

Article

Does Digital Inclusive Finance Increase Industry Chain Resilience in China?

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Abstract: A high level of industry chain resilience is essential for China's economy to operate safely, soundly, and robustly. It also serves as the foundation for the nation's capacity for growth, competitiveness, sustainable development capacity, and ability to respond to various external dangers. In this regard, the swift advancement of digital inclusive finance has shown significant prospects for enhancing the resilience of China's industry chain. This study empirically examines the impact of digital inclusive finance on industry chain resilience, based on China's provincial panel data from 2013 to 2021. The findings demonstrate the following: digital inclusive finance significantly contributes to industry chain resilience; optimization of industrial structure and technological innovation play mediating roles in the relationship between digital inclusive finance and industry chain resilience; and the high-quality development of the regional economy has a positive moderating effect on that relationship. Subsequent investigation reveals quantile and regional variations in the effect of digital inclusive finance on industry chain resilience. This study not only confirms the critical role that digital inclusive finance plays in bolstering industry chain resilience but also identifies a workable strategy for doing so in the case of China.

Keywords: digital inclusive finance; industry chain resilience; high-quality development of regional economy; sustainable development; China



Citation: Hu, L.; Chen, F.; Zhao, R. Does Digital Inclusive Finance Increase Industry Chain Resilience in China? *Sustainability* **2024**, *16*, 6028. <https://doi.org/10.3390/su16146028>

Academic Editor: Matteo Rossi

Received: 19 June 2024

Revised: 11 July 2024

Accepted: 12 July 2024

Published: 15 July 2024



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1. Introduction

In addition to serving as the cornerstone of the nation's growth potential, competitiveness, sustainable development capacity, and ability to respond to a variety of external challenges, a high degree of industry chain resilience is also essential for the safe, sound, and stable operation of the national economy. The improvement of industry chain resilience is conducive to strengthening the economic system's ability to resist external disturbances and alleviate system pressure, ultimately achieving sustainable development of the economy and society. However, China's internal industrial chain, which was established by integrating the global value chain strategy, has also given rise to important problems like "two ends outside", "low-end locking", and unsustainability, despite being a major factor in the nation's 40 years of rapid economic expansion [1,2]. The contradiction between the massive volume and medium- to high-speed growth of the Chinese economy and the brittle resilience of the industry chain was exposed in recent trade friction between China and the United States and the new coronavirus epidemic. This has had a very negative impact on China's economic and social sustainable development, leading to General Secretary Xi Jinping explicitly suggesting in the 20th Party Congress report that measures should be made to improve levels of resilience and security in the industrial supply chain. It is evident that establishing an inclusive, resilient, and sustainable industry chain system is crucial as China's economy enters a high-quality economic development stage and the environment surrounding global competitiveness becomes more complex.

Ever since Comfort introduced the originally physics-derived concept of “resilience” to the analysis of inter-organizational learning expectations [3], the concept has steadily drawn the interest of economists studying economic management. The global industrial chain is facing a significant risk of “decoupling and chain breakage” due to the growing complexity of the competitive relationships between large countries and the effects of the new coronavirus epidemic [4,5]. These challenges have not only tested the global chain but have also highlighted the urgent need for resilience and sustainability in the chain, especially for developing countries in general. As a result, industry chain resilience has drawn the attention of academics, with previous research showing how elements like the digital economy [6], environmental policies [7,8], and industrial collaborative agglomeration [9] might enhance industry chain resilience. The potential influence of digital inclusive finance, which is actively being developed and rapidly nurtured, on enhancing industry chain resilience has not, however, received enough attention in the context of the current deepening reform of China’s financial industry.

The new wave of scientific and technological revolutions is intensifying, and China’s digital economy is growing quickly; as a result, the academic community is becoming increasingly interested in digital inclusive finance, which is based on the newest generation of digital information technology. The academic community has achieved fruitful results investigating digital inclusive finance, and relevant research has extended from the connotations [10], characteristics [11], measurement [12], and other aspects of digital inclusive finance to the empowering effect of digital inclusive finance on economic development and industrial development [13]. It has been demonstrated that digital inclusive finance has given the financial system and industry new life, also having a significant positive impact on a number of macro-, meso-, and microeconomic variables, including the business environment [14], high-quality development [15,16], labor allocation efficiency [17], and corporate financing constraints [18]. As an antecedent, the growth of digital inclusive finance has led to qualitative alterations in intermediate variables, and ultimately to changes in industry chain resilience. Given the strong correlation between these economic factors and industry chain resilience, it is reasonable to assume that digital financial inclusion will have a substantial effect on industry chain resilience. Indeed, according to pertinent research reports, Chinese financial institutions have stepped up their support for “specialized, sophisticated, new” technology businesses in 2022 by offering inclusive small loans with low interest rates and medium repayment periods through digital inclusive finance. This has been crucial in creating a dual-circulation development pattern and strengthening the robustness of supply chains and industrial chains [19]. At the academic research level, there is currently a limited body of literature concentrating on the causal connection between digital financial inclusion and industry chain resilience [20]; the two studies most pertinent to this work are by Wei Yanqi [21] and Liu Wei [22]. Although both of these studies discovered that digital financial inclusion improves industry chain resilience, one may have lost its generality due to its focus on a single industry sector, and the other may have introduced bias into the econometric estimation process by employing only two indicators to describe industry chain resilience. Furthermore, both of these research works overlooked uneven and insufficient regional economic development in China, resulting in its exclusion from the econometric model. However, this aspect is especially useful for studying an environment in which high-quality economic development has emerged as a major national strategy. Therefore, this context presents a research opportunity to achieve a potential breakthrough.

For the reasons mentioned above, this study thus incorporates high-quality regional economic development into the econometric model, based on the existing literature. It also reveals in detail the fundamental principle of digital inclusive finance, which is to better utilize digital inclusive finance in the new endeavor of fully constructing socialist modernization and enhancing industry chain resilience.

