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Research on the promotion effect of supply chain finance innovation on regional economy based on blockchain technology

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ABSTRACT

Supply chain finance innovation has a significant impact on regional economy. In this paper, blockchain technology is applied to supply chain finance business to improve the technology and security of traditional supply chain finance business. Drawing on relevant research results, we construct a blockchain-based supply chain financial innovation efficiency evaluation index system and measure the supply chain financial innovation efficiency using Malmquist index. A spatial econometric model is used to test the spillover effect and spatial synergy between supply chain financial innovation and regional economic growth, and to demonstrate the promotional effect of blockchain-based supply chain financial innovation on regional economic growth.The centres of the distribution curves of the kernel density function of the logarithmic value of GDP and supply chain financial innovation of the 30 provinces and regions are all shifted to the right, and the height of the main peak rises gradually.The 2013-2023 regional Moran's index of economic growth and supply chain financial innovation are both significantly positive. The regression coefficients of supply chain financial innovation under the two spatial weights are significant at the 1% level, which provides strong data support for the view that supply chain financial innovation can promote regional economic growth in this paper.

Keywords: blockchain, Moran index, spatial econometric model, spillover effect, supply chain finance

1. Introduction

Supply chain finance business relies on core enterprises and provides financial support for SMEs based on the real transaction background of enterprises in the chain. Under the background of financial technology, supply chain finance integrating blockchain technology can effectively improve the security and privacy of transactions, control business risks, develop potential customers and reduce

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customer acquisition costs.

Although supply chain finance eases the demand for funds in the market, the offline model of supply chain financial services inevitably presents many difficult dilemmas to break through. Firstly, upstream and downstream suppliers, it is difficult to use the supply chain to increase their own credit, and the credit transmission in the chain is limited [1-2]. Secondly, most of the data transmission and business processing links in the supply chain are in the offline processing mode, which makes only a very small part of the SME group can meet the credit standards of banks [3-5]. In order to obtain bank credit, SMEs must bear unreasonable costs, making financing difficulties a common phenomenon, which greatly restricts the development of SMEs [6-7].

The unique technical characteristics of blockchain make it quickly highlighted in the era of rapid scientific development, especially decentralisation, which achieves the effect of subversion and attracts the general attention of the public. Blockchain technology can establish an irreversible, tamper-proof, anonymous, decentralised, traceable and jointly maintained credit database to achieve information interoperability and scale utility [8-11]. In supply chain finance, considering the problem of insufficient degree of connectivity among enterprises caused by the low degree of informatisation and information management, building an alliance chain can enable each participant to upload basic transaction data such as funds, transactions and financing through nodes [12-14]. Based on the consensus mechanism can effectively avoid the risk of forgery in financial business and truly reflect the credit and repayment ability of enterprises, thus solving the problems of information endorsement and information asymmetry [15-16].

Rijanto, A. analysed the value of the application of blockchain technology in supply chain finance using usefulness and perceived ease of use as the evaluation criteria, based on the multi-case methodology of risqué sampling, and the results showed that the trust, validity, and distributed ledger transaction data provided by blockchain technology provided a solution to the problem of automation in supply chain finance [17]. Hofmann, E. et al. applied blockchain technology applied to the approved accounts payable financing process, which provides visibility of the physical flow of goods and significantly enhances the effectiveness of supply chain finance [18]. Du, M. et al. constructed a new supply chain finance platform that utilises blockchain technology for the management of the whole process and proposed blockchain technology based on homomorphic encryption method, which further protects the sensitive data and user privacy in supply chain finance scenarios [19]. Zheng, K. et al. establish a model based on blockchain technology to achieve access control and management of supply chain shared transaction information, which handles a large amount of credit data and privacy data in the supply chain finance credit system through proxy re-encryption method [20]. Gong, Y. et al. showed that blockchain technology can effectively address the challenges of traditional supply chain finance in terms of financing scope, financing cost, financing efficiency and risk management, and in order to expand the implementation scope of blockchain technology in supply chain finance, it can be achieved through the formulation of laws and regulations, etc. [21]. Ioannou, I. et al. explored the role of blockchain technology in solving the financial operational, and legal issues, and established the necessary conditions for blockchain-supported trade and financing behaviours [22]. Wang, L. et al. analysed the value creation process of supply chain finance supported by blockchain technology, and pointed out that blockchain technology applies key resources and practices accordingly in order to provide service value that satisfies the motivations of participants [23]. Omran, Y. et al. developed a conceptual framework for a supply chain finance solution powered by blockchain technology that enhances the efficiency of the execution of supply chain finance instruments to coordinate the relationship between buyers and suppliers in the chain [24].

This paper applies blockchain technology in supply chain finance and builds a supply chain finance innovation system containing intelligent terminal layer, blockchain layer and application layer. Blockchain technology is used to solve the information asymmetry problem in traditional supply chain finance business and effectively increase the number of partners in the alliance company, the turnover

of supply chain finance business and the amount of financing projects. Based on the optimisation of blockchain technology for supply chain finance innovation, this paper selects panel data from 30 provinces in China to explore the role of supply chain finance innovation in promoting regional economic growth. The blockchain-based supply chain finance innovation efficiency evaluation index system is constructed from the dimensions of financing efficiency, information transparency, risk control, operational efficiency, and innovation ability, and the supply chain finance efficiency in the system is measured by using Malmquist index. The spatial correlation between supply chain financial innovation and regional economic growth is analysed with the help of the Malmquist index, and a spatial measurement model is constructed on this basis to quantify the impact of supply chain financial innovation on regional economic growth. The spatial econometric model used in this paper is determined by the least squares estimation of the model without spatial effects and by the results of the Lagrange multiplier and robust Lagrange multiplier tests. Maximum likelihood estimation is used to regress the impact of supply chain financial innovation on regional economic growth in 30 provinces from 2013 to 2023. Based on the regression results, the spatial effects, spillover effects and spatial synergies between supply chain financial innovation and regional economic growth are elaborated.

