Alleviating Effect of Supply Chain Finance on Financing Constraints of SMEs—— Empirical Analysis Based on 74 Manufacturing Samples

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Abstract. Based on the relevant literature, this paper makes an empirical study of the data of SMEs in the API manufacturing industry in China by using the cash-cash flow sensitivity model. By analyzing the experimental results, it is concluded that financing constraints generally plague SMEs in the API manufacturing industry. Supply chain finance can alleviate the financing constraints of manufacturing SMEs to a certain extent. This paper aims to enrich the research results in the field of supply chain finance, which has a specific guiding significance for developing supply chain finance theory and practice.

Keywords: Green supply chain, Supply chain finance, Financing constraints, Traditional manufacturing industry, High-end manufacturing.

1. Introduction

1.1. Research background

In recent years, manufacturing SMEs have become essential to China's economy. However, due to weak management ability and other reasons, the financing constraints faced by SMEs are becoming increasingly serious. With the development of supply chain finance, how to use this method scientifically to avoid the problems existing in enterprise operations has increasingly become the focus of attention.

1.2. Research significance

Theoretical significance: This paper theoretically analyzes how supply chain finance can alleviate API-listed companies' financing constraints in the manufacturing industry and refines its impact through empirical analysis. The research results can enrich the related research of supply chain finance theory and provide theoretical guidance for the financing constraints faced by API-listed companies. Moreover, it also can promote the transformation and upgrading of these enterprises.

Realistic significance: Under the background of the rapid development of new industries, the loans from banks to traditional manufacturing industries are decreasing yearly, and it is challenging for manufacturing enterprises to raise funds. The research of this paper helps solve the financing difficulties and expensive problems faced by SMEs, improve the financing efficiency of enterprises, and promote the development of the API industry and even the manufacturing industry.

1.3. Research innovation

(1) Recently, the research on supply chain finance mainly focuses on assessing the risks involved in its operation, while the research on the actual function test of supply chain finance is much less. In the empirical research on the role of supply chain finance in financing constraints, the researchers mainly use the sample analysis of listed companies as a whole and rarely explore the impact of supply chain finance on financing constraints of a specific industry, especially the API industry. Therefore, this paper selects API-listed companies in China's manufacturing industry as research samples and explores the effect of supply chain finance on financing constraints of sub-sectors by adopting the

ideas from theoretical research to empirical analysis to policy suggestions, which is of great significance to guide the optimization of financing channels of industries.

(2) In the quantitative analysis of the constraint effect of supply chain finance on financing, the researchers mainly select financial indicators such as accounts receivable for analysis. By constructing a concrete model, this paper verifies the practical utility of supply chain finance in financing constraints of API-listed companies in China, which is quite different from before.

2. Literature review

2.1. Definition of Supply Chain Finance and SMEs

Timme (2000) [1] and other scholars conceptualized supply chain finance for the first time. They believed that supply chain finance is a way to organically link finance and supply chain management to achieve the financing of organizations and enterprises. With supply chain finance becoming more mature and constantly adapting to economic and social development, some scholars have also explained the connotation of supply chain finance from the perspective of supply chain management. Geldomino (2016) [2] and others explained the definition of supply chain finance from two aspects: "financial-oriented" and "supply-chain oriented". The "supply chain oriented" view believes that supply chain finance is a way to optimize working capital through supply chain management.

SMEs are enterprises with larger production scales than micro-enterprises, that is, enterprises with a high concentration of labour force, labour means, labour objects and products, which play a critical role in the national economy.

2.2. Supply Chain Finance's Financing Constraints on SMEs

Supply chain finance plays an important role in easing the financing constraints of SMEs in three aspects.

