"Impact of supply chain finance on the performance of agricultural small and medium-sized enterprises: Evidence from Chinese listed companies"

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IMPACT OF SUPPLY CHAIN FINANCE ON THE PERFORMANCE OF AGRICULTURAL SMALL AND MEDIUM-SIZED ENTERPRISES: EVIDENCE FROM CHINESE LISTED COMPANIES

Abstract

In the Chinese economic system, agricultural small and medium-sized enterprises (SMEs) play a key role in promoting agricultural development. The problem of financing difficulties for agricultural SMEs has seriously constrained their economic development. The purpose of this paper is to explore the role of supply chain finance in solving the financing constraint problem of agricultural SMEs, which in turn affects the performance level of enterprises. By constructing a theoretical model and selecting the data in Chinese National Small and Medium Enterprises Stock Transfer System from 2011 to 2022 for mediation effect regression analysis, the results show that there is a stable positive correlation between supply chain finance index and return on net assets ($\beta = 0.585$, $p < 0.05$); there is a stable negative correlation between supply chain finance and financing constraints ($\beta = -0.216$, $p < 0.05$); there is a stable negative correlation between financing constraints and return on net assets ($\beta = -0.893$, $p < 0.001$). This study examines the impact of supply chain finance on the performance of agricultural SMEs from the perspective that supply chain finance can alleviate financing constraints. The results of this study suggest to business stakeholders that agricultural SMEs can choose supply chain finance as a better choice of financial strategy, and the government can formulate corresponding policies to further develop preferential and supportive policies for supply chain finance.

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INTRODUCTION

Supply chain finance is a financial tool that is gaining attention in China and even globally (Chang & Deng,2014). It provides an innovative way of financing and is expected to solve the financing problems faced by agricultural SMEs (Tong & Yang, 2021). In China, agricultural SMEs have great potential to improve agricultural productivity and promote employment and economic development in rural areas. However, their financing constraints have been a major obstacle that restricts them from achieving these goals.

Supply chain finance is an emerging financial approach that is particularly applicable to agricultural SMEs (Abbasi & Alsakarneh, 2018). The decentralized nature of the agricultural industry and the large number of SMEs provide a broad application prospect for supply chain finance. The urgency of studying this issue cannot be underestimated in the current context of China's agricultural economy. With

urbanization and modernization, rural areas need more support to ensure food supply chain security and farmers' livelihoods. The potential role of supply chain finance may lead to further development of the Chinese rural economy. In addition, the study provides important insights for the international community on how to address global agricultural sustainability challenges. With the challenges of increasing global food demand and limited resources, the efficiency and sustainability of agricultural SMEs will become a global concern (Gherghina et al., 2020).

1. LITERATURE REVIEW AND HYPOTHESES

In the 1960s and 1970s, the government dominated the supply chain and its integration with agriculture on a global scale. Agriculture relied on a centralized planning system to coordinate decisions in the whole process of transactions from inputs to outputs (Rozelle et al., 2004). However, in the 1980s and 1990s, the previously state-dominated model of supply chain finance changed dramatically, with accelerated marketization and the gradual privatization of agricultural land and enterprises constantly impacting the supply chain system. Private traders, agricultural units, retailers, and food processors provide credit as well as financing services to farms and farmers to ensure access to quality agricultural products (Swinnen et al., 2014). Miller et al. (2010) combine supply chain finance with agriculture and provide its clear definition as a transactional relationship between multiple participants in an agricultural supply chain, based on which a financial institution's financial services are provided by financial institutions based on that relationship. It consists of two aspects, the first is about internal financing, i.e. the flow of funds in the form of trade credit (or in-kind financing) between firms throughout the chain, and the second is about external financing, i.e. financial institutions that are not part of the chain and provide cash flow support to the core firms of the supply chain. Hofmann (2005) described supply chain finance as a model of joint cooperation between internal and external participants. According to Hofmann (2005), supply chain finance is a mode of cooperation between internal and external participants, i.e. multiple node enterprises and their external service providers in the supply chain, through planned, multi-party coordination and control of financial flows between enterprises, to jointly create value.