2. Application of blockchain technology in supply chain finance

2.1. Blockchain in Supply Chain Finance in Practice

Talking about the actual operation, applying blockchain technology to supply chain finance [25], the whole process can be decomposed into three levels in terms of the system structure, which are the intelligent terminal layer, blockchain layer and application layer in turn. And the core part is in the second level - blockchain layer.

2.1.1. Intelligent terminal layer records product production information. Intelligent terminal layer with radio frequency identification technology, two-dimensional code scanning technology and satellite positioning technology as the technical support, consists of a variety of Internet of Things sensing terminals, mainly to obtain all the information in the process of product production, transport and sales [26]. RFID technology is equivalent to electronic tags, in the production of the product, RFID tags are affixed to the raw materials or finished products, and the specifications of the product are automatically recorded, quantity, person in charge, time and other information, which is convenient for readers to read; in the logistics link, it relies on satellite positioning technology to obtain the location of the product. When selling to the public, consumers can scan the QR code to check the information of the products stored in the blockchain to ensure product quality.

2.1.2. Data enters the blockchain layer recorded in nodes. The data is transmitted to the nodes, which use the consensus mechanism to generate a new block, and the first node to complete the calculation within the new block acquires the right to bookkeeping and subsequently transmits the information to the entire network. After receiving the data, each node verifies it, and it can join the tail end of the blockchain if it passes the verification.

1) Process of data recording in blockchain. Regarding the process of data recording in the blockchain, it includes the following six steps.

(1) Creation of an electronic message. The information contains all the details in the transaction, such as the source of the material, the person in charge of the supplier and distributor, and the logistics information.

(2) Encrypt the data. Encrypt the data with asymmetric digital signatures and after completion transmit the data to the distributed node and inform all the users of their respective public and private key passwords.

(3) Confirm the transaction. Judge whether the contract is executable through the characteristics of the blockchain technology smart contract, and automatically give instructions to complete the

transaction for the executable contract.

(4) Broadcasting the transaction information in real time throughout the network system.

(5) Blocks containing transaction information are added to all distributed ledgers. The blocks are generated in chronological order and linked together in the form of a chain, and the transactions recorded on each block are based on the transaction record of the previous block, which is interlocked to ensure the integrity of the database.

(6) Verification of the recording of transactions. The other nodes work together to verify whether the new information recorded corresponds to the hash value in the block, and if so, the new block is connected at the end of the blockchain; if not, it is rejected, and this message is passed to the other nodes.

2) The process of combining blockchain system with supply chain finance. Applying blockchain technology to supply chain finance, the financing model diagram is shown in Figure 1. As can be seen from Figure 1, compared with the previous supply chain finance operation mode, the core enterprise and the bank carry out the capital financing link to join the blockchain supply chain finance platform. The core enterprise and the first-tier suppliers have real transactions, forming accounts receivable, and the suppliers continue to conduct subsequent business transactions with each other. When obtaining financing, SMEs do not need to use paper documents for accounts receivable as collateral as in the past. Instead, through the blockchain supply chain finance platform, they can obtain asset acceptance certificates issued by the core enterprise by virtue of the electronic transaction information, and skip the manual operation of checking the paper transaction documents, book-entry and stamping in the traditional supply chain finance, and obtain financing directly. The bank understands the strength of each financing enterprise through the blockchain supply chain finance platform and grants credit to the core enterprise. The core enterprise transfers funds according to the asset vouchers and cashes out the funds to the SMEs, which complete the subsequent transactions, and the core enterprise obtains profits and pays the capital and interest to the bank. The whole process is completed here.

