities of SMEs has become a top priority at present. However, due to their limited scale, poor risk resistance, and unstable operation, SMEs are still facing serious financing constraints and leverage problems [7]. The promotion of digital inclusive finance has facilitated access to formal financial services for microenterprises that previously had difficulties in accessing them, optimized the financing environment for SMEs, and promoted their innovative activities [8]. Can digital inclusion, therefore, reduce the leverage of SMEs by widening access to finance and reducing the cost of finance?

The goals of this paper are as follows. (1) To analyze the effect of digital inclusive finance on the reduction of leverage level from a theoretical perspective for SMEs and to investigate empirically the mechanism of the effect of digital inclusive finance on the reduction of the leverage level of SMEs using data of Chinese small- and medium-sized listed enterprises. (2) Based on the objective of reducing the financial costs of enterprises, the path is conenterprised for running digital inclusive finance first, then for reducing financial costs and reducing leverage, which provides new ideas for better understanding the relationship between digital inclusive finance and the leverage of SMEs. (3) Considering the impact of the development of digital inclusive finance on the leverage level of small-

and medium-sized enterprises, enrich the research factors affecting the leverage ratio of enterprises from the macro level, and further expand the research content in the field of leverage level, further strengthening the comprehensive strength and core competitiveness of small- and medium-sized enterprises to provide strong support for accelerating the development of a modern system and building a sustainable development pattern. The rest of this study is organized as follows. The second part reviews and summarizes related research. The third part analyzes the influence path of digital finance on the corporate leverage ratio, states the hypotheses, and builds the econometric model. In the fourth part, the empirical results are analyzed and discussed, and the stability and heterogeneity are tested. The fifth part is the summary of the article, and it proposes reasonable suggestions.

2. Literature Review

The development of digital inclusive finance in China and the continuous breakthrough in financial technology, in addition to the impact of digital inclusive finance on economic activities [9] and the traditional financial environment [10] are currently hot topics of academic focus, with the research related to digital finance mainly focusing on the following areas.

2.1. Research on the Effect of Digital Finance Development on Social Economy

The development of digital finance compensates for the shortcomings of traditional finance and can accelerate the digital transformation of traditional financial institutions, such as commercial banks, by using information technology to break the constraints of time and geography and provide more accurate financial services, which have an impact on the social economy in terms of economy, innovation, poverty reduction, and income generation respectively. Using the construction of an economic quality development evaluation index system and the use of provincial economic indicators to evaluate the level of economic quality development, it was found that the development of digital inclusive finance has made a significant contribution to China's economic quality development [11]. A method of matching the digital inclusive finance index with the number of corporate patents and city data found that the promotion of digital inclusive finance has an incentive effect on technological innovation [12]. Digital inclusive finance can reduce poverty by improving income growth and distribution mechanisms to moderate income inequality [13]. The development of digital inclusive finance can significantly contribute to farmers' income growth and has a double threshold effect, i.e., farmers' income growth increases with the development of digital inclusive finance [14].

2.2. Research on Digital Finance Development Issues and Trends

During the rapid development of digital inclusive finance, problems such as threats to information security, lagging regulatory mechanisms, and a lack of credit mechanisms have gradually become apparent, thus affecting the overall operational efficiency of digital finance. The digital technology on which digital finance relies carries the risk of exposing user information and threatening the security of funds, and its long-term development may have an impact on the stability of the market [15]. Financial innovation has repeatedly been ahead of financial regulation, and there is a lag in the regulation of digital inclusive finance, which should follow the development trend of digital finance to promote the construction of regulatory technology and shorten the distance between innovation and regulation [16]. China's credit environment suffers from difficulties in sharing credit data and a lack of application scenarios, so the credit system for digital inclusive finance is incomplete and the cost of credit is extremely high, making defaults frequent [17]. Along with technological advances in the financial sector, the future of digital finance will evolve towards regulatory innovation [18], with new dynamics arising from the in-depth application of digital technology [19].

2.3. Study on the Impact of Digital Financial Development on Business Activities

The promotion of digital inclusive finance provides new ideas for the business development of enterprises. Existing studies focus on corporate innovation activities, corporate financing constraints, corporate business performance, and corporate investment efficiency. In terms of corporate innovation activities, digital inclusive finance is significantly and positively correlated with the innovation performance of high-tech enterprises, and the promotion effect on innovation performance becomes stronger as the level of corporate debt financing increases [20]. In terms of corporate financing constraints, digital finance has become an effective way to solve financing difficulties by improving SMEs' access to finance through continuous innovation and development and by developing financial technology [21]. In terms of business performance, the development of digital finance has become an important driving force to improve the business efficiency of enterprises, and the improvement effect is stronger for small-scale enterprises and manufacturing enterprises [22]. In terms of business investment efficiency, digital finance facilitates the investment behavior of SMEs, mainly by reducing information asymmetry between lenders and borrowers, and the impact is more pronounced for emerging and midwestern enterprises [23].

2.4. Influence of Digital Finance Development on Enterprise Value

There are several key directions for this type of research.

- (1) Digital transformation: digital financial technology promotes the internal digital transformation of enterprises. On the one hand, it improves the level of enterprise operation cooperation and helps the operation and development of enterprises; on the other hand, it improves the financial environment of enterprises, timely avoids financial risks, and actively maintains credit.
- (2) Transparency of credit: due to the "exclusivity" of finance, SMEs often find it difficult to obtain the trust of banks due to asymmetric credit information. With the development of digital finance and the improvement of credit information systems, banks can obtain information through multiple channels, making credit information transparent and credible and effectively improving the possibility of lending.
- (3) Reasonable allocation of resources: digital inclusive finance can effectively match the supply and demand of funds through information technology, help enterprises obtain needed funds more accurately, effectively solve the problem of capital mismatch, and promote the steady improvement of enterprise value.