Small and medium-sized enterprises (SMEs) generally face the problems of difficult financing and high financing costs because of their weak development capacity and high guarantee costs, which have been studied by many scholars. The emergence of supply chain finance leads to an increase in the amount of credit loan funds that can be allocated by banks, which is more efficiently distributed, and thus eases the financing constraints of SMEs (Greenwood, 1990). Digal (2007) and Dries et al. (2009) found that the internal financing model of ASCF (Agricultural Supply Chain Finance) is the farmers' main source of credit in many regions and in some regions even the only source. Group (2007) suggests the development of supply chain finance as a solution for financial institutions to inject capital into upstream and downstream supply chain firms to alleviate the financing problem in the process of commodity distribution. Sarkis et al. (2017) particularly emphasized the role of SMEs in supply chain finance. The potential of supply chain finance in improving the sustainability performance of firms is presented.

Information asymmetry and lack of collateral lead to the problem of financing constraints and can significantly inhibit firms from investing in innovation, due to the existence of external financing constraints, firms rely mainly on internal funds when they need to innovate (Hall, 1992; Himmelberg, 1994). Hovakimian (2003) suggests that financing constraints can affect firms' business performance. Brown (2009) argues that financing constraints inhibit firms from innovating because they prevent a steady flow of capital to the firm, which in turn affects its R&D activities.

Pfohl et al. (2009) defined a theoretical framework and model for supply chain finance, arguing that supply chain finance can promote efficient cooperation, achieve synergies, and reduce company costs, etc. Mulure (2013) showed that supply chain finance has a significant impact

on the overall sales growth rate of SMEs, and has a significant positive impact on the development of SMEs in terms of internal cash flow, business profit, return on assets, etc. Gelsomino et al. (2016) found that the development of supply chain finance can create and continuously strengthen the links between enterprises in the whole chain so that the efficiency of enterprises can be improved, and the stable development of enterprises can be achieved.

Through the above thesis analysis, it can be found that supply chain finance can improve the problem of information asymmetry and reduce transaction costs. Based on the theory of resource dependence, enterprises on the premise of interconnectedness and competition will strive to improve their own competitiveness (Wang & Liu,2021). So that enterprises occupy an advantageous position in relative power, and by virtue of the advantage influence the other disadvantaged enterprises in the chain, to obtain more economic benefits, and to improve the economic efficiency of enterprises. Core enterprises can influence the likelihood of agricultural SMEs obtaining loans through their dominant position and guarantee role. This improves the cash-flow deficit of agricultural SMEs and enables enterprises to innovate and grow (Na & Jue, 2020).

This research mechanism provides a theoretical framework to improve the information asymmetry problem and reduce transaction costs through supply chain finance, so as to encourage core enterprises to occupy a dominant position in the supply chain, which in turn affects other disadvantaged enterprises in the chain and improves the economic efficiency of the whole supply chain. This is of great significance for the innovation and development of agricultural SMEs.

Therefore, this study aims to explore how supply chain finance affects the economic performance of agricultural SMEs in the Chinese system and context. In addition, this paper will investigate and elucidate the impact of supply chain finance on agricultural SMEs of different nature, in different regions and over different time periods, and the role of financing constraints as a mediating variable in this process. On this basis, this paper proposes three hypotheses:

H1:   *Supply chain finance can contribute to the economic performance of agricultural SMEs (ROE).*

H2:   *Supply chain finance can alleviate the financing constraints of agricultural SMEs.*

H3:   *Financing constraints are the mediating effect of the relationship between supply chain financing and the performance of agricultural SMEs.*

2. METHOD

This paper collects the financial data from 2011 to 2022 of companies listed on the Chinese National Equities Exchange and Quotations (NEEQ, Chinese Small and Medium Enterprises Stock Transfer System) for Agriculture through the WIND database and the CSMAR database, which are compiled into a panel dataset. Finally, after screening, this paper identifies 688 observations from 101 agricultural SMEs from 2011 to 2022 as the study sample. In the process of sample screening, this paper treats the samples as follows.

1)   The sample excludes companies with ST, *ST, or PT labels in Chinese stock markets. These designations reflect varying degrees of financial or operational distress. ST marks companies with financial issues, often due to consecutive losses or non-compliance with financial standards. *ST is more severe and implies heightened risks and strict regulations. PT marks companies with lower stock prices, indicating financial and operational risks, which are excluded from the sample to maintain consistency.

2)   For more samples, missing data values need to be removed in this paper.