(1) The impact of supply chain finance on enterprise information transparency

First, the third-party logistics cooperation of banks in the supply chain mode has changed the mortgage mode of fixed assets in the traditional mode. Under the new mode, banks can get a general understanding of enterprises and make the best decisions at the fastest speed. Secondly, the core enterprises in the supply chain system can get a lot of important information, which helps them selectively cooperate with banks and carry out multi-directional win-win. Finally, restricting enterprise behaviour with information reduces the overall risk of the supply chain. Sivestro, Lustrato (2014) [3] showed that the improvement in information transparency positively affected the prevention, control and governance of risks in the supply chain. After information transparency, the supply chain operation will be more stable.

(2) The impact of supply chain finance on the enterprise credit level

Part of the reason for the financing difficulties of small and medium-sized enterprises is the impact of the external environment. Barkat Ulah (2020) [4], from the perspective of empirical research, it is concluded that the constraints of the economic environment and institutions hinder the good operation of the money and capital markets. Therefore, the financing channels of small and medium-sized enterprises are severely restricted. Another part of reason is that small and medium-sized enterprises are not strong enough. Malhotra Mohini, Chen Yann (2007) [5] and others pointed out that small and medium-sized enterprises were usually more vulnerable to credit restrictions than other economic sectors. One of the reasons is that small and medium-sized enterprises are vulnerable and poorly managed. Under the supply chain financial model, enterprises should put money into ongoing projects after obtaining financing, and the profits of the projects are directly deposited into the bank account that provides funds for them as the guarantee of repayment. In addition, the bank should estimate its future profitability and possible risks according to the development strategy of the enterprise.

(3) The impact of supply chain finance on enterprise transaction costs

Combining the credit evaluation of banks' loans to financing enterprises and the information on logistics and warehousing, the credit evaluation of financing enterprises not only reduces the expenses

in the whole process but also makes it easier for core enterprises to make a correct judgment on whether to invest or finance. Additionally, the supply chain stipulates the use direction of enterprise funds, which forms a natural constraint on the behaviour of enterprises and reduces the risk of operation and default. Su and Lu (2015) [6] believe that supply chain finance reduces the overall credit risk of the supply chain through trade transactions.

2.3. Literature review

Based on the literature review and understanding, this paper forms a scientific cognition of supply chain finance, financing constraints of SMEs, and their relationship combs the financing constraints channels of supply chain finance to SMEs and verifies the actual role of supply chain finance in financing constraints of API listed companies in China's manufacturing industry through literature analysis and empirical analysis.

In the existing literature, there is little discussion on the actual function test of supply chain finance, and there is little research on the impact of supply chain finance on the financing constraints of a particular industry from the perspective of industry segmentation. Therefore, with the help of the valuable research results of domestic and foreign scholars in supply chain finance, this paper explores the effect of supply chain finance on the financing constraints of sub-industries.

3. Data source, model setting and descriptive statistics

3.1. Data sources

This paper is used the cash-cash flow model to test the listed SMEs whose main business is API, and the empirical results are compared and analyzed. The annual data of 74 manufacturing enterprises whose main business is API from 2013 to 2020 are selected as sample data for empirical tests. All the data used are from the China Commercial Industry Research Institute database.

3.2. Model settings

This paper adopts the research method of Almeida (2004) [7] and refers to the practices of other scholars. It measures the development level of supply chain finance with the supply chain financial index/current GDP and replaces the growth of enterprises with the growth rate of main business income to avoid the influence of Tobin Q measurement error. The specific model is as follows:

$$\Delta CASH_{i,t} = a_0 + a_1 \times CF_{i,t} + a_2 \times SCF_t * CF_{i,t} + a_3 \times SCF_t + a_4 \times SIZE_{i,t} + a_5 \times \Delta STD_{i,t} + a_6 \times \Delta NWC_{i,t} + a_7 \times GROW_{i,t} + a_8 \times EXPAND_{i,t} + \eta_i + \xi_{i,t}$$

As shown in Table.1. for the definition of variables in the formula. η_i is the individual effect of the enterprise; $\xi_{i,t}$ represents random error. Because the cash flow generated by operating activities is continuous and stable, it is more suitable to represent the cash flow owned by enterprises in the operating process than other indicators. Therefore, this paper is selected the net cash flow generated by operating activities as an indicator to measure the financing constraint degree of capital-intensive SMEs. The following inferences can be made from proposition 1 and proposition 2: A1 > 0, A2 < 0.