In summary, most studies have focused on the impact of digital finance on the financial environment [24] and macroenterprises [25], while few have explored the relationship between digital finance and microenterprises. Meanwhile, according to existing studies, digital inclusive finance provides new financing channels for micro- and small enterprises, alleviates financing constraints [26], and promotes innovation and development, but few articles have analyzed the changes in the leverage of SMEs. As the quality development of China's SMEs has become a top priority, we need to consider whether digital finance can drive the 'deleveraging' of enterprises. What is the mechanism of action? Given this, this paper presents an in-depth and detailed study of the relationship between digital inclusive finance and SME leverage by using data from listed SMEs in China and proposes to introduce mediating variables to reveal their transmission paths and to provide strong empirical support for promoting the development of digital finance and deepening the structural reform of the financial supply side.

3. Research Methodology

3.1. Research Hypothesis

The application of digital inclusive finance enhances the inclusiveness of financial services and plays a catalytic role in enhancing the ability of supply-side structural reform of financial services [27], mainly in terms of reducing financial transaction costs and increasing the channels of loans for enterprises to ease financing constraints and promote the develop-

ment of SMEs. To some extent, the avoidance of unnecessary expenditure has enriched the disposable cash of enterprises, and the reduction of financing constraints has alleviated the pressure on enterprises to obtain funds through other means of increasing leverage. The development of digital inclusive finance can effectively complement the gaps in the traditional financial system and play an important role in enterprises' access to effective credit support [28]. In terms of the coverage breadth of digital inclusive financial services, the emergence of mobile finance enables enterprises to use computers, smartphones, and other electronic devices to access products and services, helping to significantly reduce financing costs [19]. In terms of the depth of use of digitally inclusive financial services, the application of modern digital technology in the financial sector not only enhances the convenience and refinement of digitally inclusive financial services but also significantly improves the transparency of information and frequency of use of financial products, providing strong financial protection for enterprises [22]. The continuous development and the improvement of digital inclusive finance in China have led to an improved financing environment for SMEs and optimized financing structure, and flexible financial resources improve the availability of capital for enterprises, which is conducive to resolving the dependence on precautionary leverage financing and thus reducing the leverage ratio of enterprises. Therefore, this paper proposes the following hypothesis.

Hypothesis 1. *Digital inclusive finance can directly reduce SME leverage.*

Studies have shown that the development of digital inclusive finance can broaden SMEs' access to finance, using new financing services such as P2P lending and third-party payments to meet their capital needs [29]. Digital inclusive finance matches the large number of "tail" groups created by traditional finance with corresponding low-threshold, low-cost, and high-efficiency Internet financial services to help them obtain liquidity resources, and SMEs no longer need to leverage to obtain funds. Digital inclusive finance forms a corresponding digital financial ecosystem, such as big data credit collection and Internet lending, which enables digital inclusive finance to have efficient information processing and risk assessment capabilities, and greatly reduces time costs and transaction costs employing information technology, further helping SMEs to reduce financial costs and obtain funds with higher efficiency, thus achieving the goal of lower leverage. To sum up, on the one hand, digital finance improves the efficiency of capital use; on the other hand, it reduces capital damage in the financing process, thus helping enterprises stabilize their financial level and reducing their demand for external leverage financing. In addition, the development of digital finance promotes the digital transformation of enterprises, which improves their management efficiency and financial control ability and avoids the occurrence of ineffective leverage. In other words, enterprises can obtain funds efficiently, which is reflected in the fact that digital inclusive finance can reduce the leverage level of enterprises by reducing their financing costs, namely financial expenses. Based on this, this paper will take the corporate financial expense ratio as the main path to discuss the impact of digital finance on the corporate leverage level and its mechanism.

Hypothesis 2. *Digital financial inclusion can help companies reduce leverage by reducing their financing costs or financial expenses.*

Considering the attributes of the enterprise itself, the influence of digital finance on the leverage level of the enterprise has a certain heterogeneity, which is discussed in detail from the following two perspectives. (1) Nature of ownership: China's bank-dominated financial system has resulted in serious ownership discrimination in China's credit market, manifested by the fact that state-owned enterprises often have quick and low-interest access to bank loans, while private enterprises face the dilemma of difficult and expensive financing [30]. Private enterprises are also discriminated against by banks in terms of credit due to political factors [31], size restrictions [32], and lending policies [33]. Therefore, differences in ownership interests greatly affect the degree of financing constraints faced

by enterprises, which in turn affects their leverage levels. (2). Self-leverage level: this study focuses on the heterogeneous impact of digital financial development on the leverage ratios of private and non-private enterprises. At the same time, the leverage level of the enterprises themselves reflects a certain extent the solvency and asset structure of the enterprises. Enterprises with high leverage levels are less able to service their debts than those with medium to low leverage levels and, at the same time, face greater debt pressure. To a certain extent, leverage levels also reflect the differences in the current financing environment faced by enterprises, with higher leverage levels indicating a likelihood to face greater financing constraints, generating greater economic losses and inhibiting the growth of enterprises. Therefore, this study examines the heterogeneous impact of the development of digital inclusion on the leverage of enterprises with high and low to medium leverage levels and proposes the following hypothesis.

Hypothesis 3. *The effect of digital inclusion on SME leverage varies with the nature of the enterprise's ownership and the enterprise's leverage level.*

In order to describe the main research content and research ideas of this study in detail, a theoretical framework was drawn, as shown in Figure 2, that can provide the logic of the theory hypothesis clearly.

