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Research on the Effect of Digital Economy Development on Local Financial Pressure

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ABSTRACT

The vigorous development of the digital economy provides a new research perspective for alleviating local financial pressure. Based on the provincial panel data from 2013 to 2020, the mediating effect model and threshold regression model were used to explore the effect and mechanism of the digital economy on local fiscal pressure. The research shows that the digital economy has a significant alleviating effect on local financial pressure by increasing fiscal revenue, and this alleviating effect has a threshold effect on entrepreneurial activity. From the perspective of dimension, the alleviating effect of the digital economy development environment on local financial pressure is better than that of digital industrialization and industrial digitization. From a regional perspective, the digital economy has the most apparent impact on the western region. In addition, the quantile regression results show that with the increase in financial pressure, the easing effect of the digital economy shows an inverted U-shaped change. Therefore, in order to effectively alleviate the financial pressure on local governments, China should continue to promote the development of the digital economy, take multiple measures to increase entrepreneurial activity, and encourage various regions to implement differentiated digital economy development strategies according to local conditions.

KEYWORDS

Digital economy; Local financial pressure; Fiscal revenue; Degree of entrepreneurial activity

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1. Introduction

In recent years, China's economic growth has gradually slowed down due to the uncertainty of the global economic trend and the COVID-19 epidemic situation. On this basis, economic development policies with tax and fee reductions as the central theme further affect the fiscal revenue scale of local governments in China (Guo and Shi, 2021; Yang et al., 2022). At the same time, the rigid fiscal expenditure is not reduced, and the pressure on local government debt principal and interest payment is increased, which aggravates the contradiction between local fiscal revenue and expenditure and severely tests fiscal sustainability (Makin and Layton, 2021). As Lou Jiwei said at China's Fifth Forum on Finance and National Governance: "China's fiscal situation is extremely grim, with huge risks and challenges." The vigorous development of the digital economy provides a new research perspective for alleviating local financial pressure. China's digital economy has achieved rapid growth even under the combined impact of the economic downturn and the pandemic. In 2020, the scale of China's digital economy grew to 39.2 trillion yuan, with nominal year-on-year growth of 9.7%, including a 5.3% growth in digital industrialization and a 10.3% growth in industrial digitalization. Then, can the digital economy relieve local financial pressure, and how is its transmission mechanism? This is the question that this paper intends to explore and solve.

Theoretical research on the digital economy can be traced back to the 1990s. Tapscott (1996) first mentioned the concept of "digital economy" in his book "Digital Economy: Hope and Risk in the Era of Intellectual Interconnection" (Bowman, 1996). With the progress of science and technology, the digital economy has also accelerated its integration with the traditional economy, thus affecting economic development and real economic problems (Ding et al., 2021; Zhang et al., 2021). In addition, academic research on the measurement system (Mesenbourg ,2001; Bukht and Heeks, 2018; Barefoot et al., 2018) and the impact effect (Popkova and Gulzat, 2019; Bulturbayevich and Jurayevich, 2020; Abdurakhmanova et al., 2020) of the digital economy is also flourishing. It is generally believed that the development of the digital economy can effectively promote the upgrading of industrial structure (Su et al., 2021), improve innovation efficiency (Sultana et al., 2021; Pan et al., 2022) and narrow the gap between urban and rural areas (Wang et al., 2021; Braesemann et al., 2022). In the research on the fiscal and tax effects of digital economy development, the existing literature mainly focuses on the impact of the digital economy on local government tax revenue (Akdogan, 2021; Popkova et al., 2019) and fiscal sustainability, which indirectly indicates the impact of digital economy development on local fiscal pressure. Local fiscal pressure reflects the tension between regional fiscal revenue supply and fiscal expenditure demand, which to a certain extent reflects the great degree of local financial resources and economical operation. Therefore, the positive impact of the digital economy on macroeconomic scale, industrial structure and development momentum is conducive to promoting fiscal revenue increase and optimizing fiscal expenditure, thus achieving the effect of alleviating local fiscal pressure. At the same time, the rapid development of the digital economy also intensifies the divergence between tax revenue and economic activities among regions, which is not conducive to narrowing the financial gap between regions and is difficult to alleviate the financial pressure in some regions (Li, 2015; Peng, 2016). Based on this, this paper starts by examining the impact of the digital economy on local financial pressure, which is helpful to explore the alleviating path of financial pressure further and ensure the sustainable development of local finance in China.

To sum up, as a hot research issue, the theoretical connotation, measurement system and economic effect of the digital economy have been studied in detail. Some scholars have also begun to discuss the fiscal and tax effect of the digital economy, but few kinds of literature put the digital economy and financial pressure in the same research perspective. Based on this, with the help of China's provincial panel data from 2013 to 2020, this paper focuses on the impact and mechanism of digital economy development on local financial pressure. Compared with the existing literature, the possible innovations of this paper are as follows: Firstly, by constructing the index system of digital economy development level, Chinese province's digital level of economic development is measured, on this basis, the impact of digital economy development on local fiscal pressure is tested from the perspective of the

whole and sub-dimensions, which broadens the research angle of view in the field of the digital economy influence and enriches the relevant research on local fiscal pressure; Secondly, through the mediating effect of fiscal revenue and the threshold effect of entrepreneurial activity, the mechanism of the digital economy on local fiscal pressure is analyzed. According to the geographical location and the degree of financial pressure, it is of great significance to explore the heterogeneity of the impact of the digital economy on local financial pressure.