Table 1. Names and definitions of variables in the supply chain financial model

	Variable	Definition
Explained variable	Δ CASH $_{i,t}$	Changes in cash and cash equivalents = Changes in monetary funds / Total assets of the current period
Explanatory variable	CF $_{i,t}$	Cash flow = Net cash flow generated by current operating activities
	SCF	SCF_1 = The number of short-term loans in China / The gross domestic product of the current period
	SCF $_t$*CF $_{i,t}$	The multiplication term of supply chain financial development index and cash flow: Indicates the effect of supply chain finance on easing financing constraints
Control variable	SIZE $_{i,t}$	Natural logarithm of total assets in the current period
	STD $_{i,t}$	Short-term loan = Current liabilities / Total assets of the current period
	Δ STD $_{i,t}$	Changes in short-term loans
	NWC $_{i,t}$	Non-cash operating capital = (current assets-current liabilities-monetary funds) / Total assets of the current period
	Δ NWC $_{i,t}$	Changes in non-cash working capital
	GROW $_{i,t}$	The growth rate of main business income
	EXPEND $_{i,t}$	Capital expenditure / Total assets of the current period

3.3. Descriptive statistics of research variables

Table.2. is a descriptive sample of the main variables in the model. There are apparent differences in the change of cash holdings(Δ CASH)of enterprises. The minimum value is only -0.503, and the maximum value is 1.622, which reflects the different financing constraints faced by different enterprises, leaving room for future cash management. On the other hand, the maximum operating cash flow(CF $_{i,t}$) of an enterprise in the current period is 521,700, which is quite different from the minimum value of -44,700. The standard deviation is 46,394.084, which indicates that the cash flow of an enterprise is relatively different. Compared with other enterprise characteristic variables, the relative difference in growth capability is small, with a maximum value of 8.319 and the minimum value of -0.842. It is indicated that different enterprises have different growth capabilities and different investment decisions. There is little difference between the maximum values of enterprise capital expenditure(EXPEND), non-cash working capital change(ΔNWC)and enterprise short-term loan change(ΔSTD), showing a relatively stable state of change. The standard deviations of all variables are in a reasonable range, indicating that the model is not affected by extreme values.

Table 2. Statistical description of financial variables in the manufacturing supply chain (minimum, maximum, mean, standard deviation, skewness, kurtosis)

Variable	Observed value	Average value	Standard deviation	Minimum value	Maximum value	Skewness	Kurtosis
cash	592	0.042	0.154	-0.503	1.622	4.635	41.854
cf	592	20907.57	46394.084	-44700	521700	5.635	49.341
scf	592	5.535	0.163	5.319	5.784	0.214	1.624
size	592	11.532	1.595	7.86	15.603	-0.021	2.3
std	518	-0.018	0.098	-0.564	0.32	-0.629	6.44
nwc	518	0.015	0.183	-1.763	1.91	1.268	45.745
grow	569	0.16	0.355	-0.842	6.061	8.319	135.768
expend	592	0.088	0.106	0	1.581	6.751	78.217

4. Empirical Analysis of Supply Chain Finance's Mitigation Effect on SME Financing

4.1. Test the fixed effect/random effect-fixed effect model

According to the regression results in Table.3., it is not difficult to find that the cash flow coefficients of these two industries in each regression are greater than 0, and both are significant at the level of 1%, which indicates that the cash-cash flow sensitivity of capital-intensive SMEs in China is significant, which supports proposition 1.

The coefficients of cross-term SCF*CF are all less than 0 and significant at a 1% significance level, which shows that with the development of supply chain finance, the financing constraints faced by capital-intensive SMEs are gradually weakening, which supports proposition 2.