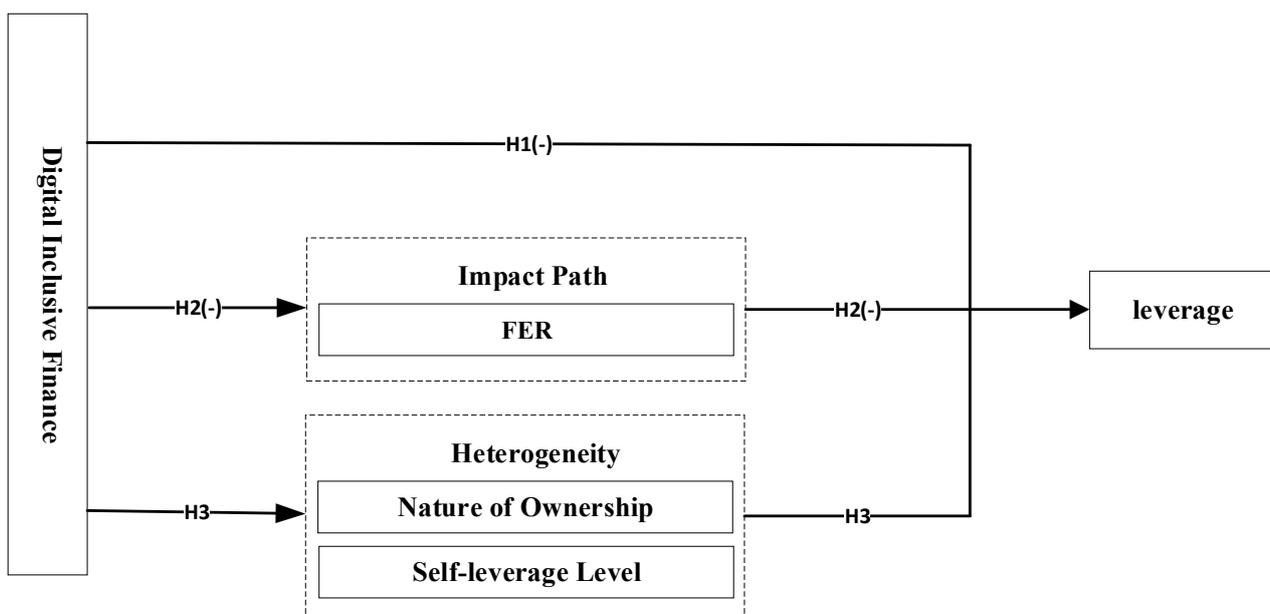


Figure 2. Theoretical framework analysis diagram. Note: “-” indicates a negative inhibiting effect.

3.2. Data Sources

This paper mainly investigates whether digital inclusive finance can help SMEs deleverage and targets A-share listed SMEs (companies with no more than 2000 employees are recognized as small- and medium-sized enterprises) in China, with a sample period of 2015–2019. The financial data of the enterprises used in this paper were obtained from the China Stock Market & Accounting Research Database (CSMAR) database. The provincial digital inclusive finance data that matched with the province where the enterprises are located were selected from the Digital Inclusive Finance Index compiled by the Peking University Digital Finance Research Centre, including the digital inclusive finance index, the digital finance coverage breadth Index, and the digital finance usage depth index, from the Peking University Digital Inclusive Finance Index (2011–2020). The data were cleaned according to existing studies, and the process is as follows: (1) exclude sample data of enterprises in the financial sector, thereby excluding the impact of accounting differences on the study; (2) exclude sample data of ST, *ST, and delisted enterprises; (3) eliminate

enterprise data with missing, unavailable, or other abnormal data; (4) in order to avoid the interference of outliers, propose 1% and 99% tail-reduction treatments for continuous variables at the enterprise level, consistent with most studies; (5) normalize the data to eliminate errors caused by inconsistencies in magnitudes. After the above processing, 3660 observations were obtained for the period from 2015 to 2019. The specific variable descriptions are shown in Table 1.

Table 1. Description of variables.

Variable Type	Variable	Variable Description
Interpreted variable	LEV	Asset–liability ratio: corporate leverage = total liabilities/total assets
Explanatory variable	DF	digital inclusive finance index
	DCB	Digital finance coverage breadth index: provincial digital inclusive finance coverage index
	DUD	Digital finance usage depth index: provincial digital inclusive finance use depth index
mediator variable	FER	Finance charge rate: corporate finance expense rate = finance expense/revenue from main business
Control variable group	Mega	The combination of two duties. If the chairman and general manager concurrently hold the position, 1 will be taken; otherwise, 0 will be taken.
	Audit	Audit opinion. When the standard is issued without reservation, 0 is taken; otherwise, 1 is taken.
	Size	The scale of operation of an enterprise is the relative value of its total assets.
	Capital	Capital intensity: enterprise capital intensity = total assets/revenue from the main business
	NET	Net profit growth rate: net profit growth rate of the enterprise = (net profit–net profit of the previous year)/net profit of the previous year
	Age	Business age: number of years since the operation of the enterprise

3.3. Definition of Variables

- 1. Explanatory variable: corporate leverage (LEV).** This paper refers to the practice in the existing literature [34–36] and uses the enterprise debt ratio as a proxy variable for the leverage level of enterprises, i.e., “total liabilities/total assets”, where a larger value indicates a higher level of indebtedness, lower solvency, and higher leverage. Choosing this index as the representative variable of the leverage ratio can better reflect the liquidity risk and sustainability of debt. The change in the debt ratio of SMEs from 2015 to 2019 is used to measure the deleveraging effect of digital inclusive finance development.
- 2. Explanatory variable: digital inclusive finance index (DF).** Based on the digital finance types in the Peking University Digital Inclusive Finance Index (2011–2020), the Digital Finance Index is divided into the digital inclusive finance index (DF), the digital finance coverage breadth index (DCB), and the digital finance usage Depth index (DUD). The index was compiled by Ant Financial Services after gathering a massive amount of data combining new features and situations of digital finance with a detailed explanation of the compilation process, and it has been used in many studies on digital inclusive finance [37]. It is reliable and reasonable to choose this indicator as a proxy variable to measure the level of development of digital inclusive finance. The larger the overall digital inclusion index, the better the level of digital inclusion development. The digital financial reach index is measured by the number of people in a place who use electronic accounts. A higher digital finance coverage breadth index indicates a high coverage of electronic accounts and a quality digital

financial environment. The digital finance usage depth index is composed of payment businesses, currency-based finance businesses, credit-lending businesses, insurance businesses, investment businesses, and credit collection. A higher digital finance usage depth index indicates a high number of people using digital finance, a high level of digital financial activity, and a deeper application of digital finance. To eliminate the right-handedness of this indicator, this indicator is treated logarithmically in the study. Additionally, considering that it takes some time for the development of digital inclusive finance to cause changes in the leverage ratio of enterprises, this paper treats the explanatory variables of the digital inclusive finance index and its components with a lag of one period.