The following chapters are arranged as follows. The second part reviews relevant literature and puts forward research hypotheses. The third part describes the model design, variable selection and data sources; The fourth part tests the influence of the digital economy on local financial pressure based on the model. In the fifth part, the mediating effect model and a threshold regression model are used to analyze the influence mechanism of the digital economy to alleviate local financial pressure. Regional heterogeneity analysis and quantile regression were used to explore the influence of heterogeneity. The sixth part summarizes the research and puts forward corresponding policy suggestions.

2. Literature Review and Hypotheses Development

2.1. The Effect of Digital Economy on Local Financial Pressure

The digital economy has changed the mode of production and consumption of the macro-economy, profoundly reshaped the social and economical form, and provided a more efficient operation mode (Sadovaya, 2019). From the perspective of financial pressure, the digital economy is closely related to macroeconomic development, and the healthy development of macroeconomics will positively impact local financial pressure. Therefore, the digital economy and local financial pressure also interact. On the one hand, as an essential part of the macroeconomy, the rapid development of the digital economy helps expand the economic scale and optimize the economic structure (Chakpitak et al., 2018; Mardonakulovich and Bulturbayevich, 2020). According to the China Academy of Information and Communications Technology (CAICT), the proportion of China's digital economy in GDP grew from 14.2 per cent to 38.6 per cent between 2005 and 2020. In addition, the digital economy can effectively reduce market transaction costs and expand market transaction scale by virtue of its convenience and external economy (Vovchenko et al., 2017). The orderly expansion of market size helps conserve tax sources, expand the tax base, and relieve the pressure on local fiscal revenue and expenditure. At the same time, it can enhance the debt-bearing capacity of the economy and reduce the pressure on the government to issue additional debt. On the other hand, developing the digital economy helps to expand employment and entrepreneurial opportunities (Ogli and Ogli, 2021; Sahut et al., 2021), improve residents' welfare level, promote residents' income level and self-security ability (Barefoot et al., 2018), and thus relieve the expenditure pressure of local governments on social security and employment. Therefore, developing the digital economy can effectively relieve local financial pressure. However, as a new business form and model of economic development, the digital economy's rapid development will also impact the existing financial system and tax rules, thus affecting its alleviating effect on local financial pressure (Peng, 2016). Specifically, the intensification effect of the digital economy on the degree of production agglomeration brings new challenges to determining consumption locations and dividing consumption amounts. Digital economy to take advantage of the cross-regional sales business model for the seat of consumers to create tax sources of tax revenue, further exacerbated the source of income and profit creation deviation degree, the deviation of the resulting in a certain extent weakened the digital economy effect on local fiscal pressures (Bauer et al., 2019; Olbert and Spengel, 2017). The digital economy tax deviation problem is essentially a mismatch between new things and the original system. With the increasing attention to the digital economy from all walks of life, Chinese government departments have noticed the negative impact of the digital economy. Furthermore, gradually improve the relevant policies and regulations and increase the balance between regional transfer payments to avoid excessive financial

pressure in local areas (Terada-Hagiwara et al., 2019; Tianyu and Tongwei, 2021). At the same time, the easing trend of the financial pressure on local governments in China in recent years also provides a realistic basis for the fiscal pressure relief effect of the digital economy. Accordingly, hypothesis 1 is proposed in this paper.

Hypothesis 1. The digital economy development could relieve local financial pressure.