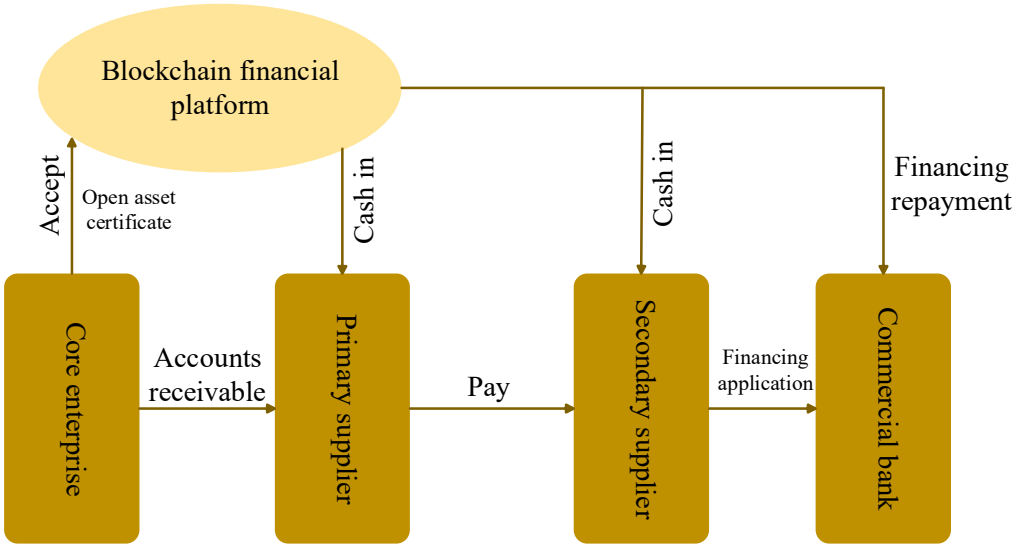


Fig. 1. Financing model

2.1.3. Users confidently query product information at the application layer. The application layer is the link that consumers can operate on their own, using a mobile phone app or dedicated management software to connect to the blockchain layer through an interface programme. Consumers must connect to the blockchain layer in order to search for products in the application layer or for enterprises to manage their supply chains. The blockchain data is transmitted from the blockchain layer to the application layer, and the information is displayed in the special management software, so that users

can download the mobile phone APP to query the product information they want to know. A supply chain that incorporates blockchain technology can provide market information to all participants, which is conducive to business expansion.

2.2. Practical Effects of Blockchain Platform in Supply Chain Finance

2.2.1. Increased number of collaborators joining the alliance chain. As the blockchain platform solves the problem of information asymmetry to a certain extent, the R&D company has reached a cooperative intention with a number of banks, trusts, insurances, small loans, guarantee companies, etc., to form an alliance chain together, in order to prepare for the application of blockchain technology to supply chain finance business. In the gradual application of blockchain, the number of collaborators joining the alliance chain is gradually increasing, and Figure 2 shows the change of collaborators within the alliance chain from 2008 to 2023. As can be seen from the figure, the number of collaborators within the alliance chain varied greatly before 2018, and the number of collaborators decreased in 2014, 2015 and 2017, with the number of collaborators decreasing by 6 in 2014.After the launch of the "Chained Finance" blockchain financial platform in 2018, the number of collaborators within the alliance chain has increased. After the launch of the "Chained Finance" blockchain financial platform in 2018, the number of collaborators within the Alliance Chain has continued to increase, and the growth has been increasing. By 2023, the number of partners in the alliance chain will have grown to 117, with 117 banks, enterprises and other partners effectively participating in the alliance chain.

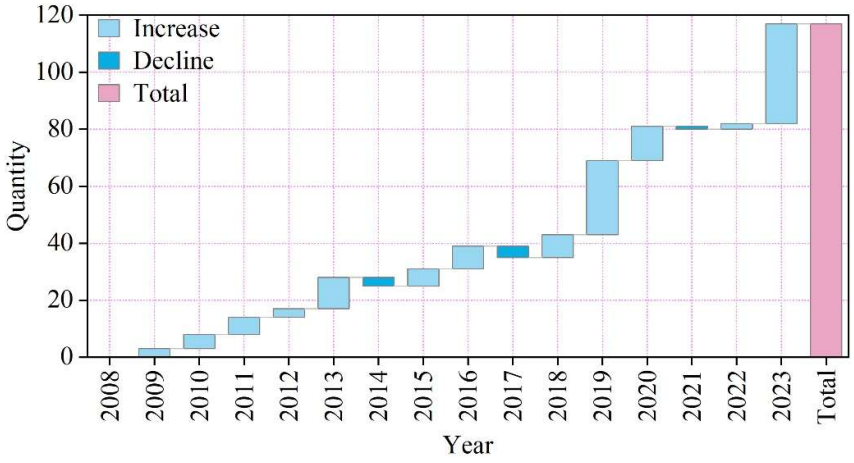


Fig. 2. Changes in collaborators

2.2.2. Blockchain supply chain platforms run fast. The comparison of blockchain supply chain platform information is shown in Table 1. From the table, it can be seen that the supply chain service system combining blockchain operates at a fast speed when processing information, and the platform transaction speeds of both the alliance chain and the private chain can reach thousands of transactions per second. At the current stage, the corresponding platform transaction speed of the alliance chain, which is formed by many banks and other cooperative enterprises, has reached 3,000-15,000 transactions per second, which is enough to deal with the business volume in the trial operation stage for the newly-born technology platform. Compared with the other two, the service system in the form of alliance chain can not only ensure that the information is not tampered with arbitrarily through the joint information processing by the participants, but also prevent the participating subjects from entering into a completely uncontrolled state and operating flexibly, so as to provide efficient services for the operation of supply chain finance business.

Table 1. Platform information comparison

Platform type	Public chain	Alliance chain	Private chain
Private chain	All	Specific organization	Individual, Entity
Degree of centralization	Decentralization	Multi-centralization	Centralization
Trading speed(times/second)	5-28	3000-15000	1000-10000
Bookkeeper	All	Participant consultation	Autograph
Node storage	Personal computer	Specific computer	Specific computer

2.2.3. Financing projects with large transaction amounts. The transactions of some cases of blockchain-based supply chain finance are shown in Figure 3. As can be seen from the figure, the transaction amounts of some randomly selected projects are basically between 3×10^8 yuan and 10×10^8 yuan, and the transaction amounts have been significantly improved compared with traditional supply chain finance. From the cases, it can be found that supply chain finance combined with blockchain technology is applicable to many industries and meets the current demand for business innovation in supply chain finance.