The possible marginal contributions of this study are as follows: First, in order to mitigate the estimation bias brought on by measurement error, a thorough assessment index

system for industry chain resilience is built from the dimensions of resistance and recovery ability. Second, the high-quality development of the regional economy is regarded as a regulating variable in the mechanism test, while the optimization of industrial structure and technological innovation are taken as mediating variables. This provides a useful addition to the existing literature by revealing both the regulating role of the high-quality development of the regional economy and the channels through which digital inclusive finance affects industry chain resilience. Third, a panel quantile regression model is built to conduct quantile heterogeneity tests in addition to regional heterogeneity tests. This helps precisely identify the impact of various quantiles of digital inclusive finance on industry chain resilience and offers more rich empirical evidence for developing policies that are specific to digital inclusive finance.

2. Institutional Background and Theoretical Analysis

2.1. Institutional Background

A novel idea known as “digital inclusive finance” emerged from the fusion of digital technology with inclusive finance. The World Bank and the United Nations originally advocated and introduced the idea of inclusive finance to China in 2005, and the Chinese government has since given it significant recognition. The notion of inclusive finance was formally introduced by the 18th Central Committee of the Communist Party of China in November 2013, when it passed the “Decision of the CPC Central Committee on Several Major Issues Concerning Comprehensive Deepening of Reform”. The “Plan for the Development of Inclusive Finance (2016–2020)”, published by the State Council in December 2015, provides a definition of inclusive finance as well as more detailed plans for its advancement. In recent years, the practice of inclusive finance in China has demonstrated a strong link with various creative digital technologies, leading to the emergence of digital inclusive finance owing to the more widespread use of digital technology. Through information technology adoption and product innovation, digital inclusive finance offers new digital financial services/products, reduces their costs, and increases their coverage, which are key features in the development and growth of inclusive finance. The “Fourteenth Five-Year Plan for National Informatization” was released in December 2021 by the Central Leading Group for Cyberspace Security and Informationization. This plan outlined the strategic priority of “Digital Inclusive Financial Services” and provided guidance for a comprehensive approach to promoting the development and construction of these services. In its “Implementation Opinions on Promoting High-Quality Development of Inclusive Finance”, published on 11 October 2023, the State Council made clear how important it is to encourage the orderly development of digital inclusive finance. This includes raising the bar for inclusive finance technology, building a thriving ecosystem, and strengthening the regulatory framework. With a focus on “Digital Technology and Inclusive Finance Integration Innovation”, the “2023 Banker Financial Innovation Forum” took place in Beijing on 17 October 2023. The event featured lively discussions about the importance of developing new models of digital inclusive finance to address the mismatch between the supply of and demand for financial services. At the Central Financial Work Conference at the end of October 2023, General Secretary Xi Jinping recommended focus should be placed on the following five major development areas: science and technology finance, green finance, inclusive finance, pension finance, and digital finance. He also suggested accelerating the development of China as a financial powerhouse, thus signifying the ascent of the country’s national strategy for digital inclusive finance, which is anticipated to have a significant impact on future social and economic development.

2.2. Theoretical Analysis

In 2011, the median of China’s provincial digital inclusive finance comprehensive index was 33.6, while the median in 2021 reached 363.6, with an average annual growth rate of 26.9% (Data source: Peking University Digital Financial Inclusion Index (2011–2021)), thus demonstrating rapid development. Combining the objective fact of the rapid development

of digital inclusive finance in China, as well as the objective need to enhance the resilience of China's industry chain in the current complex international and domestic environment, and after reviewing relevant research findings in the literature, the authors built the following theoretical framework to explore the impact of digital inclusive finance on the enhancement of industry chain resilience (as shown in Figure 1).

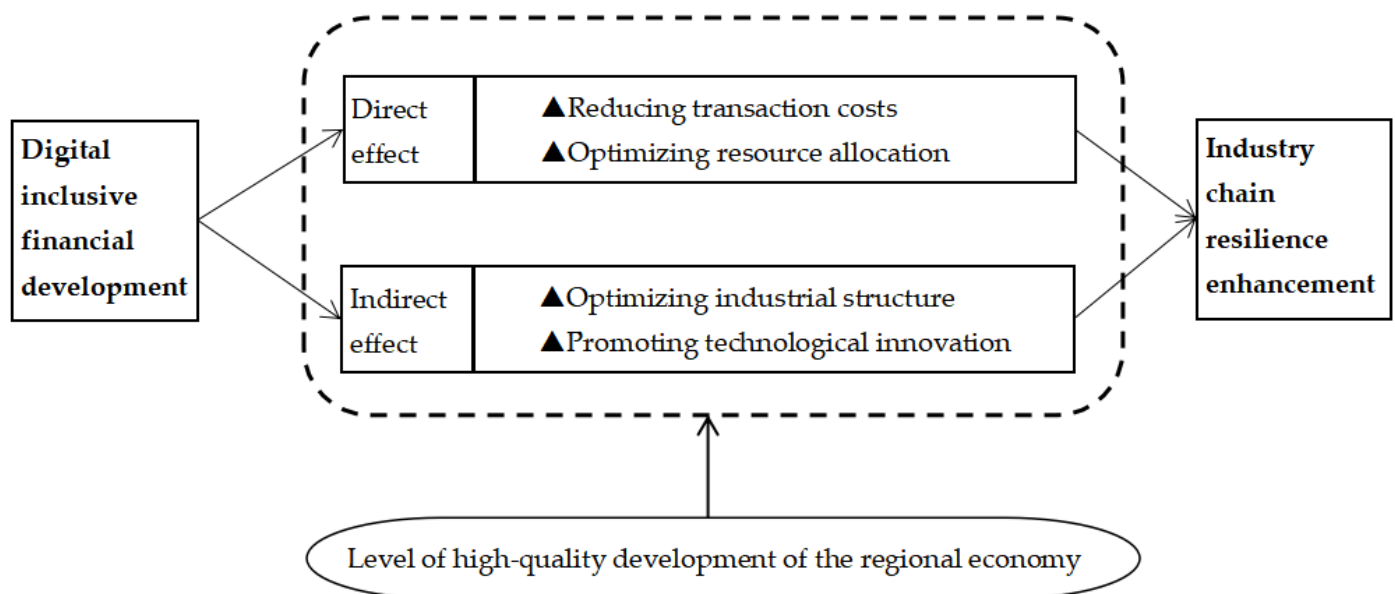


Figure 1. Analytical framework.