2.2. Mediating Effect of Digital Economy on Local Financial Pressure

The impact of digital economy development on local financial pressure is mainly reflected in fiscal revenue increases. First, the digital economy will boost national economic development and increase fiscal revenue. Both neoclassical and endogenous growth theories indicate that technological progress is an essential factor affecting long-term economic growth. The digital economy is a typical representative of the current stage of technological progress, its importance to economic growth is self-evident. The digital economy can promote economic development by improving the construction of new digital infrastructure, empowering the traditional real economy and giving birth to new business forms and models based on its characteristics of high innovation, strong permeability and comprehensive coverage (Kuzmina et al., 2020; Urinovich et al., 2021). The positive impact of the digital economy on economic development plays a role in conserving tax sources and making up for financial losses caused by tax and fee reductions. Second, the digital economy promotes consumer spending and increases fiscal revenue. Using an e-commerce platform as the carrier, the digital economy breaks the time and space limitation of consumption, broadens consumption channels and facilitates consumption modes, and the new consumption formats generated by it further improve residents' consumption willingness and stimulate consumption potential (Dahlman et al., 2016; Mützel, 2021). In addition, with its digital information technology, the digital economy can effectively alleviate the problem of information asymmetry, reduce transaction costs, and improve the level and quality of residents' consumption (Sultana et al., 2021), thereby helping to expand the commodity tax base and increase local fiscal revenue. Third, the digital economy will drive investment growth and increase fiscal revenue. On the one hand, the digital economic development helps to deepen the financial credit services, promote the development of financial institutions to digital, Pratt & Whitney, pratt & whitney financial further broadening the investment subject of financing channels and reduce the cost of financing, help to relieve the external financing constraints of small and medium-sized micro investment main body, which can effectively solve the problem of inadequate investment (Lu et al., 2022). On the other hand, the development of digital economy-related technologies can broaden the depth and breadth of investment information acquired by investment subjects, reduce the uncertainty and asymmetry of investment information, improve the accuracy and objectivity of investment, and thus improve the efficiency of investment (Ogli and Ogli, 2021; Khomenko and Ruzhnikov, 2019). Efficient investment improves the profit level of the investment subject, which is conducive to expanding the income tax base and promoting fiscal revenue. In summary, developing the digital economy can help increase fiscal revenue and safeguard local financial resources, and substantial financial resources are critical in relieving local financial pressure. Accordingly, hypothesis 2 is put forward in this paper.

Hypothesis 2. The digital economy development alleviates local financial pressure by increasing fiscal revenue.

2.3. The Threshold Effect of Digital Economy on Local Financial Pressure

The entrepreneurial activity reflects the overall development level of the entrepreneurial economy in a region and also represents the region's economic activity to a certain extent (Stel et al., 2005; Kuckertz et al., 2016). There is a strong interaction between the development of the digital economy and entrepreneurship activity. The active innovation and entrepreneurship environment is conducive to the deep integration of digital technology and the traditional economy and the accelerated transformation of the production value of digital factors, thus promoting

the vigorous development of the digital economy (Askerov et al., 2018), and the prosperous digital economy provides more entrepreneurial opportunities. It can further stimulate the improvement of regional entrepreneurial activity (Rybakova and Nazarov, 2021). Therefore, the level of entrepreneurial activity may affect the digital economy's financial pressure relief effect. Furthermore, when the degree of entrepreneurial activity is low, the process of industrial digitalization and digital industrialization is slow, and the degree of regional digitalization is low. The digital economy is challenging to promote macroeconomic development by promoting resident consumption and investment growth, which limits the fiscal revenue increase effect of tax source preservation and tax base expansion. In addition, when the level of entrepreneurial activity is low, the development of the digital economy still needs government incentives and support, which will increase the government's expenditure on the construction of the digital economy, so it is difficult to relieve the pressure on local fiscal revenue and expenditure. Only when the entrepreneurial activity reaches the threshold value, the market vitality can be released, and the flow and accumulation of digital factors will accelerate, which is helpful to stimulate the scale economy benefits of the digital economy, to realize the fiscal revenue increase effect of the digital economy and relieve the local financial pressure (Askerov et al., 2018).

Hypothesis 3. The impact of digital economy development on local financial pressure may have a threshold effect on entrepreneurial activity.

2.4. Heterogeneous Effect of Digital Economy on Local Financial Pressure

Considering the significant differences in resource endowment, economic development, own financial resources, and new digital infrastructure construction among provinces in China, the effect of the digital economy on financial pressure may exist in regional heterogeneity. Generally speaking, for the eastern provinces of China, with superior geographical location, relatively high degree of economic development, and relatively complete new digital infrastructure, their financial pressure is generally low, and the pressure relief potential has been developed to a high degree (Tianyu and Tongwei, 2021). Therefore, the impact of the digital economy on the financial pressure of eastern provinces is no different from "icing on the cake". On the contrary, the financial pressure of western provinces is generally higher than that of central and eastern provinces (Lin and Zhou, 2021), and their economic level and consumption potential also need to be further improved. This region has a substantial development space and latecomer advantage. In addition, the digital economy has a good catch-up effect (Malerba and Lee, 2021). The western region can use its advantage of increasing marginal returns to improve the digital economy's alleviating effect on local financial pressure. Therefore, the alleviating effect of the digital economy on financial pressure is more likely to play the "timely help" effect in the western region. At the same time, different regions also have significant differences in consumption level, investment intensity and entrepreneurial activity, which may also lead to heterogeneity in the impact of the digital economy on local fiscal pressure.

Accordingly, hypothesis 4 is put forward in this paper.

Hypothesis 4. Digital economy development has regional heterogeneity in alleviating local financial pressure.

3. Data and Methodology

3.1. Model Specification

Based on the above influence mechanism analysis, the panel data model is used to investigate the impact of the digital economy on local fiscal pressure, and the following benchmark regression model is constructed:

$$F - Pressure_{it} = \alpha_0 + \alpha_1 D - Economy_{it} + \alpha_2 Control_{it} + \gamma_i + \eta_t + \varepsilon_{it} \quad (1)$$

Among them, F-Pressureit represents the financial pressure of province i in year t; D-Economyit refers to the

development level of the digital economy. Controlit for control variables; γi is province fixed effect; ηt denotes year fixed effects; εit is the random interference term.