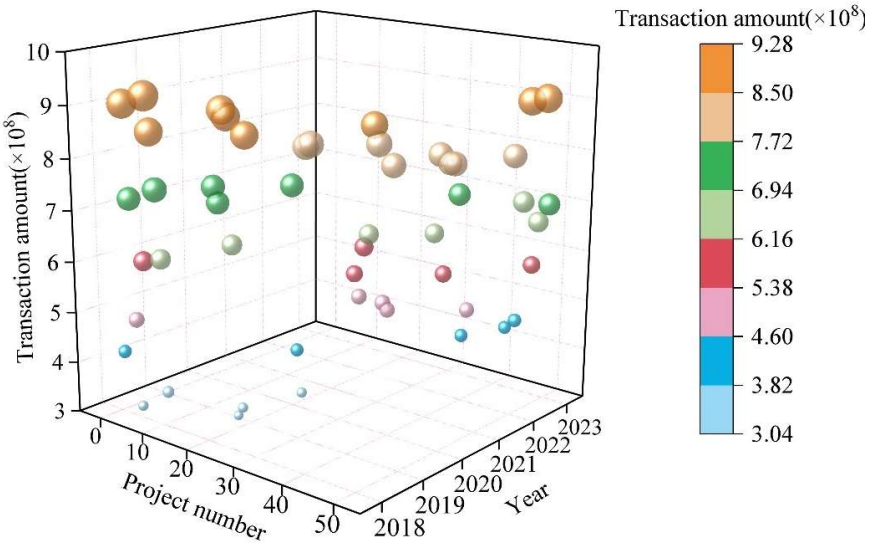


Fig. 3. Partial project transaction situation

3. Analysis of supply chain finance innovations for regional economic upliftment

The application of blockchain technology significantly improves the innovation of supply chain finance, and also makes the field of supply chain finance produce great progress. Meanwhile, supply chain finance innovation advantages one of the key driving forces of regional economic development, and usually, the higher the degree of supply chain finance innovation, the higher the quality of regional economic development. In this section, we will select 30 inter-provincial panel data in China from 2013-2023 by means of empirical analysis, measure the supply chain financial innovation efficiency by using the Malmquist index method, and on the basis of which we will use spatial econometric modelling to test the spillover effects and spatial synergies between supply chain financial innovation and regional economic growth.

3.1. Variable Selection and Model Design

3.1.1. Selection of variables. The explanatory variable is regional economic growth (LNGDP), obtained by taking the logarithm of real GDP derived from the GDP deflator with 2013 as the base

period. The explanatory variables consist of two parts: supply chain financial innovation efficiency indicators and control variables.

1) Construction of supply chain financial innovation efficiency indicators (INO). Supply chain financial innovation is not only limited to the creation of financial products and tools at the micro level, but also unaware of the amount of system and organisational changes at the meso level, but is a more richly connoted and systematic financial industry innovation. Based on this understanding, the construction of supply chain financial innovation efficiency indicators is also more comprehensive and comprehensive. This paper draws on the indicator system established by relevant scholars, and uses the DEA-Malmquist index method to measure the supply chain financial innovation efficiency based on blockchain technology in 30 provinces and cities in China (considering the availability of data, excluding Tibet, Hong Kong, Macao and Taiwan) [27], and the specific evaluation index system is shown in Table 2.

Table 2. Supply chain financial innovation efficiency evaluation indicator system

Primary indicator	Secondary indicator	Tertiary indicator
Financing efficiency	Fund availability	Difficulty of obtaining funds for financing enterprises
		Speed of fund disbursement
		Fund cost
Information transparency	Data traceability	Record and tracking ability of all links in the supply chain
		Information sharing degree
		Information security
Risk control	Credit risk management	Evaluation and management of the party's credit status
		Fraud detection
		Execution of contract
Operating efficiency	Process optimization	Business flow reduction and automation
		Trading speed
		Error rate
Innovative ability	Technical innovation	The development and application of new technologies
		Product innovation
		Model innovation

2) Control variables. Government fiscal expenditure (GOV), expressed as the share of fiscal expenditure in regional GDP by shock degree in each region. Human capital level (STU), expressed as years of education per employed person in each region after taking the logarithm. Fixed Asset Investment (IVV), expressed as the share of fixed asset investment in regional GDP in each region. Foreign Direct Investment (FDI), measured by the logarithmic value of FDI in each region.

The data in this paper are mainly from China Statistical Yearbook, China Financial Statistics Yearbook, China Regional Economic Statistics Yearbook, and Wind database.

3.1.2. Modelling:

1) Spatial correlation test. Before the analysis of spatial effects, it is necessary to examine the spatial correlation between supply chain financial innovation efficiency and regional economic growth, so this paper analyses the spatial correlation between supply chain financial innovation efficiency and regional economic growth with the help of the Moran index in order to reflect the spatial dependence between the two [28].