Various indicators have been developed to measure financing constraints, which play a crucial role in understanding their impact on firms' behavior and performance. The KZ index, introduced by Kaplan and Zingales in 1997, assesses the degree of substitution between a firm's internal and external financing, offering insights into the extent of financing constraints. Another nota-

ble index, the WW index, formulated by Whited and Wu in 2006, evaluates financing constraints by examining the connection between a firm's capital structure and investment spending, emphasizing the interplay between internal and external capital. Additionally, the SA index, devised by Steven Ongena and Alexander Popov in 2015, measures financing constraints by considering the debt-to-equity financing ratio of banks, offering insights into the influence of financial institution financing on firms. These indices provide versatile approaches to quantifying and analyzing financing constraints, enriching research in this field and enhancing our comprehension of the mechanisms and repercussions of these constraints.

Considering that there are fewer data on agricultural SMEs in Chinese National Equities Exchange and Quotations and that the SA index is relatively stable and reliable, this paper refers to Hadlock's (2010) method of calculating firms' financing constraints by using the financing constraint index (*SA* index) with the following formula:

$$SA_{it} = -0.737 \cdot SIZE_{it} + 0.043 \cdot SIZE_{it}2 - 0.04 \cdot AGE_{it}, \quad (1)$$

where $SIZE = $ ln (total assets/1 million) and AGE is the age of the firm, i.e., the difference between the year of calculation and the year of establishment of a firm. The financing constraint indices calculated by this formula are all negative, and the larger the index, the more severe the degree of financing constraint.

Supply chain finance data are from the WIND database. The data of return on net assets and other control variables are from the CSMAR database. Considering the large differences in the level of supply chain finance among Chinese agricultural SMEs, this paper conducts a bilateral 1% Winsorized shrinkage analysis of supply chain finance. For details, see Table 1.

Based on the above theoretical analysis, the following three models were constructed. Model (2) examines the relationship between supply chain

Table 1. Variable definitions

Variable Type	Variable Name	Variable Symbol	Definition
Dependent variables	Profitability	ROE	It is used to measure the net income earned by a business per unit of owner's equity. It is calculated as net profit divided by net assets
Mediating variables	Financing constraints	SA	Financing constraints are manifested when an enterprise has difficulty in obtaining sufficient funds to meet its development, expansion, or routine operational needs. It can be constructed using the logarithm of assets and the firm's age.
Independent variables	Supply chain finance intensity	SCF	Supply Chain Finance Intensity is a metric used to measure the impact and extent of supply chain finance in a business or industry. It is expressed in financial indicators as follows: ln (1+ notes payable + short-term loans)
Control variables	Equity concentration	TEN	Equity concentration usually refers to the distribution of shareholdings in a firm's ownership structure. It represents the degree of concentration of shares vested in the company. It is represented by the formula: Number of shares held by top ten shareholders /Total number of shares in the firm
	Capital Structure	GR	Capital structure refers to the composition of a firm's capital, i.e., the types and proportions of sources of financing. It represents the way in which the assets of the firm are financed, including debt and ownership capital. It can be expressed by gearing ratio, which is represented by the formula: Liabilities/ Assets
	Current asset ratio	CAR	The current assets ratio is used to measure the ability of an enterprise to be able to use its current assets to service its short-term debts as they fall due. The formula for this indicator is: Current assets / Total assets
	Cash ratio	CR	The cash ratio is a measure of an enterprise's cash on hand and cash equivalents as a proportion of its total current assets. The formula for this indicator is: (Money funds + marketable securities) ÷ Current liabilities
	Business development capacity	GRO	Enterprise development capability usually refers to the ability of an enterprise to develop, expand and grow. This indicator can be expressed in terms of the growth rate of income
	Enterprise age	AGE	Enterprise age usually refers to the time span between the establishment of an organization and the time when the data was collected in the study.
	Enterprise nature	NATURE	State-owned enterprises take the value of 0, otherwise it is 1
	Region	REGION	1 for developed regions, >1 for economically less developed regions

finance and the performance of agricultural SMEs, which is used to prove the research hypothesis *H1*. Model (3) examines the relationship between supply chain finance and financing constraints, which is used to test the research hypothesis *H2*. Model (4) examines the relationship between supply chain finance and financing constraints by substituting the independent variables, the dependent variables, and the mediating variables into the regression model at the same time to analyze the focus of this paper, which is used to test the research hypothesis *H3*.