In order to verify the influence mechanism of the digital economy on local fiscal pressure, fiscal revenue was taken as the intermediary variable to construct the following regression model:

$$F - Revenue_{it} = \beta_0 + \beta_1 D - Economy_{it} + \beta_2 Control_{it} + \gamma_i + \eta_t + \varepsilon_{it} \quad (2)$$

$$F - Pressure_{it} = \xi_0 + \xi_1 D - Economy_{it} + \xi_2 F - Revenue + \xi_3 Control_{it} + \gamma_i + \eta_t + \varepsilon_{it} \quad (3)$$

Here, F-Revenueit stands for fiscal revenue.

To further explore the impact of entrepreneurial activity on the financial pressure relief effect of the digital economy, the following threshold regression model is constructed:

$$F - Pressure_{it} = \omega_0 + \omega_1 D - Economy_{it} * I(E - Activity_{it} \leq \delta) + \omega_2 D - Economy_{it} * I(E - Activity_{it} > \delta) + \omega_3 Control_{it} + \gamma_i + \eta_t + \varepsilon_{it} \quad (4)$$

Where, I(•) denotes the representational function, where the value of the expression in parentheses is 1 when it is true, and 0 otherwise; E-Activityit stands for entrepreneurial activity; δ is the threshold value.

3.2. Variable Selection

3.2.1. Explained Variable

The explained variable in this paper is local financial pressure. The financial pressure mainly manifests as the monetary funds do not pay and the emergence of specific liquidity difficulties. At present, the academic community generally chooses the index "fiscal gap" to represent the local financial pressure, namely the ratio of the general public budget revenue and expenditure gap to GDP (Bai et al., 2019).

3.2.2. Core Explanatory Variable

This paper's core explanatory variable is the digital economy's development level (D-economy). Presently, there is much research on measuring the digital economy's development level with different emphases (Kokh Larisa and Kokh Yuriy, 2019; Ahmad and Ribarsky, 2018). Based on the connotation of the digital economy and data availability, and referring to the current literature research results, the indicator system of the digital economy development level is constructed from three dimensions: digital economy development Environment (D-environment), digital industrialization (D-industry) and Industry Digitization (I-Digitization) (Table 1).

Using the entropy method to measure the development level of the digital economy can effectively avoid the deviation caused by subjective factors. Based on the index weight and the index value after standardized processing, the digital economy development index and three sub-dimension indexes of digital economy development environment, digital industrialization and industrial digitization are calculated after multiplication and accumulation. From 2013 to 2020, the development level of China's digital economy has been on the rise. In addition to the sub-dimension of the digital economy development environment index, which declined slightly in 2020, the sub-dimension index of digital industrialization and industrial digitalization has also been increasing year by year, which is closely related to China's attention and support for the development of digital economy in recent years.

It can be seen from Table 2 that the development of the digital economy in China is not balanced. The average annual development level of the digital economy in the eastern region is significantly higher than that in the central and western regions, and especially the western region still has ample space for development. In addition, the digital economy development level of Guangdong, Beijing, Jiangsu and other provinces in the eastern region is at the forefront of the country, much higher than in other regions in China.

Table 1. The indicator system of the digital economy development level.

First Level Indicators	Second Level Indicators	Unit	Weight	Indicator Direction
D-Environment (31.81%)	1. Mobile Phone Penetration	Number of Possessions Per Hundred People	2.29%	+
	2. Number of Broadband Internet Access Ports	Ten Thousand	4.27%	+
	3. Internet Domain Name	Ten Thousand	8.79%	+
	4. Number of Invention Patent Applications	Piece	8.67%	+
	5. Public Expenditure on Science and Technology	Billion Yuan	7.79%	+
D-Industry (42%)	6. Total Telecom Business	Billion Yuan	7.76%	+
	7.Software Business Revenue	Billion Yuan	11.97%	+
	8.Output Value of Information Services	Billion Yuan	10.52%	+
	9.Total Value of Technical Contract	Billion Yuan	11.75%	+
I-Digitization (26.19%)	10. Expenditures for Technological Renovation of Industrial Enterprises Above Designated Size	Billion Yuan	5.79%	+
	11.Personnel in R&D Projects of Industrial Enterprises Above Designated Size Shall Be Equivalent to Full-time Personnel	Number of People Per Year	9.22%	+
	12.E-commerce Sale	Billion Yuan	9.06%	+
	13.Digital Financial Inclusion Index	—	2.12%	+

Table 2. Average annual digital economy development level of China's provinces (municipalities, autonomous regions) from 2013 to 2020.