2.2.1. Digital Inclusive Financial Development and Industry Chain Resilience Enhancement

- (1) **Direct effect:** The direct effect of digital inclusive finance on industry chain resilience can be explained from two aspects: transaction costs and resource allocation. From the perspective of transaction costs, the level of industry chain resilience mainly depends on the degree of trust and dependence among industry chain members [23–25]. In fact, on the one hand, digital inclusive finance, with the help of modern information technology, mines and arranges massive standardized and non-standardized data, breaks down the information barriers in the financial market, eases the degree of information asymmetry between the supply and demand sides of the funds [26], reduces the problems of adverse selection and moral hazard among chain members, and strengthens the degree of trust among chain members, thus reducing the transaction costs and enhancing industry chain resilience. On the other hand, the unique digital and inclusive characteristics of digital inclusive finance relative to traditional finance make the business relationships between enterprises and financial institutions much closer and the transactions more frequent [27,28], thus enhancing the degree of dependence between the two, reducing the transaction costs for both sides, and enhancing industry chain resilience. From the perspective of resource allocation, the level of industry chain resilience mainly depends on the efficiency of financial and non-financial resource allocation within the industry chain [29,30]. In fact, digital inclusive finance innovatively subverts the traditional credit pricing model through the transparent informatization of credit [31], and under Metcalfe's law, the value of the lending network spawned by digital inclusive finance is multiplied, allowing financial institutions to reverse their over-preference for the traditional mid- to high-end lending market, thus directly improving the efficiency of financial resource allocation. In addition, the improvement of financial resource allocation efficiency makes the integration and docking of resources at each end of the industry chain more efficient, and enterprises in the industry chain can use fewer resources to pro-

duce higher output, which will bring higher profits and stronger competitiveness to enterprises [32] and thus enhance industry chain resilience.

- (2) Indirect effect: Two channels can be used to analyze the indirect impact of digital financial inclusion on the improvement of industry chain resilience: industry structure and technical innovation. By optimizing the industrial structure, the growth of digital inclusive finance can, from the standpoint of industrial structure, enhance the robustness of the industrial chain [33,34]. Specifically, on the one hand, digital inclusive finance improves financial inclusion, expands the coverage of investment and financing funds [35], and shortens the chain in the financing of funds through the combination of internet technology and the financial industry [36], thus accelerating the flow of funds within the industry, promoting the upgrading of the industrial structure from secondary to tertiary industry, and realizing the development of the industrial structure at an advanced level [37]. On the other hand, the various financing platforms that have emerged from digital inclusive finance have reduced the cost and threshold of enterprise financing [13], giving businesses more money to investigate new development avenues and create more sensible industrial structures. From the standpoint of technological innovation, the creation of digital inclusive finance can support technological innovation, which in turn strengthens industry chain resilience [38]. To be more precise, on one hand, digital inclusive finance completely subverts the constraints of traditional financial institutions' physical locations, enhances the reach and coverage of traditional finance [39], lowers the bar for financing availability for businesses, particularly small- and medium-sized businesses (SMEs), and directly eases the financial constraints that businesses face by giving them the funding they need to implement technological innovation [40]. On the other hand, digital financial inclusion, supported by cloud computing, big data, and other information technologies, strengthens the capacity of enterprises for social interaction, fosters technical communication and exchange, and is helpful in the formation of independent innovation results for enterprises as well as the improvement of innovation efficiency [41].

This study therefore proposes and tests the following two research hypotheses, which are based on the findings shown above:

Hypothesis 1 (H1). *The development of digital inclusive finance can enhance industry chain resilience.*

Hypothesis 2 (H2). *The development of digital inclusive finance can enhance industry chain resilience by optimizing the industrial structure and promoting technological innovation.*

2.2.2. Digital Inclusive Finance, High-Quality Regional Economic Development, and Industry Chain Resilience Enhancement

The theoretical study presented above demonstrates how the development of digital inclusive finance can effectively support industry chain resilience in a homogenized regional economic environment. As a matter of fact, however, the primary source of the significant imbalance that exists in Chinese society today is uneven and inadequate regional economic development [42,43]. The 19th Party Congress report proposed high-quality economic development as a means of resolving this paradox. High-quality economic development is not only a national strategy that must be sustained over time; its static level also serves as a general reflection of the state of regional economic development when viewed from the theoretical and practical perspectives of high-quality development [44]. Consequently, disparities in the quality level of regional economies remain at the core of China's uneven and inadequate regional economic development. It is conceivable that the impact of digital inclusive finance on strengthening industry chain resilience may vary depending on the reality of regional economic growth, which is defined by the degree of high-quality regional economic development.

First of all, in regional economies, openness is a necessary route to excellent economic development [45]. Higher levels of openness are typically associated with higher levels of high-quality economic development, which also translate into higher levels of marketization and superior business environments [46,47]. Improved business conditions can contribute to lower transaction costs through digital inclusive finance [48], and more marketization can boost the optimization effect of this type of financing on resource allocation [49,50]. Secondly, excellent regional economic development is inherently dependent on coordination. In addition to needing a relatively optimized industrial structure within each of the three industries and between them, regions with higher levels of high-quality economic development will also be compelled to optimize their industrial structures due to the policy effects of different levels of government, which will support the development of the resilience of the digital inclusive finance industry chain. Finally, innovation is the primary driving force for high-quality economic development in regional economies. Higher productivity, greater competitiveness, and greater vitality are characteristics of economic zones with higher levels of high-quality economic growth; these factors draw more investment and increase job possibilities [51]. This helps digital inclusive finance support the robustness of the industrial chain by increasing transmission efficiency within the chain, thus resulting in more active factor flows.