$$ROE_{it} = \alpha_0 + \alpha_1 SCF_{it} + \alpha_2 TEN_{it} +$$
$$+\alpha_3 GR_{it} + \alpha_4 CAR_{it} + \alpha_5 CR_{it} + \alpha_6 GRO_{it} + \quad (2)$$
$$+\alpha_7 AGE_{it} + \Sigma d + \Sigma year + \varepsilon.$$

$$SA_{it} = \beta_0 + \beta_1 SCF_{it} + \beta_2 TEN_{it} +$$
$$+\beta_3 GR_{it} + \beta_4 CAR_{it} + \beta_5 CR_{it} + \beta_6 GRO_{it} + \quad (3)$$
$$+\beta_7 AGE_{it+} \Sigma d + \Sigma year + \varepsilon.$$

$$ROE_{it} = \gamma_0 + \gamma_1 SA_{it} + \gamma_2 SCF_{it} +$$
$$+\gamma_3 TEN_{it} + \gamma_4 GR_{it} + \gamma_5 CAR_{it} + \gamma_6 CR_{it} + \quad (4)$$
$$+\gamma_7 GRO_{it} + \gamma_8 AGE_{it} + \Sigma d + \Sigma year + \varepsilon.$$

3. RESULT

Descriptive statistics and regression analysis (Table 2) reveal critical insights. The supply chain financial strength (SCF) demonstrates substantial volatility, spanning 0 to 21.6, with a mean of 12.59 and a high standard deviation of 7.555, underlining SCF's development instability for agricultural SMEs. Economic performance (ROE) displays significant polarization, with values ranging from -438.3 to 257.2. The mean ROE is 3.795. This disparity emphasizes the profitability challenges faced by various Chinese agricultural SMEs. Equity concentration (TEN) presents substantial variations, with values ranging from 24.3 to 100 and an average of 89.48, highlighting instability in the equity structures of listed agricultural SMEs. The growth rate of operating income (GRO) shows wide disparities, spanning -98.27 to 3063, reflecting considerable differences in business development capabilities across agricultural enterprises. Gearing ratios (GR) exhibit notable variance, ranging from 1.15 to 104.2, with an average of 42.2, indicative

of diverse financial structures among the firms. The age (AGE) distribution of agricultural SMEs varies considerably, with an average age exceeding 13 years. These differences signify varying levels of experience and market adaptability that impact economic performance. Most agricultural SMEs are non-state-owned, and state-owned enterprises are relatively rare on national stock exchanges and quotation lists. Geographically, they are concentrated in economically and financially developed regions, reflecting their location in Chinese unique economic and market context.

Table 2. Descriptive statistics

VARIABLES	N	mean	sd	min	max
SCF	688	12.59	7.555	0	21.60
ROE	688	3.795	31.64	−438.3	257.2
TEN	688	89.48	13.43	24.30	100.0
GRO	688	26.05	161.7	−98.27	3,063
GR	688	42.20	19.58	1.150	104.2
AGE	688	13.00	5.049	4	27
CAR	688	47.76	24.80	3.175	99.04
CR	688	0.791	4.019	7.09e−05	88.47
REGION	688	1.751	0.855	1	3
ROA	681	−20.60	239.9	−4,403	129.3
NATURE	688	0.799	0.401	0	1
Number of id	101	101	101	101	101

Note: Variable definitions are given in Table 1.

The correlation coefficient reflects the strength of the linear relationship between the two variables, with values ranging from –1 to 1. Based on the Pearson correlation coefficients of the variables demonstrated in Table 3, it is possible to get a preliminary understanding of the interrelationships between the variables studied in this paper. In this study, the correlation coefficients between all variables are not greater than 0.8, which means that the linear relationship between them is relatively weak. It is in line with the research hypothesis of this study in terms of the impact of supply chain finance on enterprise performance, that is, the different variables are independent of each other to a certain extent, and there is no strong linear correlation between them.

In order to more accurately exclude the interference of multicollinearity, this paper further carried out the variance inflation factor (VIF) test, and the results obtained are shown in Table 4. The VIF value of each variable is around 1, so the interference of multicollinearity can be excluded, i.e.,

Table 3. Descriptive statistical analysis

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) ROE	1.000								
(2) SCF	0.030	1.000							
(3) GR	−0.207*	0.298*	1.000						
(4) CAR	0.129*	−0.091*	−0.125*	1.000					
(5) CR	0.030	−0.219*	−0.251*	0.073*	1.000				
(6) GRO	0.111*	−0.074*	−0.013	0.039	0.071*	1.000			
(7) TEN	−0.021	−0.080*	0.018	−0.041	0.043	0.034	1.000		
(8) AGE	−0.123*	0.280*	0.007	0.054	−0.046	−0.116*	−0.020	1.000	
(9) SA	−0.038	−0.388*	−0.114*	0.118*	0.060*	0.173*	0.143*	−0.668*	1.000

Note: *t*-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

there are no multicollinearities among the variables selected in this paper, and regression analyses can continue to be carried out.