Regions	D-Economy	Regions	D-Economy	Regions	D-Economy
Eastern region	0.256	Western region	0.073	Central region	0.105
Beijing	0.435	Inner Mongolia	0.053	Shanxi	0.066
Tianjin	0.101	Guangxi	0.080	Jilin	0.064
Hebei	0.107	Chongqing	0.096	Heilongjiang	0.062
Liaoning	0.122	Sichuan	0.169	Anhui	0.149
Shanghai	0.268	Guizhou	0.067	Jiangxi	0.079
Jiangsu	0.427	Yunnan	0.066	Henan	0.143
Zhejiang	0.320	Shaanxi	0.116	Hubei	0.151
Fujian	0.172	Gansu	0.048	Hunan	0.125
Shandong	0.273	Qinghai	0.028		
Kwangtung	0.556	Ningxia	0.036		
Hainan	0.040	Xinjiang	0.046		

3.2.3. Control Variables

In order to alleviate the endogeneity caused by omitted variables, we refer to academic studies on financial pressure (Yang et al., 2022; Kou and Han, 2021) and select Industry structure, Urbanization rate, Population density and Consumption level as control variables. Among them, the industrial structure is measured by the proportion of the added value of the tertiary industry in GDP. The urbanization rate is represented by the ratio of the permanent urban population to the total population at the end of each province. The population density was measured by the logarithm of the ratio between the resident population and each province's area at the year's end. Consumption level is measured by the logarithm of consumption expenditure per provincial resident.

3.2.4. Metavariable

The F-revenue is selected as the metavariable of the influence of digital economy development on local financial pressure, and measured by per capita general public budget revenue.

3.2.5. Threshold Variable

Entrepreneurial Activity (e-activity) is selected as the threshold variable of digital economy development affecting local financial pressure, which is measured by the number of private enterprises with 10,000 people.

3.3. Data Specification

Based on data availability, this paper selects panel data of 30 provinces in China from 2013 to 2020 (excluding Tibet, Hong Kong, Macao and Taiwan). Among them, the Digital Financial Inclusion Index comes from the Digital Financial Inclusion Index of Peking University, compiled by the Digital Finance Research Center of Peking University. Other index data are from China Science and Technology Yearbook, China Statistical Yearbook, China Electronic Information Industry Yearbook, China Population and Employment Statistical Yearbook, China Electronic Information Industry Yearbook, provincial statistical yearbooks and EPS database. Descriptive statistics of each variable are shown in Table 3.

Table 3. Variable description and statistical analysis.

Variable	Description	Samples	Mean	SD	Min	Max
F-Pressure	Local Financial Pressure	240	0.144	0.104	0.013	0.544
D-Economy	Digital Economy Development Index	240	0.149	0.143	0.016	0.852
D-Environment	Digital Economy Development Environment	240	0.176	0.155	0.028	0.881
D-Industry	Industrialization of Digital	240	0.111	0.140	0.010	0.865
I-Digitization	Digitization of Industry	240	0.176	0.156	0.011	0.996
Industry	The Industrial Structure	240	0.491	0.090	0.342	0.839
Urbanization	Urbanization Rate	240	0.595	0.116	0.378	0.896
Population	The Population Density	240	5.467	1.284	2.081	8.281
Consumption	Consumption Levels	240	9.736	0.340	9.023	10.728
F-Revenue	Fiscal Revenue	240	0.704	0.536	0.235	2.951
E-Activity	Degree of Entrepreneurial Activity	240	90.14	70.653	13.254	455.341

4. Empirical Results and Analysis

4.1. Benchmark Regression Analysis

According to the Hausman test, the sample data are more suitable for the analysis by the fixed effects model. As shown in the regression results in Table 4, under the premise of controlling individual effect and time effect, the digital economy can alleviate local financial pressure at the significance level of 1% regardless of whether control variables are added. Taking column (2) of Table 4 as an example, an increase of one unit in the digital economy can relieve local financial pressure by 0.096 units on average. In terms of control variables, the coefficient of industrial structure is significantly positive, indicating that the upgrading of industrial structure at the present stage will lead to an increase in local financial pressure, which may be caused by China's large number of preferential policies for some tertiary industries. Currently, China has formulated relatively preferential solid tax policies for the bio-active service industry, small loan companies and high-tech enterprises. The coefficient of population density and consumption level is significantly negative, indicating that the increase in population density and consumption level will help relieve the pressure on local finance. The reason may be that the increase in population density and the

improvement of consumption level promote the economic and social development of the region to a certain extent and then play the role of preserving the tax source and expanding the tax base. In addition, the increase in population density also encourages the Chinese government to rationally plan the direction and scale of fiscal expenditure and optimize the structure of fiscal expenditure. The increase in the urbanization rate can also alleviate the pressure on local finance, but the effect is not significant. The reason may be that the overall development speed of urbanization in China has been relatively low in recent years, and it is necessary to continue promoting new urbanization. Further from the digital economy development environment, digital industrialization and industrial digitization are three dimensions to analyze the digital economy on the local financial pressure effect. The regression results show that the three dimensions of the digital economy can significantly alleviate the local financial pressure, but their alleviating effects are different. Among them, the development environment of the digital economy has the best alleviating effect, followed by digital industrialization, and industry digitization has the most negligible effect. This shows that the optimization of the development environment of the digital economy at the present stage can still effectively promote economic development, promote residents' consumption, and reduce the pressure on local finance. In the influence effect of sub-dimension test, the influence of control variables did not change significantly.