In light of the aforementioned analysis, the following research hypotheses are proposed and tested in this study:

Hypothesis 3 (H3). *The contribution of digital inclusive financial development to the enhancement of industry chain resilience is affected by the regional economy's level of high-quality development.*

3. Research Design

3.1. Model Setup

3.1.1. Benchmark Model

Based on the above theoretical analyses, in order to test the facilitating effect of digital inclusive finance on the resilience enhancement of the industrial chain, the following benchmark econometric model is constructed:

$$icr_{it} = \alpha_0 + \alpha_1 dif_{it} + \alpha_2 control_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

The subscripts i and t in the model denote the region and the year, respectively, icr_{it} denotes the industry chain resilience of the region in year t , dif_{it} denotes the digital financial inclusion index, and $control_{it}$ denotes the five control variables used in this study, which are population density, informatization level, urbanization level, the degree of government intervention, and the level of economic development. α_0 is the intercept term. α_1 is the estimation of the industry chain resilience by the digital financial inclusion coefficient, which is the main parameter of interest in the text; if the coefficient is significantly positive, it indicates that digital inclusive finance promotes industry chain resilience, and H1 is verified. α_2 is the regression coefficient of the control variables. μ_i represents the fixed effect of province, controlling for other unobserved provincial characteristics that do not change with time t . λ_t represents the time-fixed effect, controlling for the same time-varying trend found in all the provinces across different survey periods. ε_{it} represents the random error term (see below).

3.1.2. Intermediary Mechanism Model

In order to better recognize the mediation mechanism of digital inclusive finance affecting the resilience enhancement of the industry chain, the following mediation mechanism model was constructed for testing on the basis of Model (1):

$$Mediator_{it} = \beta_0 + \beta_1 dif_{it} + \beta_2 control_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$icr_{it} = \gamma_0 + \gamma_1 dif_{it} + \gamma_2 Mediator_{it} + \gamma_3 control_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where Mediator_{it} is the mediator variable, i.e., the proxy variable of industrial structure and technological innovation; β_0 and γ_0 are intercept terms; β_1 and γ_1 are the regression coefficients of digital inclusive finance on the mediator variable and industry chain toughness, respectively; and γ_2 is the regression coefficient of the mediator variable. Model (2) can test whether digital inclusive finance significantly affects the mediating variables, and Model (3) can test whether the intermediating variables significantly affect the outcome variables. Separately, the mediator variables are sequentially substituted into the above models for the mediation mechanism test, which in turn verifies Hypothesis 2.

3.1.3. Regulatory Mechanism Model

To further examine whether the relationship between digital inclusive finance and industry chain resilience is affected by the high-quality development of the regional economy, the following model was constructed for testing:

$$\text{icr}_{it} = \delta_0 + \delta_1 \text{dif}_{it} + \delta_2 \text{tfp}_{it} + \delta_3 \text{control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

$$\text{icr}_{it} = \eta_0 + \eta_1 \text{dif}_{it} + \eta_2 \text{tfp}_{it} + \eta_3 (\text{dif}_{it} \times \text{tfp}_{it}) + \eta_4 \text{control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where δ_0 and η_0 are intercept terms; δ_1 and η_1 are digital financial inclusion regression coefficients; δ_2 and η_2 are regression coefficients of moderating variables; $\text{dif}_{it} \times \text{tfp}_{it}$ is the product term of digital financial inclusion and high-quality regional economic development index; and η_3 is the regression coefficient of the product term. If the product term regression coefficient η_3 is significantly positive, this indicates that the joint effect of digital inclusive finance and the level of high-quality development of the regional economy significantly contributes industry chain resilience, i.e., H3 is verified.

3.2. Variables

3.2.1. Core Explanatory Variable

Digital Inclusive Finance. The index was developed by the Peking University Digital Finance Research Center in collaboration with Ant Gold Service Group using a large amount of data, and it has been recognized by academics as having some representativeness and reliability [19,52,53]. Compared with other indicators, the index offers a distinct advantage in gauging the state of development of digital inclusive finance at the provincial level in China.

3.2.2. Explained Variable

Industry Chain Resilience. A thorough comprehension of the meaning of industry chain resilience is necessary before attempting to quantify its resilience. Initially, in physics, the term “resilience” described a system’s capacity to withstand external pressure or impact without losing its structural or functional integrity [54]. According to certain technical and economic logical relationships as well as spatial and temporal layout relationships, each link in an industry forms an objective chain-type correlation relationship that is referred to in economics as the “industrial chain” [55]. Based on references to related studies in the literature [56,57], the authors of this study therefore argue that industry chain resilience refers to the industry chain’s ability to preserve or restore its normal functioning and value creation when it suffers from external shocks or uncertainty risks on a global scale. This definition states that the statistical meaning of industry chain resilience can be investigated from the perspectives of resistance and recovery. Resistance is the industrial chain’s capacity to continue functioning properly in the face of persistent external pressure and uncertainty, while recovery is the capacity of the industrial chain to rapidly return to its initial state or a suitable state following an abrupt external shock, provided that the resistance has been fully exhausted. In the early stages of the industry chain facing shocks, if the industry chain resistance is strong, the industry chain resilience is strong and the impact of external shocks is offset, compared with when the industry chain resistance is weak [58]. Industries with good foundations and excellent supporting facilities can recover

more quickly to their original equilibrium state [59]. The current study indicates that the policy environment, industrial benefits, and the degree of dependency on external variables are the primary factors influencing recovery, whereas elements influencing resistance include human resources, manufacturing technology, and the digitalization level. Given this, resistance and recovery ability are considered the primary indicators in this study, respectively. Secondary indicators were derived from the primary indicators' fundamental influencing elements, and the industry chain resilience measurement index system was subsequently built. The specific markers are displayed in Table 1. The entropy value method has been used in the measurement process to carry out particular measurements in order to improve the scientificity and accuracy of the measurement results.