The global Moran index is calculated as:

$$Moran'sI = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(x_i - \overline{x})(x_j - \overline{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{it}} \tag{1}$$

The localised Moran's index is calculated as:

$$Moran'sI = \frac{(x_i - \overline{x})}{S^2}\sum_{i=1}^{n} W_{ij}\frac{(x_i - \overline{x})}{S} \tag{2}$$

In Eqs. (1) and (2), $S^2 = \frac{1}{n}\sum_{i=1}^{n} W_{it}(x_i - \overline{x})^2$ and x_i、x_j denote the values of the variables in province i and province j, respectively, and W_{it} is the spatial weight matrix, which denotes the spatial distance between province i and province j.

2) Design of spatial weight matrix:

(1) Geographic weight matrix (W_1): the inverse of the sum of squared geographic distances between provinces is used. The specific formula is:

$$W_{ij} = \begin{cases} \frac{1}{d^2_{ij}}, i \neq j \\ 0, i = j \end{cases} \tag{3}$$

(2) Economic weight matrix (W_2): the difference between the average values of GDP per capita of the two regions in 2013-2023 is selected, and then the inverse of the absolute value is taken to measure the economic distance between the regions. The specific expression is:

$$W_{ij} = \begin{cases} \frac{1}{|\bar{G}_i - \bar{G}_j|}, i \neq j \\ 0, i = j \end{cases} \tag{4}$$

(3) Economic-geographical weight matrix (W_3): constructed on the basis of geographic weight matrix and economic weight matrix, it can reflect the spatial spillover effect of supply chain financial innovation efficiency in geographic and economic entropy. The specific expression is:

$$W_{ij} = \begin{cases} \frac{1}{d^2_{ij} \times |\bar{G}_i - \bar{G}_j|}, i \neq j \\ 0, i = j \end{cases} \tag{5}$$

3) Spatial measurement model construction. Based on the models of related studies, this paper constructs the spatial econometric model of this paper [29], the specific expression is:

$$LNGDP_{it} = \rho \sum_{j=1}^{n} W_{ij} LNGDP_{jt} + \beta X_{it} + \theta \sum_{j=1}^{n} W_{ij} - X_{jt} + \mu_i + \vartheta_i + \varepsilon_{it} \tag{6}$$

Where i and j denote provinces and districts, t denotes time, $LNGDP_{it}$ is the explanatory variable, X_{it} is the explanatory variable, ρ is the spatial autoregressive coefficient, W is the spatial weight matrix, μ_i denotes individual fixed effects, ϑ_i denotes spatial fixed effects, and ε_{it} is the error term.

3.2. Empirical analysis and results

3.2.1. Spatial characterisation of supply chain finance innovation and regional economic growth. The Kernel function is used to analyse the spatial heterogeneity of supply chain financial innovation efficiency and regional economic growth. The spatial correlation between the two is analysed using Moran's index and local Moran's index scatter plot.

1) Analysis of dynamic evolution process. The principle of Kernel density estimation method is to analyse the dynamic changes of the wind, skewness, symmetry and other characteristics of the distribution curve graph of the selected indicators, and then reflect the dynamic evolution process of the selected indicators. In this paper, the density of the starting year and the interval of 1 year is used to estimate and draw the kernel density function distribution curve graph using the indicator data of 30 provinces and regions to reflect the dynamic evolution process of supply chain financial innovation and regional economic growth. Figure 4 shows the dynamic evolution of regional economic growth, from which it can be seen that the overall level of economic growth in the provinces and regions is growing steadily. 2013-2023, the centre of the kernel density function distribution curve of the logarithmic value of GDP is shifted to the right, and the height of the main peak gradually rises, and the width gradually becomes narrower, which indicates that the level of economic growth in the provinces

and regions is increasing year by year but the gap is gradually decreasing. The distribution curve has a trailing phenomenon and has a rightward extension.

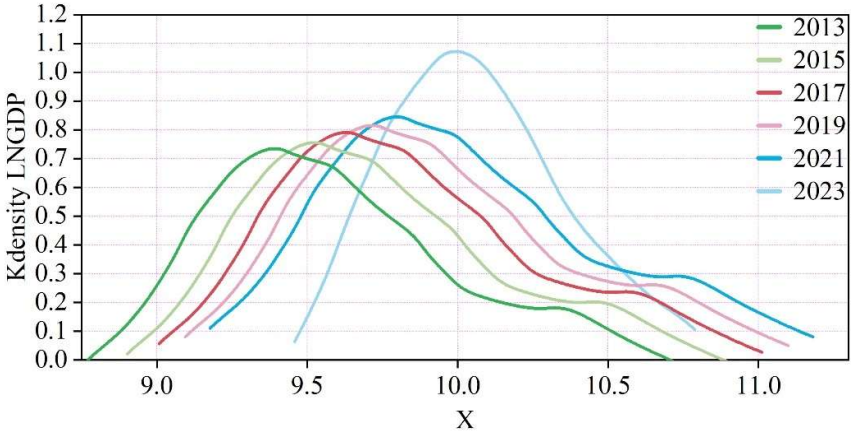


Fig. 4. The nuclear density distribution curve of GDP log value

The dynamic evolution of supply chain financial innovation efficiency is shown in Figure 5.The overall supply chain financial innovation efficiency of the 30 provinces and regions also shows an upward trend, and the centre of the distribution curve of the kernel density function of the supply chain financial innovation efficiency is shifted to the right and the height of the main peak is also gradually rising from 2013-2023, indicating that, with the development and deepening of the application degree of blockchain technology, the blockchain-based supply chain of the various provinces and regions is financial innovation efficiency is rising.