Table 4. Benchmark regression results.

Variables	(1) F-Pressure	(2) F-Pressure	(3) F-Pressure	(4) F-Pressure	(5) F-Pressure
D-Economy	-0.136*** (0.026)	-0.096*** (0.027)			
D-Environment			-0.082*** (0.023)		
D-Industry				-0.077*** (0.022)	
I-Digitization					-0.049* (0.027)
Industry		0.176*** (0.051)	0.186*** (0.051)	0.175*** (0.051)	0.205*** (0.052)
Urbanization		-0.088 (0.097)	-0.010 (0.091)	-0.097 (0.099)	-0.030 (0.101)
Population		-0.201*** (0.040)	-0.228*** (0.038)	-0.200*** (0.040)	-0.223*** (0.041)
Consumption		-0.097*** (0.031)	-0.091*** (0.032)	-0.105*** (0.031)	-0.098*** (0.032)
Constant Term	0.164*** (0.004)	2.166*** (0.321)	2.210*** (0.319)	2.233*** (0.319)	2.248*** (0.332)
Time Effect	Yes	Yes	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes	Yes	Yes
Observation	240	240	240	240	240
R^2	0.980	0.985	0.985	0.985	0.984

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

4.2. Robustness Test

In order to verify the stability and scientificity of the above research results, this paper conducted a robustness test from three aspects: data, variables and measurement methods. In terms of data, two methods, namely, tail reduction and sample elimination, were used for testing. Among them, the curtailed treatment means that the main explanatory variables are curtailed by 1%, which can eliminate the adverse effects caused by outliers to a certain extent. The results are shown in column (1) of Table 5. Sample elimination refers to considering China's

municipalities' special status and policy bias directly under the central government. After removing the sample data of Beijing, Shanghai, Tianjin and Chongqing, regression is conducted. The results are shown in column (2) of Table 5. In terms of variables, the robustness test is carried out by replacing the measurement method of the digital economy development index. Precisely, based on the index system of the digital economy development level constructed in Table 1, the development level of the digital economy is measured by the principal component analysis method, and then the regression is performed. The KMO test result of index data was 0.86, and the approximate chi-square of the Bartlett spherical test was 4157.17 (P<0.01), which met the preconditions of principal component analysis. The test results are shown in column (3) of Table 5. In terms of measurement methods, considering the continuity of local financial pressure, a lag term of local financial pressure was added to the regression model (1) to construct a dynamic panel model, and the lag period 2-3 of local financial pressure was taken as an instrumental variable to carry out one-step system GMM estimation. Among them, AR (2) test results show no serial-related problem in the model set, and Hansen test results confirm the validity of instrumental variables of the model. The test results are shown in column (4) of Table 5. The above robustness test results show that no matter what test method is adopted, the development of the digital economy has significantly alleviated the local financial pressure, which is basically consistent with the above analysis results, indicating that the benchmark regression results are stable and effective.

Table 5. Results of robustness test.

Variables	(1) Winsorization	(2) Eliminating samples	(3) PCA (principal component analysis)	(4) GMM
D-Economy	-0.124*** (0.030)	-0.094*** (0.028)	-0.025*** (0.005)	-0.019* (0.010)
L.F-Pressure				0.965*** (0.056)
Constant Term	2.050*** (0.315)	2.577*** (0.336)	2.075*** (0.317)	0.012 (0.023)
AR(2)	——	——	——	0.601
Hansen	——	——	——	0.208
Control Variables	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes	Yes
Observation	240	208	240	210

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

4.3. Endogenous

Endogeneity affects the accuracy of regression results to a large extent. The main reasons for endogeneity are the bidirectional causality between the digital economy and local financial pressure and the omission of variables. Based on this, the interaction terms between the number of fixed phones per 100 people (Tele) and the number of Post offices per million people (Post) in 1984 and the number of Chinese Internet users in the previous year were constructed as instrumental variables of the digital economy development index. The local historical communication facilities will affect the subsequent application of digital technology, and the effect of the influence is decreasing. Therefore, selecting the above instrumental variables meets the requirements of correlation and exclusivity. Considering that the number of fixed-line telephones per 100 people and the number of post offices per million people in 1984 are cross-sectional data, it is difficult to apply to the regression analysis of panel data directly.

Therefore, the interaction term between the number of Internet users in China in the previous year is constructed as the instrumental variable of the digital economic development index in that year. The results of the endogeneity test are shown in Table 6. After considering the possible problems of mutual causality and omitted variables in the model, the alleviating effect of digital economy development on local financial pressure is still significant, which further verifies the robustness of the regression results.