Table 1. Industry chain resilience measurement index system.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Direction of Indicator
Resistance	Human resources	Full employment rate	+
		Percentage of enrolment in higher education	+
		Employment in urban units of high-tech industries	+
	Manufacturing technology	R&D expenditure of industrial enterprises of designated size	+
		Expenditure on development of new products by industrial enterprises above designated size	+
		R&D personnel of industrial enterprises above designated size in full volume at that time	+
	Digitalization level	Number of websites per 100 enterprises	+
		Share of enterprises with e-commerce trading activities	+
Recovery	Policy environment	Number of state-controlled enterprises	+
		Tax revenue of local finance	+
		Expenditure on local financial supervision	+
	Industrial benefit	Total profit of industrial enterprises above designated size	+
		Profit margin on total assets of industrial enterprises above designated size	+
	External dependency	Number of foreign-controlled enterprises	−
		Foreign direct investment in GDP	−

3.2.3. Intermediate Variable

Industry Structure. According to the usual practice, industrial structure is measured by the indicators of industrial structural upgrading and rationalization. Specifically, the indicator of industrial structural upgrading is the ratio of the added value of the tertiary industry to that of the secondary industry, while the indicator of industrial structure rationalization is the reciprocal of the Theil index. It should be noted that the smaller the Theil index value, the more rational the industrial structure is.

Technological Innovation. In previous studies, the amount of money a corporation invests in research and development has commonly been used as an indicator of its ability

to innovate technologically. In actuality, however, technical innovation activities frequently carry a significant risk, and it is challenging to turn every R&D dollar into novel products. A company's capability for technological innovation may be exaggerated if such metrics are utilized to gauge it. Thus, one way to gauge technical innovation is to look at the volume of inventive patent applications. Innovation leads to patents for innovations, and the more patent applications for inventions an industry chain has, the greater its potential for technical innovation.

3.2.4. Moderator Variable

The level of high-quality development of the regional economy. Two categories can be used to summarize the current approaches to assessing the degree of high-quality development of the regional economy: the first involves developing a comprehensive indicator system, and the second involves utilizing the total factor productivity index. The former is very subjective, may experience information loss, and lacks a clear standard in the selection of indicators and weights. Consequently, the latter has been adopted in this research, i.e., the degree of high-quality growth of the regional economy is indicated by the level of total factor productivity. Regarding precise measures, this study uses data envelopment analysis (DEA) [60] to calculate the 31 provinces' total factor productivity between 2013 and 2021.

3.2.5. Control Variable

This work additionally accounts for and logs the following variables to prevent estimation errors brought on by missing variables: population density, measured by the ratio of the total population to the administrative area of each region; the degree of informatization, measured using the proportion of postal and telecommunications revenue to regional GDP; the degree of urbanization, measured using the proportion of urban population to the total population; the degree of government intervention, measured using the ratio of government expenditure to regional GDP; and the macroeconomic conditions, measured using per capita GDP.

3.3. Data Source and Descriptive Statistics

For the research sample, taking into account the availability of data, panel data were selected from 31 provincial administrative regions (excluding Hong Kong, Macau, and Taiwan) in China from 2013 to 2021. The "Digital Inclusive Finance Index" was derived from the "China Digital Inclusive Finance Index". Other data mainly came from the National Bureau of Statistics, China Statistical Yearbook, and Provincial Statistical Yearbooks. For missing data, the linear interpolation method was used to fill in the gaps.

The descriptive statistical results are shown in Table 2. Among them, the average level of digital inclusive finance is 2.662, the standard deviation is 0.758, the range is from 1.151 to 4.590, and the maximum value is 3.988 times the minimum value, indicating that there is a certain gap in the level of digital inclusive finance development among different provinces in China. The standard deviation of industrial resilience is 0.089, the median is 0.331, the average is 0.340, and the median is less than the average, which confirms the fact that the industrial resilience in China is relatively fragile at present. The standard deviation of high-quality regional economic development is 0.276, the median is 0.599, the average is 0.582, the maximum value is 13.902 times the minimum value, and the median is greater than the average, reflecting typically uneven regional economic development in China.

Table 2. Descriptive statistics and variable descriptions.

Variable	Symbolic	Description	Mean	Std. Dev.	Mid	Min	Max
Digital inclusive finance	dif	Peking University Digital Financial Inclusion Index (/100)	2.662	0.758	2.678	1.151	4.590
Industry chain resilience	icr	Calculated using the entropy method	0.340	0.089	0.331	0.220	0.709

Table 2. Cont.

Variable	Symbolic	Description	Mean	Std. Dev.	Mid	Min	Max
Industrial structure upgrading	isu	Value added of tertiary industry/Value added of secondary industry	0.301	0.112	0.272	0.158	0.821
Industrial structure rationalization	isr	Expressed as the reciprocal of the Theil index	12.810	15.580	6.905	1.423	122.600
Technological innovation	innov	Invention patents held by enterprises above designated size (/100)	107.900	188.700	49.39	0.060	1397.000
High-quality development of the regional economy	tfp	Expressed in terms of total factor productivity	0.582	0.276	0.599	0.102	1.418
Population density	people	Persons per square kilometer	5.333	1.495	5.655	0.948	8.275
Degree of informatization	inform	Total postal and telecommunication operations/GDP	−2.982	0.737	−3.208	−4.216	−1.239
Degree of urbanization	urban	Urban/Total population	−0.534	0.214	−0.531	−1.430	−0.110
Degree of government intervention	govern	Fiscal expenditure/GDP	−1.397	0.461	−1.466	−2.238	0.288
Macroeconomic conditions	gdp	Per capita GDP	9.311	0.464	9.176	8.647	10.780

4. Empirical Analysis

4.1. Benchmark Regression

The strong balanced panel data in this paper were modeled using the F, BP, and Hausman tests. All three methods were significant at the 1% significant level, and the synthesis suggested that the fixed-effect model should be chosen. Accordingly, the empirical analysis that follows is based on the fixed-effects model. Table 3 displays the test results for the correlation between industry chain resilience and digital inclusive finance.

First, fixed-effects models without the addition of control variables were used to investigate the effects of the comprehensive index of digital inclusive finance and its three aspects on industry chain resilience. These aspects included the breadth of digital inclusive finance coverage, the depth of digital inclusive finance usage, and the level of digitalization of inclusive finance. According to the findings in column (1), digital inclusive finance had an impact coefficient of 0.018 on industry chain resilience, passing the 1% significance test. The impact of digital inclusive finance's coverage breadth, usage depth, and digitalization level on industrial resilience was determined by the results of columns (2)–(4), all of which were statistically significant at the 1% level. These results were 0.017, 0.016, and 0.019, respectively. To summarize, the preliminary results from columns (1)–(4) indicate that digital inclusive finance significantly enhances industry chain resilience.