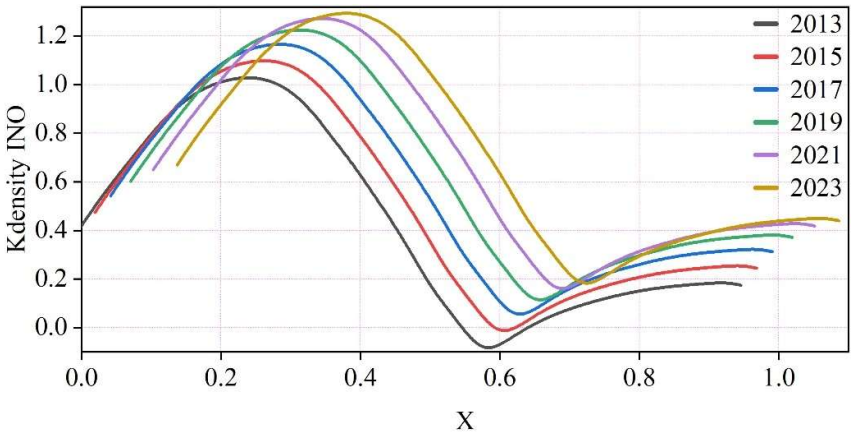


Fig. 5. Nuclear density curve of supply chain financial innovation efficiency

2) Spatial correlation analysis. This paper adopts Moran index to analyse the spatial correlation between supply chain financial innovation and regional economic growth. The value range of Moran index is [-1,1], I is greater than 0 indicating the existence of positive spatial correlation, and I is less than 0 indicating the existence of negative spatial correlation. The larger the absolute value, the stronger the spatial correlation. $I=0$ indicates a random distribution. Figure 6 shows the global Moran index of regional economic growth and supply chain finance innovation from 2013 to 2023. From the estimation results in the figure, it can be seen that the Moran indices of regional economic growth and supply chain financial innovation from 2013 to 2023 are all integers, and all Moran indices obtained through statistical analysis pass the significance level test of 1%, 5% and 10%, which indicates that there is a positive spatial correlation between the two and a strong spatial clustering phenomenon.

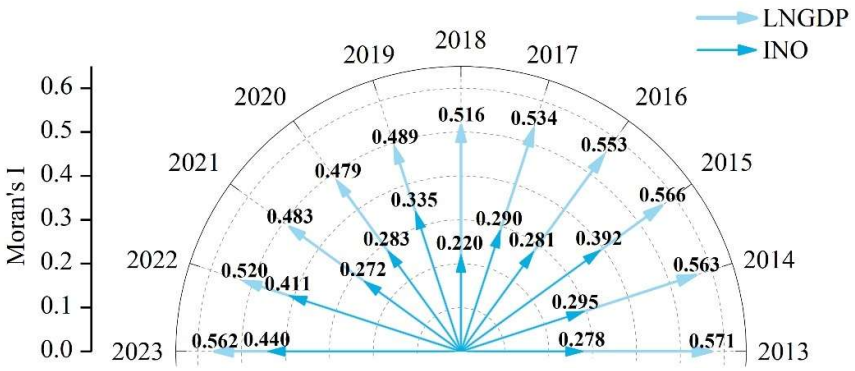
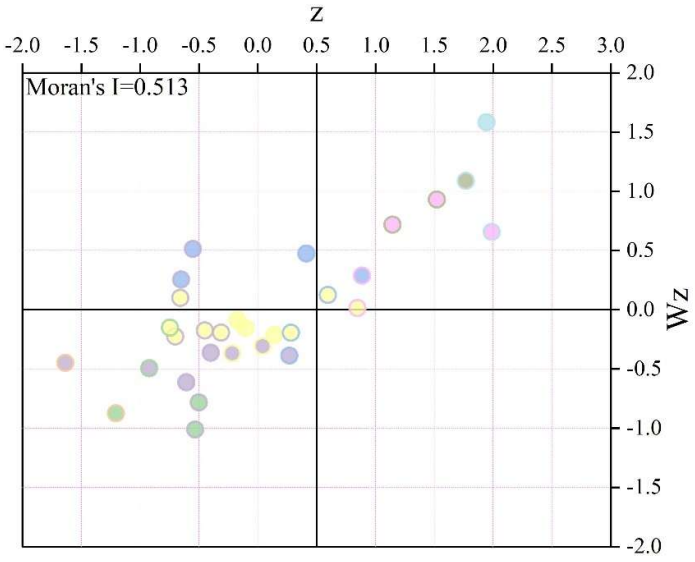
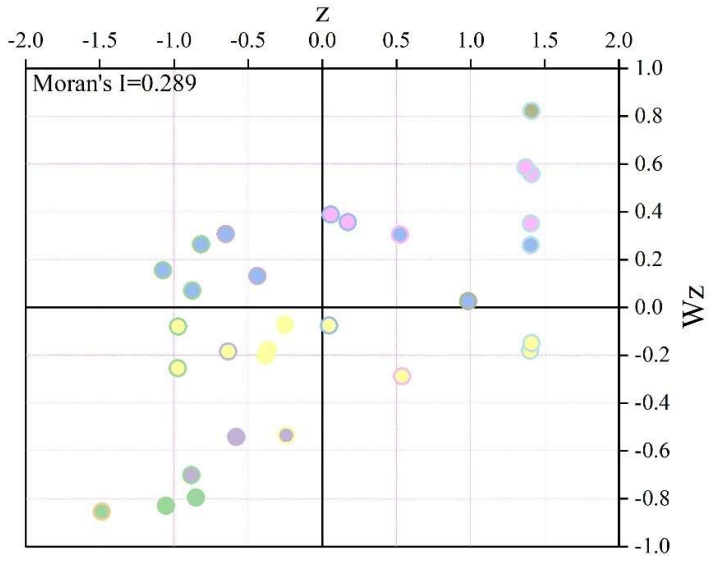