Table 4. Variance inflation factor (VIF) test for variables

Variable	VIF	1/VIF
GR	1.21	0.825309
SCF	1.19	0.839335
CR	1.09	0.920918
CARa~t	1.04	0.957851
AGE	1.01	0.985392
TEN	1.01	0.986146
GRO	1.01	0.989491

To test the impact of supply chain finance on the economic performance of agricultural companies in the NSSB, this paper controls for both individual fixed effects and time effects for agricultural companies. Table 5 shows the main effect regression results, the regression coefficient of supply chain finance indicators on return on net assets is 0.585, and the regression result passes the 5% significance level test, which indicates that supply chain finance indicators have a positive and significant impact on the economic performance of agricultural SMEs (ROE), and this can verify hypothesis *H1*.

Table 5. The main effect regression results

VARIABLES	ROE
SCF	0.585**
	(2.38)
GR	−0.747***
	(−6.88)
CAR	0.416***
	(3.66)
CR	−0.408
	(−1.24)

VARIABLES	ROE
GRO	0.010
	(1.35)
TEN	0.502**
	(2.01)
AGE	−1.214
	(−0.93)
Constant	−14.934
	(−0.45)
Observations	688
Number of id	101
R-squared	0.150
Firm FE	YES
Year FE	YES

Note: *t*-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In order to test whether supply chain finance can promote the economic performance level of agricultural listed companies by alleviating financing constraints and then promote the economic performance level of agricultural listed companies, this paper firstly measures the financing constraint index of agricultural enterprises through supply chain finance, which can verify the test of hypothesis *H2*. The impact of supply chain finance and financing constraints on the level of economic performance is then empirically analyzed to test whether there is a mediating effect of financing constraints.

Table 6 verifies the relationship between supply chain finance and financing constraints of agricultural SMEs, supply chain finance (SCF) and financing constraints (SA) are negatively correlated and significant at a 5% significance level, and the regression coefficient is −0.216, i.e., the greater the intensity of supply chain finance, the lower the level of financing constraints of agricultural SMEs. Therefore, hypothesis *H2* is verified.

Table 6. Results of the impact of supply chain finance on financing constraints

VARIABLES	SA
SCF	−0.216**
	(−2.58)
GR	−0.313***
	(−8.54)
CAR	−0.103***
	(−2.67)
CR	−0.147
	(−1.31)
GRO	0.005**
	(2.18)
TEN	0.241***
	(2.83)
AGE	−7.048***
	(−15.88)
Constant	−219.842***
	(−19.42)
Observations	690
Number of id	101
R−squared	0.761
Firm FE	YES
Year FE	YES

*Note: t-statistics in parentheses, *** p < 0.05,* p < 0.1.*

Table 7. Impact of supply chain finance and financing constraints on ROE

VARIABLES	ROE
SCF	0.404*
	(1.71)
SA	−0.893***
	(−7.62)
GR	−1.037***
	(−9.40)
CAR	0.324***
	(2.97)
CR	−0.541*
	(−1.73)
GRO	0.014**
	(2.09)
TEN	0.717***
	(2.99)
AGE	−7.528***
	(−5.04)
Constant	−210.838***
	(−5.17)
Observations	688
Number of id	101
R-squared	0.228
Firm FE	YES
Year FE	YES

*Note: t-statistics in parentheses, *** p < 0.01, ** p < 0.05,* p < 0.1.*

Table 7 shows the impact of supply chain finance and financing constraints on the economic performance of enterprises. The regression results analysis found that the supply chain finance indicators and financing constraint indicators are put into the model at the same time, and the regression coefficient of supply chain finance indicators on profitability indicators is significantly positive 0.404, and the regression coefficient of financing constraints indicators on profitability is significantly negative 0.893. This indicates that the supply chain finance can significantly enhance the profitability of agricultural companies, while the financing constraints will have an inhibiting effect on the profitability of agricultural companies, combined with the regression results in Table 6. This suggests that supply chain finance can reduce financing constraints, and by alleviating the degree of financing constraints it can in turn contribute to the level of profitability of agricultural companies.