3. **Mediating variable: finance cost ratio (FER).** The FER is the proportion of financial costs incurred by an enterprise from its main business, and it is also a factor affecting the leverage level of an enterprise. In this paper, the financial cost ratio is chosen as the ratio of financial expenses. Accordingly, this paper selects the finance cost ratio as a mediating variable to measure the mediating effect of digital inclusive finance on the reduction of leverage of SMEs. In this paper, the ratio of “finance costs/main business income” is chosen as a proxy variable for the finance cost ratio. The larger the finance cost ratio, the higher the finance cost of the enterprise.
4. **Control variables: dual employment (Mega), audit opinion (Audit), enterprise size (Size), capital intensity (Capital), net profit growth rate (NET), enterprise age (Age).** To overcome the effect of omitted variables as much as possible, this paper is designed to add Mega, Audit, Size, Capital, NET, and Age to the set of control variables (see Table 1 for detailed definitions), taking into account the existing literature on digital finance research. In addition, this paper also considers the time-fixed effect (Year) and industry-fixed effect (Industry) of the enterprise. The results of the descriptive statistics of the variables are shown in Table 2.

Table 2. Basic statistical characteristics of the main variables.

Variables	Observations	Mean	Std. Dev.	Min	Max	P50	P25	P75
LEV	3660	0.3926	0.1850	0.0174	1.4079	0.3837	0.1973	0.7684
DF	3660	266.4035	49.6116	143.9100	377.7300	264.8500	198.5700	312.5600
DF_R	3660	5.5667	0.1906	4.9700	5.9300	5.5800	5.0092	5.7866
DCB	3660	246.8822	47.9558	126.6700	353.8700	240.0700	176.7460	293.1537
DCB_R	3660	5.4894	0.1998	4.8400	5.8700	5.4800	5.2600	5.5800
DUD	3660	262.7389	67.5175	107.2900	400.4000	253.0800	170.3100	327.1900
DUD_R	3660	5.5357	0.2709	4.6800	5.9900	5.5300	4.8700	5.7400
Age	3660	7.2265	3.2026	0.1000	15.0000	7.0000	3.0000	11.0000
Size	3660	22.1305	0.9540	18.5381	26.2629	22.0854	19.4753	24.1928
Capital	3660	1.0307	0.0290	0.9166	1.3282	1.0288	0.9673	1.2362
NET	3660	−8.1174	1356.3293	−71,132.7407	40,867.2316	0.0360	−3451.1845	2306.4066
Mega	3660	0.3306	0.4705	0.0000	1.0000	0.0000	0.0000	1.0000
Audit	3660	0.6175	0.4861	0.0000	1.0000	1.0000	0.0000	1.0000
FER	3660	0.0158	0.1251	−0.2881	7.2681	0.0076	−0.0187	5.3247

3.4. Model Construction

This paper investigates the mechanism of the impact of digital inclusive finance development on the leverage of SMEs and the panel regression model constructed is as follows.

$$LEV_{ijt} = \beta_0 + \beta_1 Ind_{ijt} + \beta_2 Control_{ijt} + \epsilon Year + \theta Industry + \epsilon_{it} \quad (1)$$

The leverage ratio of enterprises (LEV_{ijt}) is the explanatory variable, representing the leverage ratio of enterprise, j , in year, t , in region, i , (at the provincial level); the digital inclusive finance index (Ind_{ijt}) is the core explanatory variable, representing the digital financial development of enterprise, j , in the region, i , in year, t , including the total index, the coverage breadth index, and the usage depth index; $Control_{ijt}$ is a series of control variables; $Year$ and $Industry$ represent time fixed effects and industry fixed effects, respectively. β_0 is a constant term, β_1 is the parameter for the effect of the level of development of digital inclusive finance, and β_2 is the parameter of the effect of the set of control variables on the leverage ratio of enterprises, and ε_{it} is the random error term. Considering that the impact of digital inclusive finance on enterprise leverage takes some time, the digital inclusive finance index is treated with a one-period lag.

4. Empirical Analysis

4.1. Baseline Regression Results

Based on the results of the Hausman test, this paper selects panel fixed effects to verify the impact of the development of digital inclusive finance on the leverage ratio of SMEs. The regression results of digital inclusive finance and the leverage of SMEs are shown in Table 3. Columns (1) to (3) of Table 3 test the impact of the total digital inclusive finance index, the coverage breadth index, and the usage depth index on the leverage ratio of SMEs, respectively. After controlling for time- and industry-level influences, the regression coefficient of the total digital inclusive finance index is -0.085 , and the regression coefficients of the coverage breadth index and the usage depth index are -0.064 and -0.092 , respectively, while the regression coefficients of each indicate that the development of digital finance has significantly reduced the leverage of SMEs, and the higher the level of development of digital inclusive finance, the lower the leverage of SMEs in the provinces. In particular, the suppression effect of the depth of use of digital inclusive finance is more obvious, with a 100-unit increase in the usage depth index of digital inclusive finance reducing the leverage of SMEs by 9.200%. The regression coefficients of the control variables show that enterprise size, capital intensity ratio, net profit growth rate, and audit opinion all have a significant effect on enterprise leverage, with capital intensity ratio, net profit growth rate, and audit opinion growth harming enterprise leverage (at the 1% level), while enterprise scale has a positive effect (1% level), which may be due to the need for external financial support in the process of enterprise scale expansion. The increase in leverage is due to the need for external funding to support the expansion of the enterprise's size and the enterprise's increasing leverage behavior. The age of the enterprise and dual employment do not have a significant effect on the leverage of the enterprise.

The above results emerge, this paper speculates, because of the following reasons. (1) the emergence of digital inclusive finance bridges the gaps in traditional financial services; meets the financial needs of SMEs excluded by traditional finance; provides them with rich services such as payments, insurance, and monetary funds; lowers the transaction threshold; enhances the availability of funds; and reduces the need for SMEs to use leveraging to obtain funds. (2) Digital inclusive finance is characterized by low cost, high efficiency, and convenience, effectively reducing finance costs and time costs, and to a certain extent, it can reduce the consumption of funds during financial transactions and prevent enterprises from passively relying on leveraged financing due to high costs. (3) The development of digital inclusive finance drives the digitization of financial institutions and SMEs, using technological means such as Internet+, cloud computing, and blockchain to enrich the application scenarios of financial transactions, thereby enhancing the internal and external information flow and operational efficiency of SMEs and promoting high-quality corporate development.