By analyzing the regression results of the supply chain finance development level indicators, it is not difficult to find that short-term loans have a noticeable alleviation effect on API manufacturing industry financing constraints, which is consistent with the development reality of supply chain finance in China. Although the domestic supply chain finance business is huge, it contains many credit businesses based on the guarantee of core enterprises, and the financing dilemma of SMEs has not been fundamentally solved. The supply chain finance development time in China is still short, with broad development prospects in capital-intensive industries.

Table 3. Mitigation effect of supply chain finance on SME financing

		Explained variable			
		(1)	(3)	(5)	(6)
	Variable	Cash	Cash	Cash	Cash
Explanatory variable	cf	0.004** (2.03)	0.005* (1.90)	0.005* (1.77)	0.005* (1.82)
	scf*cf	0001 (0.62)	-0.004 (-0.83)	-0.003 (-0.66)	-0.003 (-0.73)
	scf	509.698 (1.44)	1,792.238*** (4.41)	1,767.579*** (4.38)	1,822.577*** (4.55)
Control variable	size		801.773*** (4.86)	794.195*** (4.84)	797.489*** (4.90)
	std		-716.435 (-1.31)	-1,733.980*** (-2.67)	-1,642.028** (-2.55)
	nwc			-945.516*** (-2.84)	-955.069*** (-2.89)
	grow			-13.407 (-0.09)	-44.255 (-0.31)
	expend				-2,502.178*** (-2.97)
	Constant	-2,504.495 (-1.27)	-18,979.320*** (-4.99)	-18,752.114*** (-4.96)	-18,879.739*** (-5.04)
	R-squared	0.010	0.075	0.092	0.110
	F-test	6.708	6.708	6.708	6.708

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

4.2. The robustness test of supply chain finance's mitigation effect on SME financing

In this paper, the mixed regression model is used to re-estimate the benchmark model and the extended model. The regression results are shown in Table.4., and the robustness test results have not changed significantly. The coefficient before the operating cash flow(CF)of enterprises in model 1 is 0.004>0, which is significant at a 1% significant level, indicating that financing constraints generally exist in SMEs in the API manufacturing industry, and proposition one is established.

In model(2), the cross-product(CF*SCF)coefficient of cash flow and development indicators of supply chain finance is -0.005<0, and it is significant at a 5% significance level, which fully shows that supply chain finance can indeed alleviate the financing constraints faced by manufacturing SMEs. Proposition 2 is established, and the conclusion of the robustness test is consistent with the above regression results. Therefore, the assumptions and conclusions put forward in this paper are convincing.

Table 4. Robustness test of supply chain finance on financing mitigation effect of SMEs (mixed regression (column 1), random effect (column 2), fixed effect and robust standard error (column 3))

		(1)	(2)	(3)
		a	b	c
	Variable	Cash	Cash	Cash
Explanatory variable	cf	0.004* (1.93)	0.005** (2.00)	0.005** (2.46)
	scf*cf	-0.005 (-0.91)	-0.005 (-1.06)	-0.003 (-1.59)
	scf	294.982 (0.82)	366.110 (1.13)	1,822.577*** (3.48)
Explained variable	size	-58.046 (-1.16)	-29.111 (-0.45)	797.489*** (3.27)
	std	-824.795 (-1.11)	-1,269.864* (-1.89)	-1,642.028 (-1.25)
	nwc	-412.077 (-1.05)	-763.095** (-2.20)	-955.069 (-0.94)
	grow	131.907 (0.80)	65.288 (0.44)	-44.255 (-0.45)
	expend	1,088.441 (1.47)	-449.026 (-0.58)	-2,502.178*** (-4.70)
	Constant	-769.094 (-0.36)	-1,371.061 (-0.65)	-18,879.739*** (-3.35)