Table 6. Endogeneity test based on 2SLS instrumental variable method.

Variables	(1) D-Economy	(2) F-Pressure	(3) D-Economy	(4) F-Pressure
D-Economy		-0.104** (0.041)		-0.085** (0.042)
Tele Phase One	0.000*** (0.000)			
Post Phase One			0.000*** (0.000)	
Constant Term	-3.768*** (0.739)	2.574*** (0.368)	-1.381* (0.787)	2.643*** (0.370)
Control Variables	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes	Yes
Observation	240	240	240	240

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

5. In-depth Exploration

5.1. Influencing Mechanism Analysis

According to the three-step stepwise regression method of mediating effect test, the influence mechanism of the digital economy alleviating local financial pressure is tested. Columns (1) - (3) of Table 7 report the test results of stepwise regression, where column (1) is the test result of the total effect, and columns (2) and (3) reflect the estimation results of the mediation effect. The regression results show that the development of the digital economy has a significant alleviating effect on financial pressure. Further, the regression coefficient of the digital economy on financial pressure changes from -0.096 to -0.073 after increasing the intermediary variable of fiscal revenue, and the impact of the digital economy on fiscal revenue is significantly positive. This indicates that fiscal revenue plays a mediating role in the digital economy alleviating local financial pressure, and the mediating effect is -0.023 (-0.027×0.844), the total effect is -0.096, and the mediating effect accounts for 23.96%. In order to accurately identify the mechanism of the digital economy affecting financial pressure, the interaction term between the number of fixed phones per 100 people in 1984 and the number of Internet users in the previous year was still selected as an instrumental variable to test the endogeneity of the mediating effect. The results are shown in columns (4) and (5) of Table 7. After adopting instrumental variables for estimation, the transmission path of mediating effect of "digital economy → fiscal revenue → local fiscal pressure" is consistent with the benchmark regression. Therefore, the digital economy alleviates local financial pressure by increasing fiscal revenue, and Hypothesis 2 is tested.

The threshold regression model was used to explore further the impact of entrepreneurial activity on the financial pressure relief effect of the digital economy. Before regression analysis, the existence of the threshold is tested first. After 500 times of sampling by the Bootstrap autonomous sampling method, the results show that entrepreneurial activity passes the single threshold test at the 10% level but does not pass the double threshold

and triple threshold test at the 10% level, with the corresponding threshold value of 52.11. The regression results are shown in column (6) of Table 7. When the entrepreneurial activity is less than or equal to the threshold value of 52.11, the development of the digital economy increases local financial pressure; when the entrepreneurial activity is higher than the threshold value of 52.11, the regression results are reversed, and the impact of digital economy development on local financial pressure is negative, but not significant. Therefore, there is a threshold effect of entrepreneurial activity on the impact of digital economy development on local financial pressure, and there are apparent differences in the impact of different stages. The reason may be that when the level of entrepreneurial activity is low, the development of the digital economy needs financial and policy support from the government, so it is difficult to achieve the effect of alleviating financial pressure. Only after the entrepreneurial activity has developed to a certain extent can the vitality of the digital economy be stimulated, and the alleviating effect on financial pressure will appear. In conclusion, hypothesis 3 can be tested.

Table 7. Test results of mediating effect and threshold effect.

Variables	(1) F-Pressure	(2) F-Revenue	(3) F-Pressure	(4) F-Revenue	(5) F-Pressure	(6) F-Pressure
D-Economy	-0.096*** (0.027)	0.844*** (0.165)	-0.073** (0.078)	0.881*** (0.255)	-0.082* (0.044)	
F-Revenue			-0.027** (0.011)		-0.025** (0.011)	
Tele Phase One				0.000*** (0.000)	0.000*** (0.000)	
D-Economy·I ($R\leq\delta_1$)						0.118*** (0.043)
D-Economy·I ($R>\delta_1$)						-0.028 (0.023)
Constant Term	2.166*** (0.321)	1.465 (1.997)	2.206*** (0.318)	4.330* (2.540)	2.680*** (0.372)	1.175*** (0.236)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	——
Individual Effect	Yes	Yes	Yes	Yes	Yes	——
Observation	240	240	240	240	240	240

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

5.2. Regional Heterogeneity Analysis

Considering the different parts of China's endowment conditions and different development degrees, digital economy pressure on local finance effects in different areas, there may be differences in eastern, central and western regions by the standard of the geographical location of the sample points regression, test the influence of digital economy regional heterogeneity. According to the regression results in Table 8, there are significant differences in the three regions' alleviating effects of the digital economy on fiscal pressure. Specifically, the digital economy alleviates the financial pressure in the western region significantly better than in the eastern and central regions. This shows that the development of the digital economy helps to narrow the gap of financial pressure among different regions and fully reflects the late-mover advantage of the digital economy in western China. Hypothesis 4 is tested.

Table 8. Results of regional heterogeneity test.