Table 3. Digital inclusive finance and SME leverage.

Variables	LEV		
	(1)	(2)	(3)
DF_R	−0.085 *** (−3.10)		
DCB_R		−0.064 *** (−2.80)	
DUD_R			−0.092 *** (−3.39)
Size	0.457 *** (28.88)	0.458 *** (28.88)	0.457 *** (28.83)
Age	−0.004 (−0.26)	−0.005 (−0.30)	−0.003 (−0.20)
Capital	−0.155 *** (−8.70)	−0.154 *** (−8.65)	−0.155 *** (−8.73)
NET	−10.949 *** (−2.76)	−10.916 *** (−2.75)	−10.839 *** (−2.73)
Mega	0.008 (0.59)	0.008 (0.55)	0.009 (0.64)
Audit	−0.363 *** (−6.51)	−0.362 *** (−6.50)	−0.363 *** (−6.52)
Constant	−0.991 *** (−4.40)	−0.936 *** (−4.16)	−1.001 *** (−4.52)
Time effect	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed
N	3660	3660	3660
R ²	0.391	0.390	0.391

Note: *** denote significance at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable.

4.2. Analysis of Transmission Mechanisms

Based on the above empirical results revealing a significant impact of digital inclusive finance on corporate leverage, it is not sufficient to explain the specific mechanism of action between the development of digital inclusive finance and the reduction of corporate leverage, so it seems necessary to analyze the factors through which digital inclusive finance affects corporate leverage levels. Here, we take the approach of introducing a mediating effect test (financial cost) and construct the following model to explore the transmission mechanism between digital inclusive finance and the reduction of leverage of SMEs in a more complete perspective.

First, the effect of digital inclusive finance on the financial costs of enterprises is analyzed to determine whether the effect of the explanatory variables on the mediating variables is significant, followed by a discussion of the transmission mechanism of digital inclusive finance on reducing the level of leverage of enterprises and whether it can rely on the reduction of financial costs to achieve the effect of reducing the level of leverage, as shown in Equations (1) and (2).

$$FER_{ijt} = \gamma_0 + \gamma_1 Ind_{ijt} + \gamma_2 Control_{ijt} + \epsilon Year + \theta Industry + \epsilon_{it} \quad (2)$$

$$LEV_{ijt} = \delta_0 + \delta_1 Ind_{ijt} + \delta_2 FER_{ijt} + \delta_3 Control_{ijt} + \epsilon Year + \theta Industry + \epsilon_{it} \quad (3)$$

where FER_{ijt} denotes the level of financial costs of enterprise, j , in year, t , in region, i (at the provincial level).

The results of the regression between digital inclusive finance and finance costs are shown in Table 4. Column (1) of Table 4 examines the impact of the total digital inclusive finance index on SMEs' finance costs. After controlling for time- and industry-level influences, the regression coefficient of digital finance on the finance cost variable (FER) is -0.018 and passes the 1% significance test. This indicates that the development of digital

finance can reduce the financial costs of enterprises. The regression coefficient of digital finance in column (2) of Table 4 is -0.043 and is significant at the 10% level, while the regression coefficient of the corporate finance cost ratio is 2.349 and is significant at the 1% level, indicating that a higher financing cost of enterprises leads to a higher leverage level of enterprises, thus a path of digital finance reducing corporate finance cost and lower corporate finance cost helping enterprises to deleverage can be formed. Further analysis of other indicators of digital inclusion finance shows that the regression coefficient of the use of the depth index on the financial expense ratio is negative but not significant, while the regression coefficient on the leverage ratio is significantly negative, indicating that with the increase of the use depth of digital finance, the financial expense ratio of enterprises is not significantly affected, but the leverage ratio is reduced. The regression coefficients of coverage breadth on the financial expense ratio and leverage ratio are significantly negative, indicating that the increase of coverage breadth of digital finance can reduce the financial expense ratio and leverage ratio.

Table 4. Transmission mechanisms for digital inclusive finance relying on the impact of finance costs.

Variables	FER (1)	LEV (2)
DF_R	-0.018^{***} (-2.70)	-0.043^* (-1.92)
DCB_R	-0.021^{***} (-2.135)	-0.038^* (-2.362)
DUD_R	-0.011 (-1.606)	-0.019^* (-2.115)
FER		2.349^{***} (30.14)
Size	0.050^{***} (12.25)	0.340^{***} (24.70)
Age	0.010^{***} (3.06)	-0.028^{**} (-2.12)
Capital	0.081^{***} (12.30)	-0.346^{***} (-22.34)
NET	-2.327^{**} (-2.08)	-5.483^* (-1.70)
Mega	0.004 (1.35)	-0.002 (-0.21)
Audit	-0.083^{***} (-4.83)	-0.168^{***} (-4.13)
Constant	-0.347^{***} (-7.36)	-0.177 (-0.95)
Time effect	Fixed	Fixed
Industry effects	Fixed	Fixed
N	3660	3660
R ²	0.302	0.581

Note: $***$, $**$, and $*$ denote significance at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable.

The above results confirm that the reduction of financial costs can significantly enhance the effect of digital financial development on the reduction of corporate leverage. The theoretical basis for this is as follows. (1) The development of digital inclusive finance can effectively broaden corporate financing channels and scientifically optimize the financing environment, enabling SMEs to meet their funding needs conveniently and quickly, thereby alleviating financing constraints. Under this circumstance, enterprises have flexible capital turnover and a high-quality financing environment, which effectively prevent them from generating leveraging behavior. (2) The development of digital inclusive finance greatly reduces the loss of human and financial resources caused by the financing process of SMEs under the traditional financial environment and saves the financial costs of enterprises. In addition, the use of innovative technologies such as big data and cloud computing would

also improve the rate of matching information between supply and demand, enhance the financial soundness of enterprises, and help them save costs in many ways. In this case, the financial savings from the application of digital finance can be better applied to the actual production and operation activities of the enterprise. This good financial closure can in turn further reduce corporate leverage.