In order to verify the existence of the mediation effect, which is the research hypothesis *H3* of this paper (the results are shown in Table 8), using the Sobel Test, there is still a strong mediation effect between supply chain finance and the performance of Chinese agricultural SMEs, and supply chain finance (SCF) can have an impact on the economic performance of Chinese agricultural SMEs by alleviating the problem of financing constraints (SA).

Table 8. Sobel test

VARIABLES	ROE
SCF	0.393**
	(2.252)
GR	−0.564***
	(−8.974)
CAR	0.216***
	(4.695)
CR	−0.282
	(−0.970)
GRO	0.0172**
	(2.494)

Table 8 (cont.). Sobel test

VARIABLES	ROE
TEN	0.107
	(1.266)
AGE	−1.484***
	(−4.651)
Constant	−53.09***
	(−3.986)
Observations	688
R-squared	0.168
Firm FE	YES
Year FE	YES

Note: t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9 shows that in the regression analysis after excluding extreme values, the regression coefficient of the supply chain finance index on return on net assets is 0.587, and the result passes the test of the 5% significance level. This means that after removing the effect of extreme values of supply chain finance, supply chain finance still makes a significant contribution to the economic performance of agricultural SMEs, which is consistent with the conclusion of the main regression results. This proves the robustness of the results of the regression analysis in this paper.

Table 9. Results of the empirical analysis between supply chain finance and economic performance after removing extreme values

VARIABLES	ROE
SCF	0.587**
	(2.38)
GR	−0.748***
	(−6.89)
CAR	0.416***
	(3.66)
CR	−0.407
	(−1.24)
GRO	0.010
	(1.35)
TEN	0.503**
	(2.02)
AGE	−1.212
	(−0.93)
Constant	−15.070
	(−0.45)
Observations	688
Number of id	101
R-squared	0.150
Firm FE	YES
Year FE	YES

Note: t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10 shows the results of the empirical analysis after using the return on total assets to measure the level of profitability, and the regression coefficient of the supply chain finance indicator on the return on total assets is found to be positive 5.164 through the empirical analysis, and the result passes the 1% significance level. This indicates that after using the return on total assets to replace the net asset collection rate, the supply chain finance index can still promote the profitability level of Chinese agricultural SMEs, which is consistent with the main regression results and proves that the conclusions obtained from the benchmark regression results of this paper are robust.

Table 10. Results of the empirical analysis after measuring economic performance using ROA

VARIABLES	ROA
SCF	5.164***
	(2.74)
GR	−4.791***
	(−5.76)
CAR	2.245**
	(2.56)
CR	−0.615
	(−0.25)
GRO	0.067
	(1.24)
TEN	0.186
	(0.09)
AGE	−11.676
	(−1.17)
Constant	183.953
	(0.71)
Observations	683
Number of id	100
R-squared	0.102
Firm FE	YES
Year FE	YES

Note: t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As shown by the results of Table 11, the empirical analysis of two sets of data, in which the regression results (1) reported the impact of the level of supply chain finance on the level of economic performance of non-state and state-owned agricultural SMEs, through regression analysis, it was found that the regression coefficient of the supply chain finance of non-state enterprises on the economic performance of the regression coefficient is significantly positive 0.665, and the results pass he 5% significance level test. This indicates that the supply chain finance of non-state enterprises can

make a significant contribution to economic performance. The regression result (2) reports that the supply chain finance indicators of state-owned enterprises do not have a significant effect on their economic performance.

Table 11. Results of supply chain financing on the economic performance of enterprises with different equity natures

VARIABLES	(1)ROE	(2)ROE
SCF	0.665**	−0.070
	(2.23)	(−0.23)
GEARINGRATIO	−0.890***	−0.375**
	(−6.82)	(−2.52)
CAR	0.521***	0.082
	(3.92)	(0.47)
CR	−1.743*	−0.135
	(−1.93)	(−0.68)
GRO	0.008	0.113***
	(1.08)	(2.72)
TEN	0.446	0.250
	(1.45)	(0.84)
AGE	−3.902*	0.399
	(−1.86)	(0.40)
Constant	33.687	−10.019
	(0.70)	(−0.31)
Observations	550	138
R-squared	0.169	0.273
Number of id	81	20
Firm FE	YES	YES
Year FE	YES	YES