Fig. 6. Global Moran's I

Figure 7 shows the scatter plot of local Moran index of regional economic growth and supply chain financial innovation in 2023, (a) and (b) are regional economic growth and supply chain financial innovation respectively. From the figure, it can be seen that the economic growth and supply chain financial innovation of the 30 provinces and regions are basically concentrated in the first and third quadrants, i.e., presenting the characteristics of HH and LL clustering, saying that there exists an obvious positive spatial correlation with strong spatial clustering characteristics. Therefore, both geographical factors and spatial spillover effects cannot be ignored when studying the impact of supply chain financial innovation on regional economic growth.



(a) Regional economic growth



(b) Supply chain financial innovation

Fig. 7. Moran's I of regional economic and supply chain financial innovation

3.2.2. Spatial econometric analysis of supply chain financial innovation on regional economic growth:

1) Spatial model test. The above has determined that both regional economic growth and supply chain financial innovation have spatial autocorrelation through the Moran index, next, through the model without spatial effects for least squares estimation, and through the results of Lagrange multiplier and robust Lagrange multiplier test to determine the use of appropriate spatial econometric models, the specific results are shown in Table 3. From the results in the table, it can be seen that in both matrices, the LM-error and Robust LM-error as well as the LM-lag and Robust LM-lag test results are significant, indicating the rejection of the original hypothesis: there is no spatial lag effect and spatial error effect. So this paper can directly adopt the more general SDM model for testing.

Table 3. Lagrange multiplier test

Test statistic	W1		W3	
	Statistic	P	Statistic	P
LM-error	673.826***	0.000	261.384***	0.001
Robust LM-error	35.089***	0.000	9.845***	0.002
LM-lag	771.238***	0.000	396.802***	0.000
Robust LM-lag	136.482***	0.000	144.637***	0.001

2) Analysis of regression results. According to the spatial econometric model established in the previous section, the maximum likelihood estimation method is used to regress the impact of supply chain financial innovation on regional economic growth from 2013-2023, and the regression results are shown in Table 4, where the z-values corresponding to the regression coefficients are shown in parentheses, and the P-values are shown in middle brackets. As can be seen from Table 4, under the two matrices, the P-value of Wald test and LR test is 0.0000, indicating that the SDM model cannot be simplified to SLM model and SEM model, and the SDM model is more applicable to the spatial measurement regression in this paper. Then the results of Hausman test can be obtained that the statistics corresponding to SLM model and SEM model are negative and have not passed the significance test, so the random effect is selected for reporting, and the statistics corresponding to SDM model are positive and have passed the 1% significance level, so the fixed effect is selected for reporting the coefficients of each variable. Based on the test of the spatial model above, this paper focuses on analysing the results of the SDM model.

As can be seen in Table 4, the regression coefficients of supply chain financial innovation (INO) under both spatial weight matrices are significant at the 1% level, indicating that supply chain financial innovation based on blockchain technology plays a significant positive role in regional economic growth through technological innovation, risk control, and reduction of transaction costs. The regression coefficients of foreign direct investment (FDI) are significantly positive under both spatial weight matrices, indicating that FDI promotes the increase of regional investment capital, which in turn contributes to regional economic growth. The regression coefficient of investment in fixed assets (IVV) is positive but not significant, indicating that the expansion of investment in fixed assets helps to promote regional economic growth, but the scale of investment needs to be further increased. The coefficient of human capital level (STU) is significant under both weights, indicating that strengthening the education level and increasing skill training can improve the efficiency of one's own labour, thus promoting economic growth. The regression coefficient of government fiscal expenditure (GOV) is significant, indicating that a reasonable increase in government fiscal expenditure is also conducive to promoting regional economic growth.

Regarding the analysis of the regression coefficients of the spatial lag terms, what is illustrated is the impact of the relevant explanatory variables in the neighbouring regions on the explanatory variables in the region. As can be seen from Table 4, under the two spatial weight matrices, the regression coefficients of the spatial lag term of supply chain financial innovation (W×INO) are positive, and all of them are significant at the 1% level, indicating that there is a significant positive spatial spillover effect of supply chain financial innovation, i.e., supply chain financial innovation of the peripheral region has a facilitating effect on the economic growth of the region.