4.3. Heterogeneity Analysis

4.3.1. Types of Ownership

The results of the assessment of the overall deleveraging level of SMEs show that digital inclusive finance has played a positive role. Considering that the ownership of enterprises can make certain differences in leverage, this paper divides SMEs into private SMEs and non-private SMEs (state-owned enterprises, foreign-owned enterprises, and mixed enterprises) and tests their differences. The regression results of the differences between the two types of ownership enterprises are shown in Table 5. The results from columns (1) and (4) of Table 5 show that the regression coefficient for private enterprises is -0.084 , which is significant at the 1% level, while the regression coefficient for non-private enterprises is -0.245 , which is significant at the 1% level, indicating that digital finance has a suppressive effect on the leverage level of enterprises of different ownership and has a positive effect on the completion of China's "macro deleveraging". This indicates that digital finance has a suppressive effect on the leverage levels of enterprises of all ownership systems and has a positive effect on the completion of China's macro deleveraging policy. Compared to private enterprises, the development of digital inclusive finance has a more significant effect on reducing the leverage of non-private enterprises. This may be since non-private enterprises have a higher level of leverage compared to private enterprises themselves and their leverage ratio is more elastic and vulnerable to the impact of digital inclusive finance. Further analysis of other indicators of digital inclusive finance reveals that the regression coefficients of the depth of the digital finance use index are all greater than those of the breadth of the digital finance coverage index, and all are significant at the 1% level. It can be seen that the better the actual use of digital financial services in the development of digital finance, the more the leverage level of SMEs can be significantly controlled.

Table 5. Regression analysis of ownership differences.

Variables	LEV					
	(1)	(2)	(3)	(4)	(5)	(6)
DF_R	-0.084^{***} (-2.66)			-0.246^{***} (-4.22)		
DCB_R		-0.064^{**} (-2.41)			-0.204^{***} (-4.35)	
DUD_R			-0.090^{***} (-2.85)			-0.228^{***} (-3.93)
Size	0.471^{***} (24.30)	0.471^{***} (24.30)	0.471^{***} (24.26)	0.441^{***} (-15.63)	0.442^{***} (-15.65)	0.438^{***} (-15.52)
Age	-0.006 (-0.31)	-0.007 (-0.37)	-0.005 (-0.26)	-0.073^{**} (-2.28)	-0.074^{**} (-2.32)	-0.070^{**} (-2.21)
Capital	-0.123^{***} (-6.14)	-0.123^{***} (-6.10)	-0.123^{***} (-6.14)	-0.294^{***} (-7.72)	-0.295^{***} (-7.73)	-0.293^{***} (-7.67)
NET	-5.157 (-1.22)	-5.146 (-1.22)	-5.006 (-1.19)	-15.769^* (-1.95)	-15.602^* (-1.93)	-15.639^* (-1.94)
Mega	0.004 (0.26)	0.004 (0.24)	0.004 (0.29)	0.010 (-0.30)	0.010 (-0.27)	0.010 (-0.33)
Audit	-0.387^{***} (-6.79)	-0.386^{***} (-6.78)	-0.387^{***} (-6.80)	-0.140 (-0.92)	-0.140 (-0.94)	-0.140 (-0.93)

Table 5. Cont.

Variables	LEV					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−1.088 *** (−4.88)	−1.034 *** (−4.66)	−1.096 *** (−4.99)	1.737 *** (−7.26)	1.858 *** (−8.12)	1.769 *** (−7.43)
Time effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
N	2719	2719	2719	1007	1007	1007
R ²	0.397	0.396	0.397	0.530	0.530	0.529

Note: ***, **, and * denote significant at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable. Private enterprises models: (1), (2), (3). Non-private enterprises models: (4), (5), (6).

4.3.2. Level of Leverage

Differences in leverage levels are caused by differences in the financing environment faced by different companies in different sectors. Does the development of digital inclusive finance have a differential impact on the deleveraging effect of enterprises at different leverage levels? This paper examines the differences by dividing enterprises into those with high leverage levels and those with medium to low leverage levels. The leverage ratio level of enterprises is delimited (50% quantile as the limit), and the utility difference of enterprise deleveraging driven by digital finance is investigated. The results of the difference-in-difference regressions for enterprises with different leverage levels are shown in Table 6. The results from columns (1) and (4) in Table 6 show that the regression coefficient for enterprises with high leverage levels is -0.063 , which is significant at the 1% level, while the regression coefficient for enterprises with low and medium leverage levels is -0.082 , which is significant at the 1% level, indicating that digital finance has a stronger deleveraging effect on enterprises with low and medium leverage levels. This may be because, in the past, medium- and low-leverage enterprises were sidelined by traditional financial services due to the limitations of corporate capital and size. The promotion of digital inclusive finance has precisely met the financing needs of such enterprises and helped them reduce their leverage, which also reflects the inclusive nature of digital finance. Further analysis reveals that enterprises with different leverage levels rely on digital inclusive finance in different directions. The regression coefficient of the digital finance coverage breadth index for highly leveraged enterprises is -0.067 , which is significant at the 1% level, indicating that the deleveraging effect of highly leveraged enterprises is more dependent on the digital financial coverage of their provinces, and the larger the scope, the better the deleveraging effect. The regression coefficient of the digital finance usage depth index for medium and low leverage enterprises is -0.090 , significant at the 1% level, indicating that the deleveraging effect of medium and low leverage enterprises is more dependent on the extent of digital finance usage and that the expansion of the number of transactions and actual users of digital finance is more helpful to medium- and small-leverage enterprises in deleveraging.

4.4. Robustness Analysis

To enhance the robustness of the empirical results of this study, the following approach to robustness testing is adopted in this paper.