Note: t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As shown in Table 12, the impact of supply chain finance on economic performance in regions with different levels of economic development is reported, and it mainly reports two sets of empirical analysis results, in which regression result (1) reports the impact of supply chain finance on economic performance of enterprises in developed regions; the regression coefficient of supply chain finance on economic performance is positive 1.324, and the result passes the 1% significance level test, which indicates that in agricultural SMEs of developed regions, supply chain finance can significantly contribute to their economic performance. The regression result (2) reports the effect of supply chain finance on the economic performance of agricultural enterprises in less developed regions, and the regression analysis reveals that the regression coefficient of supply chain finance on the economic performance of agricultural enterprises in less developed regions is not significant.

Table 12. Impact of supply chain finance on profitability in regions with different levels of economic development

VARIABLES	(1) ROE	(2) ROE
SCF	1.324***	−0.128
	(3.12)	(−0.57)
GR	−1.210***	−0.296***
	(−6.56)	(−2.92)
CAR	0.550***	0.327***
	(2.92)	(2.92)
CR	−2.289	−0.291
	(−1.50)	(−1.34)
GRO	−0.001	0.014**
	(−0.08)	(2.33)
TEN	0.723	0.513**
	(1.56)	(2.33)
AGE	−1.715	−0.854
	(−0.86)	(−0.61)
Constant	−21.716	−27.391
	(−0.37)	(−0.88)
Observations	358	330
R-squared	0.210	0.168
Number of id	52	49
Firm FE	YES	YES
Year FE	YES	YES

Note: t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As shown in Table 13, the regression results after solving the endogeneity problem using two-stage least squares (2SLS) indicate that supply chain finance still contributes significantly and positively to the economic performance of agricultural SMEs and is validated at the 1% significance level. This indicates that the findings of this paper after solving the endogeneity problem remain robust and that the positive impact of supply chain finance on the economic performance of agricultural-based enterprises is real and valid.

Table 13. Endogeneity test

VARIABLES	ROE
SCF	1.087***
	(4.29)
GR	−0.547***
	(−8.06)
CAR	0.187***
	(3.98)
CR	0.070
	(0.24)
GRO	0.015**
	(2.18)
TEN	0.039
	(0.45)

Table 13 (cont.). Endogeneity test

VARIABLES	ROE
AGE	−0.105
	(−0.46)
Constant	1.694
	(0.18)
Observations	688
R-squared	0.121
Firm FE	YES
Year FE	YES

Note: t-statistics in parentheses, *** *p* < 0.01, ** *p* < 0.05, * *p* < 0.1.

4. DISCUSSION

Based on the panel data of agricultural enterprises in the Chinese National Equities Exchange and Quotations (NEEQ) from 2011 to 2022, this paper first verifies that supply chain finance can significantly improve the profitability of enterprises. In the process of regression analysis, individual fixed effects and time effects of agricultural SMEs are controlled. The results of the empirical analyses show that supply chain finance indicators have a significant positive impact on the economic performance (ROE) of agricultural SMEs. This clearly supports the works of Sachin and Rajesh (2022), Guo and Wu (2022), and Gambelli et al. (2021).

Another finding of this paper shows that supply chain finance (SCF) and financing constraints (SA) show a significant negative relationship. This implies that as the intensity of supply chain finance increases, the level of financing constraints of agricultural SMEs decreases. Supply chain financing, as an emerging form of financing, provides agricultural SMEs with more diversified financing channels. It helps to reduce the reliance of enterprises on traditional financing, thus alleviating financing constraints. Supply chain financing is usually able to provide a more convenient and flexible form of financing, and its financing cost may be lower compared to traditional financing tools. This helps to reduce the financing pressure on enterprises and reduces the degree of financing constraints. Supply chain financing is usually closer to the actual business, based on the trade and supply chain relationships of enterprises. This approach may provide more flexible financing terms and have a positive impact on firms' financial con-

straints. The finding of this negative correlation implies that supply chain financing, as a new type of financing instrument, is expected to help agricultural SMEs reduce their financing constraints, improve the availability of funds, and reduce financing costs. This is crucial for the development and economic growth of agricultural SMEs. This view is consistent with Zhu and Yang (2019), Yan and Liang (2022), and Luo and Chen (2023).