Variables	(1) Eastern Region	(2) Central Region	(3) Western Region
D-Economy	-0.034* (0.019)	-0.382** (0.143)	-0.414*** (0.108)
Constant Term	0.106 (0.318)	3.774*** (0.701)	0.959 (0.604)
Control Variables	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes
Observation	88	64	88

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

5.3. Quantile Regression

Quantile regression has the advantage of mining intrinsic structural features from a large number of different samples. Furthermore, quantile regression is used to test whether there is heterogeneity in the financial pressure relief effect of the digital economy under different levels of financial pressure. The results show significant differences in the impact of the digital economy on local financial pressure at different quantiles, explicitly showing that the impact of the digital economy on both ends of the financial pressure is less than the impact of the middle part. This shows that with the continuous increase of quantile, the alleviating effect of the digital economy on local financial pressure shows an inverted U-shaped change, which first increases and then decreases. Fundamentally, it may be that the causes of the high degree of financial pressure are more complex, and the accumulation time is longer, while the financial pressure of the low degree of financial pressure has been relieved to a large extent, and there is little room for further relief, so the digital economy is not the best for its alleviation effect.

Table 9. Heterogeneity test results of financial pressure degree.

Variables	(1) Q20	(2) Q40	(3) Q60	(4) Q80
D-Economy	-0.078** (0.037)	-0.091*** (0.035)	-0.104*** (0.025)	-0.055* (0.032)
Constant Term	1.221** (0.501)	2.147*** (0.378)	1.523*** (0.451)	1.208 (0.435)
Control Variables	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes	Yes
Observation	240	240	240	240

*Note: ***, ** and * are significant at 1%, 5% and 10% levels, respectively; standard deviation in parentheses.*

6. Conclusions and Policy Recommendations

6.1. Conclusions

This article first elaborated on the digital economy from the aspects of theory and the mechanism of action to alleviate the pressure of the local finance, then to the Chinese provincial panel data from 2013 to 2020 as samples, using the fixed effect model, the mediation effect model, panel threshold regression model and quantile regression empirical model test of the digital economy pressure to local finance effect and the influence of the path. The main

conclusions are: First, the digital economy can effectively relieve local financial pressure. After a series of robustness tests and endogeneity discussions, the conclusion is still reliable. In terms of dimensions, the development environment of the digital economy has the most apparent mitigation effect, followed by digital industrialization, and industrial digitalization has the most negligible mitigation effect. Second, the digital economy can alleviate local financial pressure by increasing fiscal revenue, and the mediating effect accounts for 23.96%. Considering endogeneity, the transmission mechanism of "digital economy → fiscal revenue → local fiscal pressure" is still significant. Thirdly, there is a threshold effect of entrepreneurial activity on the alleviating effect of the digital economy on local financial pressure. Only when entrepreneurial activity reaches a certain level can the digital economy's alleviating effect on financial pressure be brought into play. Fourth, there is regional heterogeneity in the alleviating effect of the digital economy on local financial pressure, and the alleviating effect of the digital economy on financial pressure in western China is significantly more potent than that in eastern and central China. Fifth, there are differences in the alleviating effect of the digital economy on different degrees of financial pressure. With the increase in financial pressure, the alleviating effect of the digital economy shows an inverted U-shaped change.

6.2. Policy Recommendations

Based on the above conclusions, to further play the role of the digital economy in alleviating local financial pressure, this paper puts forward the following policy suggestions. First, the optimization of the development environment of China's digital economy at this stage has the most apparent effect on alleviating financial pressure. Therefore, we should promote the construction of new digital infrastructure and optimize the development environment of the digital economy through policy guarantees and financial support. Second, on the basis of giving full play to the advantages of the market in resource allocation, we will increase policy support and guidance to boost the enthusiasm for social entrepreneurship. In addition, we should vigorously develop inclusive digital finance and intellectual property pledge financing to alleviate financing constraints of start-ups and improve regional entrepreneurial activity to strengthen the digital economy's alleviating effect on local financial pressure. Third, given the regional heterogeneity of the impact of the digital economy on local fiscal pressures, the Chinese government should encourage various regions to implement differentiated digital economy development policies tailored to local conditions.

6.3. Limitations and Outlook

Although this paper uses various empirical methods to explore the impact of the digital economy on local fiscal pressure, there are still some shortcomings. On the one hand, based on data availability, this paper uses China's provincial panel data for empirical analysis, and the sample size is small, which may lead to sample bias. In the following research, we will try to obtain the city-level data of China or the county-level data of a particular region to expand the sample size and improve the accuracy of conclusions. On the other hand, this paper only discusses the overall effect, mediating effect, threshold effect and heterogeneity effect of the digital economy on local fiscal pressure, and does not test its spatial effect. The principle of spatial interaction points out a particular interaction between different regions. Considering the external economic development of the digital economy, it is reasonable to examine further the spatial effect of the digital economy on local financial pressure. In the future, we will try to use a spatial econometric model to test the spatial impact of the digital economy on local fiscal pressure in order to study the relationship between them more accurately and comprehensively.

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

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