Excluding the impact of major external financial shocks, enterprises' operating conditions and debt performance, as well as the development of digital inclusive finance, are subject to various external influences, such as changes in the overall economic environment, national policy adjustments, and financial trend shocks, so the impact of major financial events on enterprises' leverage levels must be taken into account in this study, and the changes caused by this impact should be excluded. In the time window of this study, the domestic "stock market crash" that occurred in 2015 inevitably had an impact on the

macrofinancial environment and the production and operation of enterprises. Given this, this paper excludes the data for 2015 and excludes the impact of the “stock market crash” on the leverage ratio of enterprises as far as possible. The results of the regression are shown in Table 7. The results of the benchmark regression for the total digital inclusive finance index, as well as its coverage breadth index and usage depth index, are all negative, significantly reducing the leverage ratio of SMEs, which is generally consistent with the results of the previous benchmark regression.

Table 6. Regression analysis of differences in leverage levels.

Variables	LEV					
	(1)	(2)	(3)	(4)	(5)	(6)
DF_R	−0.063 ** (−0.030)			−0.082 *** (−0.021)		
DCB_R		−0.067 *** (−0.025)			−0.060 *** (−0.018)	
DUD_R			−0.041 (−0.030)			−0.090 *** (−0.021)
Size	0.178 *** (−0.017)	0.177 *** (−0.017)	0.179 *** (−0.017)	0.184 *** (−0.013)	0.183 *** (−0.013)	0.184 *** (−0.014)
Age	0.024 (−0.017)	0.023 (−0.017)	0.023 (−0.017)	−0.001 (−0.012)	−0.001 (−0.012)	0.000 (−0.012)
Capital	0.001 (−0.018)	−0.001 (−0.018)	0.003 (−0.018)	−0.146 *** (−0.013)	−0.146 *** (−0.013)	−0.147 *** (−0.013)
NET	−2.016 (−4.087)	−2.104 (−4.102)	−1.815 (−4.080)	1.748 (−2.879)	1.718 (−2.881)	1.854 (−2.883)
Mega	−0.009 (−0.013)	−0.008 (−0.013)	−0.010 (−0.013)	0.010 (−0.011)	0.009 (−0.011)	0.011 (−0.011)
Audit	−0.273 *** (−0.042)	−0.273 *** (−0.042)	−0.273 *** (−0.042)	−0.030 (−0.040)	−0.030 (−0.040)	−0.031 (−0.040)
Constant	0.037 (−0.112)	0.065 (−0.096)	0.080 (−0.112)	−0.817 *** (−0.181)	−0.763 *** (−0.182)	−0.827 *** (−0.178)
Time effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
N	1760	1760	1760	1900	1900	1900
R ²	0.261	0.262	0.259	0.234	0.232	0.236

Note: ***, ** denote significance at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable. Highly leveraged companies models: (1), (2), (3). Low- to medium-leverage companies models: (4), (5), (6).

4.5. Endogenetic Processing

In order to avoid the endogeneity problems caused by reverse causality and missing variables, the substitution regression model was used to conduct an endogeneity test. This paper uses a bivariate fixed effects model with both time and industry-fixed effects, which is common in current research and may have endogeneity issues due to data processing limitations. Because of this, this paper draws on Moser and Voena’s approach and uses a joint fixed-effects model, controlling for the ‘time × industry’ effect to validate again. The regression results are shown in Table 8, with no significant change in the regression results or significance levels. Based on the results of the two robustness analyses, it can be verified that the findings of the baseline test in this paper are robust and reliable, i.e., digital finance development is beneficial in reducing the leverage of SMEs.

Table 7. Robustness analysis, excluding financial shock events.

Variables	LEV		
	(1)	(2)	(3)
DF_R	−0.094 *** (−2.81)		
DCB_R		−0.066 ** (−2.42)	
DUD_R			−0.099 *** (−2.94)
Size	0.456 *** (26.38)	0.456 *** (26.36)	0.455 *** (26.32)
Age	−0.015 (−0.92)	−0.016 (−0.97)	−0.015 (−0.86)
Capital	−0.165 *** (−8.51)	−0.165 *** (−8.45)	−0.166 *** (−8.53)
NET	−5.917 (−1.45)	−5.863 (−1.44)	−5.859 (−1.44)
Mega	−0.001 (−0.07)	−0.002 (−0.11)	−0.000 (−0.02)
Audit	−0.374 *** (−6.70)	−0.374 *** (−6.69)	−0.375 *** (−6.71)
Constant	−1.016 *** (−4.34)	−0.994 *** (−4.18)	−1.074 *** (−4.58)
Observations	3032	3032	3032
R ²	0.397	0.397	0.397

Note: ***, ** denote significance at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable.

Table 8. Endogenetic processing: replacement regression models.

Variables	LEV		
	(1)	(2)	(3)
DF_R	−0.091 *** (0.028)		
DCB_R		−0.066 *** (0.023)	
DUD_R			−0.096 *** (0.0028)
Size	0.458 *** (0.016)	0.458 *** (0.016)	0.457 *** (0.016)
Age	−0.003 (0.016)	−0.003 (0.016)	−0.002 (0.016)
Capital	−0.158 *** (0.018)	−0.157 *** (0.018)	−0.158 *** (0.018)
NET	−9.608 *** (4.036)	−9.559 *** (4.043)	−9.499 *** (4.028)
Mega	−0.011 (0.014)	0.011 (0.014)	0.012 (0.014)
Audit	−0.377 *** (0.058)	−0.376 *** (0.058)	−0.377 *** (0.058)
Constant	−1.235 *** (0.102)	−1.175 *** (0.095)	−1.224 *** (0.098)
Observations	3660	3660	3660
R ²	0.413	0.413	0.414

Note: *** denote significance at 1%, 5%, and 10% levels, respectively; t-values are in parentheses; N is the sample size; and R² is the degree to which the explanatory variable explains the explained variable.