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

4.3. Heterogeneity Analysis of Supply Chain Finance's Mitigation Effect on SME Financing

The third and fourth columns of Table.5 show the heterogeneity analysis results according to the total assets level. The results are shown that the correlation coefficients between cash flow and cash holdings of enterprises with high and low total assets are 0.003 and 0.058, respectively, and the data for enterprises with high total assets is significant at 10%. Meanwhile, this paper tests the significance of the difference in model coefficients, and the results show that the difference between the two groups of coefficients is significant and can be compared. Therefore, SMEs with high and low total assets are subject to financing constraints, and enterprises with high total assets have a more significant response to financing constraints, while the development of supply chain finance and the entry of financing play a more significant role in breaking the financing dilemma of enterprises with high total assets.

Table 5. Differences of mitigation effects of leading industries with high total assets and industries with fewer assets on financing constraints of SMEs

		High total assets	Low total assets
		(1)	(2)
	Variable	Cash	Cash
Explanatory variable	cf	0.003* (1.70)	0.058 (1.59)
	scf*cf	0.000 (0.05)	-0.011 (-0.12)
	scf	1,403.371*** (3.62)	2,262.885*** (3.05)
Explained variable	size	601.706*** (3.08)	935.706*** (3.27)
	std	-5,522.981*** (-5.85)	-589.751 (-0.61)
	nwc	-5,191.258*** (-7.01)	-281.879 (-0.65)
	grow	-308.853 (-1.24)	61.283 (0.32)
	expend	-5,280.229*** (-3.69)	-2,064.804* (-1.82)

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

5. Research conclusions and policy implications

5.1. Research conclusion

From the perspective of cash-cash flow sensitivity, this paper selects the relevant data of 74 manufacturing enterprises from 2013 to 2020, empirically measures the financing constraints of Chinese manufacturing SMEs by establishing a model, and analyzes the role of supply chain finance in alleviating the financing constraints of Chinese SMEs. Furthermore, the heterogeneity analysis of the mitigation effect of supply chain finance on the financing of SMEs is carried out to verify the degree to which enterprises with different asset sizes are constrained by supply chain financing. Through the analysis of the empirical results, the following conclusions can be drawn:

(1) China's manufacturing SMEs do have financing constraints.

(2) Supply chain finance can alleviate the financing constraints of enterprises.

(3) Enterprises with different asset sizes are affected by the supply chain's financing constraints to different degrees, and enterprises with higher total assets are more likely to be trapped in financing constraints.

5.2. Policy enlightenment

Conclusion Based on the current overall economic environment and macro policies, this paper puts forward the following suggestions:

(1) SMEs should take adequate measures to optimize the financing structure and open up financing channels to alleviate the problem of insufficient funds directly. In addition, enterprises should constantly improve the internal management level and the governance structure. It is focused on improving the overall quality of personnel and keeping vitality in the competitive environment. By standardizing their behaviour, enterprises can avoid information transmission distortion caused by irregular behaviour and alleviate the financing constraints caused by the asymmetry of internal and external information of the company Morellec, Schurhoff (2011) [8].

(2) Through empirical research, it can be seen that SMEs with high total assets have a more significant response to financing constraints. The more stable the cooperation between SMEs in the supply chain, the more significant the mitigation effect of supply chain finance. Therefore, SMEs with high total assets should strengthen cooperation with enterprises in the supply chain and improve cooperative relations management. Besides, they should also provide the foundation for stable cooperation with real business contacts to promote business development and meet their financing needs.

(3) The government and financial institutions should actively encourage and promote the development of small and medium-sized enterprises. It can be improved the external financial level and then positively impact corporate financing Khurana (2006) [9]. On the government side, the government should encourage enterprises to change their management concepts and give preferential taxation policies to promote enterprises' development. In terms of financial institutions, financial institutions can actively expand product types and strengthen service innovation. Through an in-depth understanding of the characteristics of the industry and the business nature of SMEs, it takes targeted risk prevention measures and masters the transactions in the supply chain to truly meet the financing needs of SMEs.

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