We then employed fixed-effects models with the inclusion of control variables to examine the impact of digital inclusive finance's coverage breadth, usage depth, and digitalization level, as well as its comprehensive index, on industry chain resilience. Columns (5)–(8) present the estimated findings. From column (5), we can see that the estimated coefficient of the digital inclusive finance comprehensive index remained significant after adding control variables, and the coefficient increased from 0.018 to 0.027. Meanwhile, the five control variables of population density, government intervention, macroeconomic conditions, urbanization level, and information level all passed the significance test, indicating that the control variables selected in this study were necessary and appropriate. From columns (6)–(8), the estimated coefficients of the coverage breadth, usage depth, and digitalization of digital inclusive finance were 0.026, 0.016, and 0.016, respectively, all of which were statistically significant at the 1% level. In summary, columns (5)–(8) further confirm that digital inclusive finance has a positive impact on industry chain resilience, thereby verifying our core hypothesis (Hypothesis 1).

Table 3. Benchmark regression results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dif	0.018 *** (0.002)				0.027 *** (0.003)			
coverage		0.017 *** (0.001)				0.026 *** (0.003)		
usage			0.016 *** (0.001)				0.016 *** (0.003)	
digital				0.019 *** (0.002)				0.016 *** (0.002)
people					0.171 *** (0.052)	0.177 *** (0.053)	0.165 *** (0.056)	0.145 *** (0.055)
inform					−0.012 *** (0.002)	−0.013 *** (0.002)	−0.011 *** (0.002)	−0.011 *** (0.002)
urban					−0.079 ** (0.032)	−0.094 *** (0.035)	0.010 (0.031)	0.076 *** (0.023)
govern					0.044 *** (0.017)	0.048 *** (0.017)	0.049 *** (0.018)	0.025 (0.018)
gdp					0.049 ** (0.022)	0.054 ** (0.022)	0.054 ** (0.023)	0.038 * (0.023)
constant	0.299 *** (0.004)	0.307 *** (0.004)	0.307 *** (0.004)	0.283 *** (0.006)	−1.113 *** (0.283)	−1.185 *** (0.287)	−1.036 *** (0.303)	−0.790 *** (0.297)
control variable	No	No	No	No	Yes	Yes	Yes	Yes
fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	279.000	279.000	279.000	279.000	279.000	279.000	279.000	279.000
R ²	0.351	0.338	0.309	0.296	0.507	0.498	0.437	0.453

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Parentheses indicate robust standard errors. The estimated results are from STATA 16.0, and all variables were standardized before estimation, likewise for the following.

4.2. Endogeneity and Robustness Test

4.2.1. Endogeneity Test

Endogeneity test 1: This study used two-stage least squares (2SLS) to include the one lagged period of digital inclusive finance as an instrumental variable in the model and conducted regression to alleviate this endogeneity problem. The reasoning behind this process is that there may be a two-way causal relationship between industry chain resilience and digital inclusive finance. The current shock had no effect on the one-period lag of digital inclusive finance, and it was somewhat uncorrelated with the error term, helping to mitigate the endogeneity issue brought on by the two-way causal link. Table 4 displays the findings from column (1). The estimated coefficient of the lagged period of digital inclusive finance, according to the results in column (1), was 0.031, which was significant at the 1% level. This suggests that the internal consistency of the test model setup and the choice of instrumental variable were appropriate.

Endogeneity Test 2: Using the system GMM approach, we further investigated the first-order lag of industry chain resilience in the model, taking into account the possibility of any autocorrelation in the explanatory variable of industry chain resilience. The outcomes are displayed in Table 4, column (2). The strong results in column (2) demonstrate that the explanatory variable's first-order lag had a considerable positive impact on itself at the 1% level. Furthermore, the endogenous test model was deemed to be properly set, based on the non-significant *p* values of 0.237 for the AR (2) test and 0.899 for the Hansen test.

Table 4. Endogeneity and robustness test results.

	Endogeneity Test 1	Endogeneity Test 2	Robustness Test 1		Robustness Test 2	
	(1)	(2)	(3)	(4)	(5)	(6)
L.icr		0.968 *** (0.042)				
dif	0.031 *** (0.008)	0.009 *** (0.003)	0.009 *** (0.002)	0.018 *** (0.002)	0.026 *** (0.003)	0.020 *** (0.003)
control variable	yes	yes	yes	yes	yes	yes
fixed effect	no	yes	yes	yes	yes	yes
N	248.000	248.000	279.000	279.000	279.000	279.000
R ²	0.589		0.288	0.374	0.500	0.455
Hansen		0.899				
AR(1)		0.002				
AR(2)		0.237				

Note: Due to space limitations, the regression results for the control variables are not presented, and likewise for the following. *** indicate statistical significance at the 1% levels, respectively. Parentheses indicate robust standard errors.

4.2.2. Robustness Test

Robustness test 1: replacement of explanatory variables. The resistance and recovery abilities of the industry chain were substituted for the provincial industry chain resilience, respectively. Columns (3) and (4) demonstrate the robustness of the benchmark regression results, estimating the coefficients of the industry chain's resistance and recovery abilities with respect to digital inclusive finance to be 0.009 and 0.018, respectively, and both were statistically significant at the 1% level. This suggests that digital inclusive finance is positively correlated with the two industry chain resilience substitutes.

Robustness test 2: Trimming. The second robustness test was trimming. The data were trimmed independently at the 1–99% and 5–95% levels in light of the possibility of extreme outliers. The trimmed data were then re-incorporated into the model for fixed-effects testing. The calculated coefficients of digital financial inclusion, as indicated by columns (5) and (6), were 0.026 and 0.02, respectively, and both were significant at the 1% level. The direction and extent of the impact of digital financial inclusion had not altered much compared with Table 3's benchmark regression column (5), further demonstrating the reliability of the benchmark regression results.