Table 4. The space panel model returns

Variable	W1			W3		
	SLM	SEM	SDM	SLM	SEM	SDM
INO	0.1238***	0.0628*	0.1038***	0.1682***	0.0249	0.1039***
	(4.16)	(1.73)	(3.14)	(5.31)	(0.71)	(3.28)
GOV	0.2018***	-0.2334***	0.2302***	0.1692***	0.2176***	0.1982***
	(6.83)	(6.69)	(7.52)	(5.34)	(6.65)	(6.43)
STU	0.0728	0.2401***	0.2611***	0.1068***	0.2287***	0.2374***
	(1.57)	(4.13)	(4.73)	(2.31)	(3.85)	(4.38)
IVV	0.0129	-0.0005	0.0073	0.0094	0.0127	0.0123
	(1.58)	(-0.04)	(1.02)	(1.18)	(1.46)	(1.54)
FDI	0.2005***	0.2352***	0.2894***	0.2286***	0.1913***	0.2586***
	(5.81)	(6.17)	(8.59)	(6.84)	(5.21)	(8.14)
W×INO			0.2854***			0.2283***
			(3.87)			(4.72)
W×GOV			0.0358			0.0752
			(0.38)			(1.56)
W×STU			-0.1311			-0.0914
			(-1.33)			(-1.36)
W×IVV			0.0928***			0.0124
			(4.11)			(0.96)
W×FDI			-0.1092*			-0.0026
			(-1.74)			(-0.08)
ρ	0.5553***		0.2084**	0.4873***		0.2618***
	(11.98)		(2.28)	(11.18)		(4.67)
R2	0.9384	0.8407	0.9536	0.9423	0.7771	0.9502

Log-L	313.5964	297.6831	449.9328	308.2682	254.3043	443.9736
Hausman	-413.17	5.72	77.98***	-32.84	-183.69	70.83***
Wald-error		41.74**** [0.0000]			102.91*** [0.0000]	
Wald-lag		45.58*** [0.0000]			56.87*** [0.0000]	
LR-error		73.28*** [0.0000]			158.36*** [0.0000]	
LR-lag		43.61*** [0.0000]			55.83*** [0.0000]	

Further, this paper will decompose the spatial effects based on the SDM model, in which the direct effect illustrates the impact of supply chain financial innovation in the region on the economic growth of the region, the indirect effect reflects the impact of supply chain financial innovation in the region on the economic growth of the neighbouring regions, and the total effect is the sum of the direct effect and the indirect effect.The results of the spatial effects decomposition of the SDM model are shown in Table 5, and the values of z corresponding to the regression coefficients are shown in the parentheses. The z-value corresponding to the regression coefficient, supply chain financial innovation, whether under the direct effect or indirect effect, the coefficient is significantly positive, indicating that the factor of supply chain financial innovation can produce a more significant role in promoting the economic growth of the region and the neighbouring regions. Supply chain financial innovation can not only directly promote the economic growth of the region, but also provide financial support for the technological development and industrial development of neighbouring regions, and the neighbouring regions can acquire experience and knowledge through learning and exchange, so that the economic strength of the neighbouring regions can be improved accordingly, i.e. there is a positive spatial spillover effect. In general, the decomposition results of spatial effects of control variables are similar to Table 4 in terms of sign and significance. In addition, it is found by comparison that, in terms of indirect effects, the regression coefficient of supply chain financial innovation under the geographic weight matrix is larger than the regression coefficient under the economic-geographic nested weight matrix, which indicates that the spatial spillovers of supply chain financial innovation are more significant for regional economic growth under the characteristics of geographic distance.

Table 5. SDM model space effect decomposition

Variable	W1			W3		
	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect
INO	0.1113*** (3.26)	0.3901*** (5.72)	0.5014*** (7.68)	0.1268*** (3.94)	0.3239*** (6.43)	0.4507*** (8.03)
GOV	0.2914*** (9.13)	-0.0652*** (-0.91)	0.2262*** (3.33)	0.2617*** (8.83)	0.0749*** (1.41)	0.3366** (5.83)
STU	0.0092 (1.26)	0.0913*** (0.73)	0.1005*** (1.52)	0.2358*** (4.63)	0.0354*** (0.48)	0.2712*** (2.68)
IVV	0.2396 (1.29)	-0.1211 (4.73)	0.1185 (5.03)	0.0136 (1.79)	0.0218 (1.38)	0.0354 (1.97)
FDI	0.2918*** (9.04)	0.0651*** (0.92)	0.3569*** (3.36)	0.2617*** (8.84)	0.0758*** (1.41)	0.3375*** (5.89)

4. Conclusion

In this paper, the traditional supply chain finance business is innovated and optimised through the

blockchain technology degree, and based on the innovation results, the promotion effect of supply chain finance innovation on regional economic growth is explored.

1) The global Moran index of supply chain financial innovation and regional economic growth are both significantly positive. In 2023, the economic growth and supply chain financial innovation of 30 provinces and regions are basically concentrated in the first and third quadrants. It reflects a significant positive spatial correlation between supply chain financial innovation and regional economic growth. At the same time, it indicates that geographical factors and spatial spillover effects need to be paid attention to when studying the impact of supply chain financial innovation on regional economic growth.

2) The regression coefficients of supply chain financial innovation are significant at the 1% level under both geographic spatial weight matrix and geo-economic spatial weight matrix. It indicates that supply chain financial innovation based on blockchain technology plays a significant positive role in regional economic growth through technological innovation, risk control, and reduction of transaction costs. The regression coefficients of the spatial lag term (W×INO) of supply chain financial innovation are positive, and all of them are significant at the 1% level, indicating that there is a significant positive spatial spillover effect of supply chain financial innovation. Meanwhile, the coefficients of supply chain financial innovation are significantly positive under both direct and indirect effects, indicating that the factor of supply chain financial innovation can have a more significant role in promoting the economic growth of the region and neighbouring regions.

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