By analyzing the control variables, it is found that the gearing ratio and current asset ratio have a significant negative impact on financing constraints, which implies that the higher the firm's gearing ratio and the lower the current asset ratio, the correspondingly the degree of financial constraints increases. This is in line with Myers and Majluf's (1984) theory of financial robustness, which suggests that a firm's high debt ratio or insufficient liquid assets may limit its ability to raise finance. Firm growth capacity (gro), although statistically significant, has a smaller effect, which may indicate that the growth rate of operating income is not a major factor in financing constraints. In addition, firm age may affect financing constraints, with younger firms facing greater financing constraints, while mature firms are more likely to have access to financing support. This is because they are relatively less able to raise finance due to their lower visibility and credibility in the market. On the contrary, mature firms usually have more access to finance and better credit records and can obtain financing support more easily, thus alleviating the financing constraint problem. These factors have an impact on the financing constraint status of firms, which in turn affects the regression results. The study's view is consistent with Drakos and Kallandranis (2005). Equity concentration is significantly positively related to financing constraints, implying that firms with higher equity concentration have easier access to financing and mitigate the financing constraint problem. This finding contrasts with the results of Wilson et al. (2019).

The impact of supply chain finance on the performance of non-state-owned agricultural SMEs is significant, while state-owned ones are not significant. This is because different types of agricultural SMEs have different strategies and preferences in supply chain finance. Non-state-owned

enterprises are usually more market-oriented and flexible and are more willing to use supply chain finance to optimize their capital flow and financing structure. They are more active in seeking supply chain financial services to meet the financial needs of their production and operation and to improve their economic performance. In contrast, state-owned enterprises may rely more on government support and traditional financing channels and make less use of supply chain finance, so the impact on their economic performance is more limited.

Agricultural-based firms in developed regions usually benefit from a significant boost from supply chain finance, while in less economically developed regions, the impact of supply chain finance on their economic performance is not significant. Developed regions have more mature and perfect financial systems and markets, thus it is easier to adapt and accept the model of supply chain finance and achieve more obvious economic benefits. On the contrary, in less developed regions, the financial infrastructure may not be sufficiently robust, and thus supply chain finance may face more challenges, and its impact on economic performance thus becomes less significant.

These differences stem from a combination of factors such as differences in the Chinese level of economic development, the adaptability of supply chain finance, and the industry structure and competitive environment. Studying and deeply analyzing the impact of these factors can help to better understand the mechanism of supply chain finance on the economic performance of agricultural-based enterprises and provide a reference basis for the formulation of targeted policies and strategies.

CONCLUSION

The efficiency and sustainability of agricultural SMEs have become one of the global concerns with the increasing global demand for food and the challenge of limited resources. This paper examines the impact of supply chain finance on the economic performance of agricultural SMEs. The study confirms a significant positive relationship between supply chain finance and non-state-owned agricultural SMEs in China. Supply chain finance can alleviate the financing constraints of agricultural SMEs and improve the overall performance level. The study also reveals a significant association between the economic performance of agricultural SMEs and several control variables. Gearing ratios show a negative impact, with high gearing increasing the pressure on firms to service their debts and hindering their growth. On the contrary, higher liquidity ratios positively affect economic performance by providing better financial reserves that help to cope with uncertainties and emergencies. In addition, higher equity concentration positively affects performance by reflecting more effective strategic decision making and resource allocation, which helps to enhance firms' economic performance. However, this study is conducted based on the financial data of agricultural SMEs in the Chinese National Equities Exchange and Quotations, while firms not in the system are excluded from the analysis. In addition, this study focuses on financial indicators and does not consider other factors (e.g., market dynamics, technological advances, or socio-economic factors) that may also affect the performance of agricultural SMEs.

The findings of this paper have important implications and insights for stakeholders. Agricultural SMEs should establish a good brand image and strengthen supply chain management to enhance their comprehensive competitiveness and financing capability. Financial institutions should innovate financial products and optimize supply chain financing tools to provide more flexible financing support. The government should formulate policy support to increase financial coverage and regulation to promote the sound development of agricultural modernization and supply chain finance. In conclusion, this study introduces a key question that helps to fill the gap regarding the relationship between supply chain finance and agricultural SME performance. Through in-depth analyses, this study expects to provide policy and practice recommendations for China and the international community on how to support the development of this key economic sector.

AUTHOR CONTRIBUTIONS

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Formal analysis: Chonlavit Sutunyarak.
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