4.3. Mechanism Test

4.3.1. Intermediary Mechanism Test

According to the intermediary mechanism model mentioned above, the stepwise regression method was utilized to investigate the intermediary mechanism through which digital inclusive finance impacts industry chain resilience, specifically focusing on the intermediary role played by industrial structure and technological innovation. The results in Table 5, column (1) indicate that digital financial inclusion had a positive impact on industry chain resilience, which was consistent with the results of the benchmark test and served as a control group to the mediating mechanism results. Table 5, columns (2)–(7) show the results of the mediating mechanism tests for industrial structure upgrading, industrial structure rationalization, and technological innovation. Columns (2), (4), and (6) in the table show that the effects of digital inclusive finance on industrial structure upgrading, industrial structure rationalization, and technological innovation all passed the significance test at the 1% level and had positive coefficients. These findings suggest that digital inclusive finance can support these processes. The calculated coefficients of the impact of digital inclusive finance on industry chain resilience were 0.025, 0.024, and 0.018, respectively, even after adding intermediary factors, as shown in columns (3), (5), and (7).

in the table. Comparing the estimated coefficients of digital inclusive finance before and after adding intermediary variables (0.027), it was observed that the estimated coefficient values decreased. This suggests that digital inclusive finance can indirectly enhance the level of industry chain resilience by promoting technological innovation and industrial structure optimization. In other words, these factors contribute to the intermediary effect that digital inclusive finance uses to promote industry chain resilience, and Hypothesis 2 is thus confirmed.

Table 5. Intermediary mechanisms test results.

	Control Group	Industrial Structure Upgrading		Industrial Structure Rationalization		Technological Innovation	
variable	(1) icr	(2) isu	(3) icr	(4) isr	(5) icr	(6) innov	(7) icr
dif	0.027 *** (0.003)	0.018 ** (0.007)	0.025 *** (0.003)	9.574 *** (1.235)	0.024 *** (0.003)	86.986 *** (10.789)	0.018 *** (0.003)
isu			0.115 *** (0.026)				
isr					0.000 * (0.000)		
innov							0.000 *** (0.000)
control variable	yes	yes	yes	yes	yes	yes	yes
fixed effect	yes	yes	yes	yes	yes	yes	yes
N	279.000	279.000	279.000	279.000	279.000	279.000	279.000
R ²	0.507	0.104	0.544	0.323	0.514	0.361	0.580

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Parentheses indicate robust standard errors.

4.3.2. Regulatory Mechanism Test

In order to assess the moderating impacts of high-quality regional economic development between digital inclusive finance and industry chain resilience, this study suggests using a moderating effects model. The least-squares approach was used to examine the moderating impact, which improved the significance and comprehensibility of the findings. Column (1) of Table 6 indicates that in the first stage, before the moderator factors are added, the estimated coefficient of digital inclusive finance on industry chain resilience was 0.036, which was significant at the 1% level. The second step involved adding the high-quality development of the regional economy to the models for testing. The results, as displayed in column (2), indicate that both the estimated coefficients of digital financial inclusion and the high-quality development of the regional economy on industry chain resilience were positive (0.041 and 0.075, respectively). This suggests that industry chain resilience can be driven by both high-quality regional economic growth and digital inclusive finance. The results of column (3) in Table 6 were obtained in the third step, which built on the foundation of the first two steps by adding the interaction terms “high-quality development of the regional economy” and “digital financial inclusion” and decentralizing the interaction terms to address the multicollinearity issue brought on by the addition of the interaction terms. The findings in column (3) demonstrate that the estimated coefficients for high-quality regional economic development, digital inclusive finance, and their interaction terms were all significantly positive at the 1% level. This suggests that the influence of digital inclusive finance on industry chain resilience is positively moderated by high-quality regional economic development. Comparing columns (2) and (3) with column (1), it was found that the estimated coefficients of digital inclusive finance increased from 0.036 to 0.041 and 0.040, respectively, and the model fit gradually improved after adding the

adjustment variables, further suggesting that the high-quality development of the regional economy can improve the positive promotion effect of digital inclusive finance on industry chain resilience. Hypothesis 3 is therefore verified.

Table 6. Regulatory mechanism test results.

	(1)	(2)	(3)
dif	0.036 *** (0.006)	0.041 *** (0.006)	0.040 *** (0.006)
tfp		0.075 *** (0.016)	0.081 *** (0.016)
dif×tfp			0.049 *** (0.017)
people	−0.003 (0.004)	−0.011 ** (0.004)	−0.011 ** (0.004)
inform	0.006 (0.006)	0.004 (0.005)	0.004 (0.005)
urban	−0.214 *** (0.031)	−0.207 *** (0.030)	−0.191 *** (0.030)
govern	−0.152 *** (0.013)	−0.149 *** (0.013)	−0.152 *** (0.013)
gdp	0.080 *** (0.012)	0.071 *** (0.012)	0.060 *** (0.013)
constant	−0.787 *** (0.128)	−0.715 *** (0.124)	−0.606 *** (0.128)
N	279.000	279.000	279.000
R ²	0.596	0.625	0.636

Note: **, *** indicate statistical significance at the 5% and 1% levels, respectively. Parentheses indicate robust standard errors.

While the high-quality development of the regional economy plays a moderating role in digital financial inclusion and industry chain resilience, it also has the potential to have an impact on other related elements, increasing its own moderating effect. This was evident from the perspective of the control variables, where the estimated coefficients of most of the control variables remained significant after the moderator factors were added to the model.

4.4. Heterogeneity Test

4.4.1. Regional Heterogeneity

To further verify the regional heterogeneity of the influence of digital financial inclusion on industry chain resilience, the 31 provinces were separated into three samples: east, middle, and west. Table 7 presents the findings. The results of the regional heterogeneity regression showed that in the eastern region, digital financial inclusion had the greatest impact on industry chain resilience, whether or not the control variables were added. In the eastern region, the impact coefficients were higher than those in the middle and western regions, and they were all significant and positive at the 1% level. In the middle and western regions, however, the impact coefficients were lower, and their significance even seems to have decreased in the western region. This suggests that regional heterogeneity in the promoting effect of digital financial inclusion on industry chain resilience was evident across the three regions of east, middle, and west.

Table 7. Regional heterogeneity test results.