5. Conclusions and Recommendations

5.1. Conclusions

The application and deepening of Internet technology in the financial industry has promoted the integration of finance and technology, broken the barriers of time and space limitations in traditional finance, and created a breakthrough in digital inclusive finance, which has had a significant impact on enhancing economic efficiency and promoting the sustainable development of the real economy. During the 13th Five-Year Plan period, digital inclusive finance formed a financial service system that is compatible with the building of a moderately prosperous society, and it has played a role in alleviating the problem of “difficult financing and inclusiveness” for SMEs. This paper uses the data of listed companies in China’s small- and medium-sized boards from 2015 to 2019 and constructs a panel regression model combining provincial digital inclusive finance indices to analyze the impact of digital inclusive finance on SMEs’ deleveraging effect, and explores the impact path and mechanism of digital inclusive finance on SMEs’ deleveraging from various perspectives, such as mediation effect and heterogeneity analysis. The findings of the study are as follows:

1. Digital inclusion has a direct contribution to the reduction of SME leverage, and both dimensions of digital inclusion (breadth of coverage and depth of use) have positive impacts on SME deleveraging. Capital intensity ratio, net profit growth rate, and audit opinion contribute to the reduction of corporate leverage, and corporate size has a dampening effect on it. The development of digital finance optimizes the financial environment, effectively improves the information gap between the two sides of capital supply and demand, promotes the effective allocation of both sides, increases the financing channels of enterprises, reduces the demand for traditional leverage financing, further avoids the occurrence of preventive financing, and generally achieves the effect of deleveraging.
2. Further analysis of the transmission path of the deleveraging effect reveals that digital inclusive finance can reduce finance costs and promote lower leverage levels of SMEs, with a negative transmission mechanism. The promotion of digital finance reduces the finance cost rate and expands the funds available to enterprises so that they no longer need to generate leveraging behavior to obtain funds. The development of digital finance can significantly optimize the financing structure, give play to the advantages of the financial system, and provide an important supplement to alleviate the financing difficulties of enterprises.
3. There is heterogeneity in the performance of the impact of digital inclusive finance on the leverage ratio of SMEs across ownership and leverage levels. At the ownership level, the effect of digital inclusive finance on leverage reduction is weaker for private enterprises compared to non-private enterprises, i.e., the promotion of digital inclusive finance contributes relatively more to deleveraging for non-private SMEs. Digital finance can effectively establish the identification and control of enterprise risks, which is beneficial to activate banks’ credit support for private enterprises to a certain extent and avoid the occurrence of “ownership discrimination”. At the level of leverage, the development of digital finance is more effective in deleveraging medium- and low-leverage enterprises than high-leverage enterprises. By constantly extending financial services, digital finance can reach the long-tail groups with extensive financing intentions but difficulty in matching financial supply, improve matching efficiency, and maximize the utility of funds.

In summary, the development of digital inclusive finance has a more obvious positive effect on the reduction of leverage of Chinese SMEs, and digital finance has played an important role in promoting the economic development of SMEs and solving the financing problems of small and microenterprises. Therefore, the country should continue to promote digital inclusive financial services, build a diversified financial industry, and deepen the structural reform of the financial supply side with a more complete service system.

5.2. Recommendations

Based on the conclusions drawn from the empirical study in this paper, the following recommendations are made:

1. For the government, should deepen the structural reform on the supply side of finance, continuously promote the development of digital inclusive finance, the focus should be on enhancing financial services that are more dependent on financial inclusion for small- and medium-sized enterprises, give active financial support and encouraging digital financial institutions to accurately connect with financial vulnerable groups, encourage the development of digital fields such as 5G, big data, and blockchain, help the financial industry breakthrough data barriers, broaden the coverage of digital finance, enhance the depth of digital finance usage, narrow the gap in the level of digital finance development between different regions, and truly In a meaningful sense, digital finance can be made accessible to all. In this way, we can stimulate the endogenous driving force for the development of small- and medium-sized enterprises, develop circular economy, help achieve the goal of “double carbon”, and lay a solid foundation for the sustainable development of small- and medium-sized enterprises.
2. For SMEs, against the backdrop of China’s “1 + 2” combination of policies to boost SME development, SMEs have accelerated their digital transformation, prompting digital financial services to be precisely matched. The government should innovate the mode and method of financial services and promote tax and fee reduction and financing support to enhance the enthusiasm of SMEs in innovation and entrepreneurship; it should also provide appropriate liquidity support and talent input to strengthen the innovation drive of enterprises and reinvigorate market confidence to fundamentally help SMEs alleviate the pressure of high leverage. At the same time, credit information sharing and other supporting mechanisms should be promoted to improve the quality, efficiency, and sustainable development of financial services.
3. Preventing and defusing major risks is the first of the three key battles that have been established since the 19th CPC National Congress. Developing digital finance will help prevent and defuse major risks, which should be prevented on the basis of stable growth. For financial institutions, the digital inclusive finance system should be improved as soon as possible to achieve scientific supervision and risk prevention and control. As digital inclusive finance has emerged rapidly in China and developed in a relatively short period, there are still various problems, such as the lack of relevant laws and regulations and imperfect regulatory mechanisms. Relevant organizations should clarify the regulatory responsibilities of digital inclusive finance as soon as possible, formulate relevant regulations and systems, and improve industry norms. At the same time, it is necessary to increase the combination of technology and finance, master data and information, and improve risk prevention and control capabilities. In addition, the development of digital inclusive finance should also fully absorb the diversified requirements brought about by various factors such as regions, industries, and policies and continuously push forward new ideas according to the individual needs of service recipients to comprehensively build a digital inclusive finance system for the future potential of leveraging digital finance to have a transformative impact on sustainable development.

There are still some shortcomings in this study. (1) The time span of the data selected for the empirical test of this study is too small to reflect the influence of the relationship between the development of digital finance and the leverage ratio under the economic cycle. If more abundant data can be obtained in the future, the time span can be extended appropriately to further verify the relationship between the two. (2) There are certain limitations in the selection of indicators in this paper. As for the proxy variable of the development level of digital inclusive finance, only the index of digital inclusive finance of Peking University is used, and different evaluation indexes are not used for comparison and verification. In future studies, a more comprehensive evaluation of indexes of digital

finance can be considered, so as to further enhance the robustness of the conclusion. In addition, the impact of digital finance on enterprise value, enterprise innovation, and development is also of great research significance, and we will consider further exploration in the future.

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