	(1) East	(2) Mid	(3) West	(4) East	(5) Mid	(6) West
Dif	0.025 *** (0.003)	0.010 *** (0.003)	0.016 *** (0.002)	0.030 *** (0.005)	0.025 * (0.014)	0.008 (0.007)
control variable	no	no	no	yes	yes	yes
fixed effect	yes	yes	yes	yes	yes	yes
N	99.000	72.000	108.000	99.000	72.000	108.000
R ²	0.447	0.212	0.356	0.633	0.518	0.577

Note: *, *** indicate statistical significance at the 10% and 1% levels, respectively. Parentheses indicate robust standard errors.

4.4.2. Quantile Heterogeneity

Using quantile regression models, we tested the sensitivity of the stages of the industrial chain to digital inclusive finance, to deepen our understanding of the relationship between digital inclusive finance and industry chain resilience. Specifically, we selected 10%, 25%, 50%, 75%, 80%, and 90% as important quantile points and analyze the impact of digital inclusive finance on the different quantile points of industry chain resilience. The results are shown in Table 8. At each quantile point, the impact of digital inclusive finance on industry chain resilience was statistically significant and positive at the 1% level. A further comparison of the estimated coefficients at each quantile point revealed that as the quantile points increased, the impact of digital inclusive finance on industry chain resilience tended to increase. At the 80% quantile point, the positive promotional effect of digital inclusive finance on industry chain resilience reached its maximum value of 0.05, and at the 90% quantile point, the estimated coefficient decreased to the same level as that at the 70% quantile point.

Table 8. Quantile heterogeneity test results.

	(1) 10%	(2) 25%	(3) 50%	(4) 75%	(5) 80%	(6) 90%
dif	0.025 *** (0.005)	0.034 *** (0.005)	0.041 *** (0.007)	0.046 *** (0.012)	0.050 *** (0.017)	0.046 *** (0.014)
control variable	Yes	yes	yes	yes	yes	yes
N	279.000	279.000	279.000	279.000	279.000	279.000
R ²	0.396	0.414	0.417	0.414	0.418	0.458

Note: *** indicate statistical significance at the 1% levels, respectively. Parentheses indicate robust standard errors.

5. Conclusions and Policy Recommendations

This study empirically investigated the impact of digital inclusive finance on industry chain resilience and its mechanisms, using provincial panel data from 2013–2021. The following four main research conclusions were drawn: (1) Industry chain resilience was found to be significantly enhanced by digital inclusive finance, and this finding remained true even after performing numerous robustness tests. Utilizing its three key components—digitization, inclusivity, and finances—digital inclusive finance has enhanced the resistance and recovery ability of China’s industry chain in the face of external shocks. (2) Industrial structure optimization and technical innovation are the two avenues through which the positive impact of digital inclusive finance on industry chain resilience can be achieved. In particular, digital inclusive finance can contribute to the mediating effect by fostering an advanced and rationalized industrial structure as well as increasing the potential for technological innovation, all of which will strengthen industry chain resilience. (3) The

high-quality development of the regional economy can help the industrial chain overcome obstacles, strengthen its integrity and stability, make it easier for digital inclusive finance to assist businesses in finding solutions, and give the process of using digital inclusive finance a significant boost in order to increase industry chain resilience. All of these factors have a positive moderating effect. (4) The impact of digital inclusive finance on industry chain resilience exhibited both quantile and regional heterogeneity. The eastern region played a particularly prominent role, while the middle and western regions each played relatively weak one. When the resilience level of the industry chain was low, the promotional role of digital inclusive finance gradually increased as the resilience level of the industry chain improved, but when the resilience level of the industry chain reached a certain threshold, the promotional role of digital inclusive finance tended to weaken.

Drawing from the aforementioned conclusions, this article proposes the subsequent policy recommendations:

Firstly, it is necessary to vigorously develop digital inclusive finance and fully leverage its positive role in promoting and enhancing industry chain resilience. In general, we should enhance the level of inclusive finance technology, build a healthy digital inclusive finance ecosystem, and improve the regulatory system for digital inclusive finance on multiple levels to ensure the healthy and rapid development of digital inclusive finance and promote its deep integration with industrial chains to reduce the regional disparities in digital inclusive finance; at the same time, we need to formulate differentiated policies for the development of digital inclusive finance for different regions at different stages of the resilience development of industrial chains.

Secondly, it is recommended to optimize regional industrial structures, implement a strategy of innovation-driven development, and establish a transmission mechanism to enhance industry chain resilience. On the one hand, we should continuously optimize the regional industrial structure to promote the healthy and coordinated development of primary, secondary, and tertiary industries. On the other hand, we should vigorously promote the deep integration of digital and intelligent technologies, green technologies, and the real economy, using technological innovation to lead industrial innovation and ultimately drive changes in regional production modes and development patterns.

Thirdly, we must continuously enhance the level of high-quality economic development in regional areas, strengthening its positive regulation effect on industry chain resilience. At the micro level, it is necessary to integrate and optimize the allocation of resources and factors across the entire industrial chain and increase the effective supply of resources and medium- and high-end supply, thus promoting the enhancement of total factor productivity in each region; at the macro level, we should accelerate the construction of a unified national market, promote the efficient flow of factors of production across regions, improve production efficiency, and ultimately promote high-quality economic development in regional areas.

There are two main aspects to the research deficiencies and prospects of this study. First, the empirical data only covered the period up to 2021. Due to restricted availability, data for 2022 and 2023 were, unfortunately, not fully compiled. Once the data have been updated, the research work described in this paper will be continued. Second, despite this study deconstructing the concept and connotation of digital inclusive finance and industry chain resilience and attempting to establish a scientific system of evaluating industry chain resilience from multiple perspectives, the evaluation system utilized can still be further enhanced and optimized, subject to data availability. Therefore, future comprehensive evaluations of industry chain toughness will be more detailed and targeted in terms of index system design.

Author Contributions: Writing—original draft preparation, L.H. and F.C.; writing—review and editing, L.H., F.C. and R.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the National Social Science Fund of China (Grant number: 20BJL113), Hunan Natural Science Foundation Project (Grant number: 2024JJ5169), and the Project of Hunan Provincial Department of Education (Grant number: 22A0335).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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